The Role of Everyday Sounds in Advanced Dementia Care

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ABSTRACT
The representation of sounds derived from everyday life can be beneficial for people with dementia by evoking memories and emotional responses. Despite this potential, integrating sound and sound-based interventions in care facilities has not received much research attention. In this paper, we present the findings from a field study that explored the responses of 19 people with advanced dementia to a selection of everyday sounds presented to them in a care home and the role of these responses in the care environment. To study this, we deployed Vita, a ‘pillow-like’ sound player, in two dementia care facilities for four weeks, during which observations were recorded. Afterwards, we conducted interviews with caregivers who used Vita in everyday care practice. Our findings reveal how everyday sounds provided by Vita stimulated meaningful conversation, playfulness, and connection between residents and caregivers. Furthermore, we propose design implications for integrating everyday sounds in dementia care.

Author Keywords
Care home; dementia; design; everyday sounds; soundscapes.

CSS Concepts
• Human-centered computing—Empirical studies in HCI

INTRODUCTION
As the global population is aging, the number of people living with dementia is increasing rapidly [61]. Unfortunately, there is currently no cure for dementia, and none is anticipated in the near future [20]. Non-pharmacological approaches are therefore being explored as alternatives to address the needs and wellbeing of people living with dementia. For example, music has been found to be beneficial for people with dementia, as it stimulates reminiscence [3], physical movement [49], and social interactions [58]. In addition, researchers in the field of HCI have been exploring the role of technology and design in adding value to the lived experiences of people with dementia and improving their quality of life [46,57]. This is why we see research bringing together music, technology, and dementia in exploring the role of technology in music therapy sessions, during which people with dementia play instruments or listen to music from their past [41,48,58].

However, in everyday life, people are impacted by many sounds other than music [63]. These everyday sounds support us in our day-to-day functioning by providing information about our surroundings [5], cueing behavior, and signaling required responses [25]. Our previous research [40] has shown how sounds selected from everyday life and represented for people with dementia can provide meaningful engagement and pleasurable experiences by evoking memories and emotions linked to past experiences. Furthermore, everyday sounds can offer cues for enjoyable social interactions between people with dementia and their extended care network [58,67].

While existing research [23,51,67] acknowledges the beneficial effects of sound for people with dementia, researchers have yet to effectively explore the integration of sound-based interventions in dementia care homes. This raises questions and reveals a gap in knowledge about how the beneficial effects of everyday sounds can be leveraged in care practice. For example, can exposing people with dementia to everyday sounds in daily care routines be beneficial against the backdrop of existing environmental noise. More insight is needed into whether sound can add...
value to the everyday life of people in the advanced stages of dementia living in long-term dementia care homes, and, if so, how sound interventions can be implemented in such environments.

This paper presents the findings of a field study in which we deployed a sound-based intervention named Vita, a ‘pillow-like’ sound player (see Figure 1) in a day-to-day care context. More specifically, we explored 1) the responses of people with advanced dementia to everyday sounds facilitated by Vita in a care home, and 2) the relevance of these responses in the care environment and care practice. Prior to the field study, we organized introductory sessions where professional caregivers were introduced to Vita and reflected together on potential use-cases in dementia care homes to understand where and when it could be used. We then deployed three Vita devices in two care homes, each for four weeks during which 16 professional caregivers and 19 people with advanced dementia were invited to use the device. To gather data, the main researcher was present and conducted active and passive observations [26] on the residents’ responses and interactions with Vita. Finally, the main researcher held exit interviews with the professional caregivers which offered additional insights into how Vita was used in everyday care practice when the researcher was not present. A thematic analysis of the field notes and the transcriptions of the exit interviews revealed how everyday sounds facilitated by Vita stimulated meaningful conversations, playfulness and curiosity, and connection with caregivers. Furthermore, based on how Vita was used in existing care routines, we propose design implications for the implementation of sound-based interventions in care homes, for example, how sound offers a new tool for caregivers to facilitate meaningful experiences and how it can be situated in various contexts.

RELATED WORK

Advanced Dementia and HCI

People in advanced stages of dementia experience symptoms such as severe memory loss, disorientation, stress, and agitation [54]. Furthermore, the progression of dementia in many cases results in aphasia, as people with dementia have difficulties with speaking or verbally expressing themselves [19]. As a result, people with dementia are often stigmatized as ‘sufferers’ and identified by these symptoms [45]. Current views on dementia have adopted a more inclusive approach, by looking at the potential and abilities of people with dementia [27] who, like everyone else, have values, beliefs, emotions, and a need for social interaction [45]. These views are based on care philosophies such as ‘person-centered care’ [14] which foregrounds the individual experience of the person with dementia in care practice [43]. People with dementia need to be recognized and acknowledged for their verbal and tacit forms of expression and supported in their sense of belonging and social membership [46]. Technology can include this perspective and reinforce a sense of self [10]. Its use in dementia care can therefore offer a sense of agency and support social connections between residents and their caregivers [30].

Recent research and developments in HCI and design have acknowledged these inclusive and socially just perspectives in dementia [46,65]. This research aims to address the daily lived experiences of people with dementia and explore how design can enrich everyday life in care settings [57]. This strand of research has resulted in various multi-sensory technologies for people with dementia designed to enrich their everyday lives [28,39,40,58,68]. For instance, tailored virtual reality experiences offer new worlds that can be shared between caregivers and people with dementia [39] and interactive installations that combine multiple modalities, such as vision, sound, and touch [28]. In this paper, we build further on pre-existing work [30,39,40,46,58] within the context of HCI and dementia by exploring the value of everyday sounds in adding quality to the daily lives of people with advanced dementia living in residential care homes.

Everyday Sounds in Dementia Care

The impact of music in dementia care has been extensively studied [4,33,56,58,62,68], while the full potential of everyday sounds has yet to be demonstrated. This gap exists despite research in HCI demonstrating how sounds from everyday life evoke memories [7,31] and how people value familiar sounds that have positive associations linked to loved ones or meaningful events in their lives [52,60]. Everyday sounds that are perceived as pleasant and enjoyable can induce positive emotions [66], resulting in beneficial effects for physical and cognitive wellbeing [1].

For these reasons, researchers have begun to explore the responses of people with dementia to everyday sounds. Initial research with people with cognitive disabilities in general [8,9] has shown how sounds that were perceived as pleasant or enjoyable resulted in observed behavioral and emotional changes [9]. For example, therapy sessions involving listening to calming sounds can reduce stress and agitation for people with dementia [17]. Similarly, researchers have been exploring opportunities for administering playlists of everyday sounds in private rooms and public spaces of dementia care facilities to reduce anxiety and improve sleeping patterns [23,51]. However, people with dementia cannot be viewed as a homogenous group [46], as the experience of dementia differs for every individual [43]. Sounds that evoke meaningful responses, such as memories or emotions, are highly personal, as people with dementia make associations through their own lived experiences [40].

In previous research, we illustrated how sounds from everyday life offered cues for exploring personal values, beliefs, past experiences, and emotions [40]. Research and practice are increasingly exploring how sound can be used as a tool for social connection in the care space [35], as it can foster social interactions between people with dementia and their caregivers through shared listening experiences [67].
While literature suggests opportunities for using sound in dementia care, there is limited work on how the positive effects of sound play out in day-to-day care practice [23,51]. The outcomes of our field study contribute to existing theories and practices in relation to dementia and sound by reporting on the personal responses to everyday sounds of people with advanced dementia situated within a care home.

**Design Interventions in Care Homes**

People with advanced dementia living in care homes often rely on professional caregivers to support them in everyday activities and provide personal care [53]. In addition, professional caregivers develop social relationships with residents [27]. This person-centered approach allows caregivers to meet the everyday needs of care residents in a dignified and respectful way [16]. Establishing and maintaining relationships are fundamental to self-identity and essential for recognizing ‘selfhood’ [27,44]. However, caregivers often lack sufficient resources, time, or tools for providing meaningful activities to facilitate and nurture social relationships due to the heavy workload involved in physical care tasks [10].

Within the field of HCI and design, there is an increasing amount of research on how design interventions can initiate and support social interactions and identity in people with advanced dementia in residential care homes [29,30,57,58]. Personal design probes in care homes have proven to be a valuable asset in exploring personal values and beliefs [71]. Personal design probes in care homes have proven to be a valuable asset in exploring personal values and beliefs [71]. Personal design probes in care homes have proven to be a valuable asset in exploring personal values and beliefs [71]. Personal design probes in care homes have proven to be a valuable asset in exploring personal values and beliefs [71]. Personal design probes in care homes have proven to be a valuable asset in exploring personal values and beliefs [71].

Ethnographic approaches have highlighted the importance of recognizing people with advanced dementia by acknowledging tacit forms of communication and regarding nonverbal responses and expressions as legitimate forms of agency [29,56,58]. Inclusive, accessible design interventions in care homes can stimulate agency for people in advanced stages of dementia and encourage social connection with caregivers and other residents [30]. By using Vita, we aim to capture the perspective of the residents in the care home [65] and offer a sense of agency when exploring everyday sounds.

**METHOD**

This paper reports on our field study in which we explored the in-context responses of people with advanced dementia to everyday sounds, facilitated by Vita, and the potential impact of these responses on existing care practice. We also involved the perspective of the professional caregivers to gain insight into how to integrate technology in dementia care [11] and how this technology fostered connections between residents and caregivers [69]. However, we do not consider caregivers as spokespersons or proxies for people with dementia [38], but as valuable stakeholders who offer their own perspectives and experience of dementia [50].

**Vita: Interactive Sound Cushion**

Vita (see Figure 1) is an interactive cushion that offers an interface specifically designed for people with dementia to provide them with direct access to sound [51,64]. By touching one of the six textile touchpads of Vita, users can play a sound fragment. An interface integrated into the reverse side of Vita (see Figure 2) allows professional caregivers to select personal sound sets for each resident, access general sound sets, and adjust the volume. By pressing the buttons, caregivers can ‘scroll’ through the various sound sets, while voice feedback indicates which set is selected. Vita is portable and can be used in various settings in a care home. Furthermore, the cushion blends in with the existing care space, which lowers the barrier for using it. For these reasons, we selected Vita as the vehicle for a sound-based intervention in our field study. Vita is still in development by the researchers and not on the market at the time of this study.

**General and Personal Sets of Everyday Sounds**

To study the role of sounds in care practice, Vita offered access to both personal and general sounds (see Figure 3). The two right-side touchpads (5-6) provided access to two personalized sounds for each resident in line with their preferences. These sounds were selected in consultation with the caregivers and family members, for example, a racing car sound was selected for a resident who was a sports car enthusiast. The other four touchpads (1-4) provided a general set of four everyday sounds. Caregivers could choose between four general sets, resulting in a collection of 16 different sounds. The general sets were selected to represent a broad array of everyday sounds and potential ways that they could be used in the care setting. These sets were based on a soundscape appraisal model [9] for rating sound in terms of pleasantness and arousal. We translated the four main

![Figure 2. The personal and general sound sets can be selected by pressing the buttons on the reverse side of Vita to go through the sets, with voice feedback indicating which set is selected.](image)

General sets
- **4 sets available, each consisting of 4 sounds**

Personal sets
- **2 personal sounds per resident**

![Figure 3. Vita provides access to general sets of four everyday sounds (e.g., Play) with touchpads 1 to 4 and to personal sets of sounds for each resident (e.g., Birds or Cycling) on touchpads 5 and 6.](image)
components on the ‘pleasant’ spectrum: active, interested, enjoying, and relaxed, respectively into the following sets: play, day out, listening and daydreaming (as shown in Figure 3). Sound set play consisted of short, dynamic sounds to trigger playful responses, e.g., a dog barking. The set day out consisted of sounds representing leisure activities, e.g., a bike ride. With listening, we provided calming domestic sounds, such as raindrops on a window. Finally, daydreaming offered soundscapes of picturesque landscapes, such as a campfire with chirping crickets. For each set, we collected four high-quality sound files that matched the overall description of the set from an online open-source database [74]. All personalized and general sounds were provided by the researchers and tested for sound quality on the built-in speaker of Vita.

Setting and Participants
The field study took place in two residential care homes, one located in the south (A) and one in the middle (B) of the Netherlands. Both facilities provided long-term care for people in an advanced stage of dementia. In total, 19 residents with advanced dementia took part in this study; 10 residents at location A [R1-10] and 9 residents at location B [R11-19]. The age of the residents varied between 70 and 97. Most residents were female, except R3, R10, and R19. Healthcare professionals of the care organizations recruited participants based on whether the resident: 1) was willing to participate; 2) was diagnosed with dementia caused by Alzheimer’s or vascular diseases; 3) was in advanced stage of dementia (indicated by the care organization); 4) lived permanently at the dementia care home; 5) had no severe difficulty with processing audio; 6) was able to physically interact with Vita.

Proxy consent was sought from the legally authorized representative (i.e., legal guardian) of each resident, such as a spouse, family member, or caregiver. Furthermore, the ability of residents to be included in this research was assessed by professional caregivers who are familiar with the residents. In addition to the residents, 16 professional caregivers were recruited, eight of whom worked at location A [C1-8] and eight at location B [C9-16]. The professional caregivers were also invited to attend an introductory session.

Ethics
This research was approved by the Ethics Review Board of Tilburg School of Social and Behavioral Sciences (ref: EC-2019.22) and was evaluated and debriefed at the Client Representation Board of the care organization. This study is part of the ‘Everyday Sounds of Dementia’ project, a multi-disciplinary collaboration between partners from care practice, health, and design. The main researcher conducting the in-context observations had previous experience in doing research with people with dementia and was supported by a project representative from the care organizations. As interaction sessions with Vita were organized as part of the daily activities and routines at the care home, the residents and the care staff at the facility did not need to allocate additional time to engage with Vita, as it served as a meaningful substitute for or addition to regularly scheduled care activities. The residents who did not consent were not introduced to Vita and excluded from data collection. However, on occasions people who had not given consent wanted to interact with Vita, caregivers were instructed not to refuse this interaction and naturally include everyone when using Vita to avoid potential negative responses. No data was gathered from non-consenting residents who used Vita and their responses were not discussed during the exit interviews. The professional caregivers involved in this study were familiar with the residents and were designated the task of overseeing the deployment of Vita in the care unit they worked in. Therefore, the researcher was always in communication with the care staff and they were always present during observation. The duty of care was always maintained with the care staff. Gaining informed consent was not a singular act, but a continuous dialogue [18,24] between the care staff, researcher, and residents. The care staff continually assessed participants’ involvement based on their in-context responses and by communicating with the researcher and participants directly. These measures provided a safe environment for the participant, researcher, and caregivers.

Study Procedure
This study consisted of: 1) introductory sessions for caregivers; 2) deployment of Vita in care homes; and 3) exit interviews with caregivers.

Introductory Sessions for Caregivers
Three introductory sessions were organized for approximately one hour each, with one session at location A and two at location B to fit the schedules of the caregivers. In total, 12 caregivers participated in the introductory sessions, while four [C7-8, 15-16] were not able to attend the session and were therefore provided with information by the researcher at the beginning of the deployment phase. The goal of these sessions was to increase the engagement of the caregivers within the study. First, the caregivers were asked to map a ‘typical day’ of the residents on a 24-hour cycle. Secondly, the caregivers discussed cards with statements from sound-related literature, e.g., ‘familiar sounds can

Figure 4. Vita was introduced in sessions during which the caregivers were encouraged to think about ways of using Vita in the care home.
and implicit forms of expression by residents with advanced phenomenological aspects of being within the care home. During the participatory observations, the connection offers the researcher insight into the value of tacit engagement with the participants and establishing a social and build a trust relationship with the residents and care staff. The researcher took field notes and made photographic documentation, and 3) audio of interviews with caregivers. In total, 23 sessions with Vita were observed over the course of 4 weeks on location A and 4 weeks on location B, with 9 days of observations on each location. The audio recordings of the 10 exit interviews with the caregivers were transcribed verbatim. Thematic analysis of the field notes and transcriptions was used inductively as research analysis steps [12]. Statements were classified using codes recording the responses of people with advanced dementia to Vita, and the social and physical contexts of these responses. New sub-codes were then developed, based on patterns and the reoccurrence of codes within each concept.

**RESULTS**

In this section, we discuss our analysis of the field notes combined with the transcriptions of the exit interviews.

**Cueing Meaningful Conversations**

Most residents [R1-4, 7-8, 10, 12, 14-16, 18-19] were able to recognize sounds triggered by Vita. Associations with these sounds formed the starting point of conversations between residents, caregivers, and the researcher who was present during the observations. More specifically, the sounds offered cues and potential conversation subjects for the caregiver to start a dialogue: “And based on those sounds, we started to ask questions, to get a conversation going” [C2]. For instance, after hearing Play_Dog, R19 began to talk about his pets, as described in the field notes:

R19 talks to me about his pets: “If the cat came in, it would go after [the dog] too.” C13 joins the conversation: “Are they not eating each other's food then?” R19 responds: “No, and [the dog] was colossal, he was too big for most people. I also had a cat, and two dachshunds, they would sometimes cuddle up and sleep together!”

Residents [R10, 15, 18-19] linked sounds to aspects of their personal life, which had emotional meaning to them, such as family and loved ones, house environment, and meaningful events. For instance, R18 made associations with going to the local football stadium to attend a soccer match of her favorite soccer team (this is facilitated by the care organization in partnership with the soccer team). This association was not linked to experiences from the past, but to an activity in her current life at the care home. She always took part in this activity and very much enjoyed it, so she wanted to share this experience:

After hearing Play_Cheering, R18 suddenly shouts ‘Yeah!’ and laughs to me [Researcher] and C15. “It’s just like when I go to support [her favorite soccer team].” R18 explains the activity: “Yes I have just been, yes, then we just sit together, women and men together, and then we see if we can get a good place” [...] C15 asks what they do when their favorite team scores. In response, R18 raises her arms in the air, starts waving and shouts “woohoo!”

Residents [R5, 7, 10, 15, 18-19] made associations with everyday sounds that were explicitly linked to experiences in the past. For R10, personal Racecars sounds evoked...
meaningful memories (see Figure 6). R10 is bedridden and individual care activities always take place in his private room on a daily basis. While talking is difficult for R10, the sounds served as cues for conversing with the caregiver, establishing a connection by exploring his past, and talking about his hobbies and interests. While listening to Racecars in conversation with C5, he talked about how he used to race on a well-known race circuit:

R10 touches and feels Vita, playing his Racecar and Porsche sounds. C5 asks: “Where can you hear those sounds?” “That is from the [city] racing circuit,” R10 says. C5 looks surprised and replies: “Did you ever go there to watch the races?” R10 immediately responded: “I’ve raced there!”

Figure 6. A resident talks about his past experiences as a race car driver while listening to Racecar sounds.

Engaging in Different Realities
Although residents [R4, 8, 15, 19] misheard sounds, it did not seem to matter that sounds were misinterpreted or misidentified. Guessing and sharing interpretations worked as a conversation starter, despite the associations being ‘incorrect’. The researcher and the caregiver did not correct the resident but further engaged in the interpretation during the conversation that followed:

Upon hearing the Listening_Footsteps sounds, R15 directs her left ear towards Vita and says: “I hear horses, I’m not doing anything wrong because I’ve told you before, I’m going to walk the horses with someone... Haha!”

Furthermore, R15 and R18 shared elaborate stories that seemed to mix elements of memories with situations and events in the present. They appeared to be in their own reality as they shared “inconsistent stories” [C8] or “stories you can’t make head nor tail of, but still whole stories.” [C14] For instance, upon hearing Play_Bubbles, R18 seemed to be telling a story from the past, when she suddenly mentions the researcher and Vita in the past tense, in a ‘memory’ in which she was telling her son about the current study:

C15 touches Vita and triggers Play_Bubbles. R18 imitates the sound: “Bloopbloopbloopbloopbloop! Haha! It’s like I’m at home... Then my youngest [child] came and would say: ‘Grandma, are you home yet? [...] I said ‘yes, I saw some beautiful things, a young man was here, and he had made a nice pillow, and then I looked at it!’”

These examples illustrate how conversations triggered by Vita offered opportunities for residents to share meaningful events and experiences, or a story that made sense to them, with caregivers in the care home setting.

Connecting Through Nonverbal Expressions
Residents in the late stages of dementia were not always capable of verbally responding to the sounds facilitated by Vita. However, nonverbal responses were also observed during the deployment. These nonverbal responses triggered by Vita were nonlinguistic forms of expression, which facilitated ways for the professional caregivers to (re)connect with people in an advanced stage of dementia.

Immersed in One’s Own Reality
Caregivers indicated how some of the residents are often immersed in their own worlds: “a bomb could explode, so to speak, and she wouldn’t have noticed. She’s so immersed in her own mind.” [C2] This disconnect with reality presents difficulties in connecting with residents with dementia, as verbal communication is no longer possible: “It is also difficult to communicate with her. You can't always understand what she means; maybe she understands it, but can't express it to me.” [C8] It was observed how several residents [R1-3, 8, 14] would mumble or quietly say something indistinctly, which was not understandable for either the researcher or the caregiver. For instance, during an individual care activity, R3 would start to mumble things after interacting with Vita. R3 was saying something incomprehensible, but appeared to make sense to him, as he was committed to telling his story:

Upon hearing Day Out_ChurchBells, R3 looks up and mumbles something unintelligible: “fai, fai, fai, fai…” [...] He starts to mutter a lot more than before, but it is not really understandable. C5 says: “He has a lot to say [...] , but I don't really know what it is....”

Figure 7. The residents explored Vita together with caregivers.

Connecting Through Sound
During the deployment, Vita was used in one-on-one care sessions during which caregivers aimed to (re-)establish a social connection with the residents. In this regard, Vita was seen as: “a kind of tool, the cushion, the embroidery, the sounds, a means to communicate in any way.” [C5] Exploring Vita and engaging with the different sounds was therefore a nonverbal approach for caregivers to connect with people in an advanced stage of dementia who were limited in verbal communication or unable to participate in a fully developed conversation. Reacting to the sounds became a form of expression and communication between the person
with dementia and the caregiver, even when the responses were not clear or understandable:

When R8 laughs in response to the Play_Cheering sound, the caregiver says “applause for you!” Several times, R8 gave the caregiver a kiss after looking at her. She also laughs with the Play_Dog sounds and seems to imitate it: “woof, woof!” She says to the caregiver: “I hug them like that.” After hearing the dog, the caregiver asked her what she had heard. R8 doesn’t reply, but spontaneously grabs the stuffed dog cushion that lies behind her.

**Touch and Proximity**

In addition to sound, our findings also report on meaningful responses relating to touch and proximity with caregivers. In many cases [R4, 8-9, 12-15, 17-19], the caregiver or researcher would take the hand of a resident and start exploring Vita (as shown in Figure 7). When interacting with Vita, R13 and R17 were hesitant in the beginning. Touch and physical connection were a way for the researcher and the caregivers to connect with the residents to establish and recognize the presence of the person. R17 was very introverted at the beginning of the session with Vita and did not react to Vita when it was presented in front of her, holding her arms close to her body. After a handshake with the researcher, she started to feel more at ease in the setting, and connected with the caregiver who was also present:

C15 asks R17 to put her hand on Vita. R17 shakes her head indicating ‘no’ to the caregiver and pulls her hand back to her chest. The caregiver plays some sounds, but she doesn’t react. She suddenly looks at me [researcher] and laughs, she takes my hand and starts shaking it. I shake it back, and then C15 lays her hand on Vita and plays Play_Dog: “Oh a dog!!” R17 now smiles at the caregiver and nods ‘yes’. The caregiver asks her: “Did you also have dogs at home in the past?” R17 looks at the caregiver and nods ‘yes’. She still holds one hand to her chest but was looking at C15 who was pulling silly faces such as looking amazed and smiling at her. R17 smiles back, leans towards the caregiver, and gives her a kiss on the cheek. “Oh sweetheart” says C15.

These observations reveal how everyday sounds provide opportunities to establish a new connection between caregivers and residents, who cannot verbally connect anymore by expressing associations with sounds through gestures, facial expressions, movement, and imitation.

**Curiosity and Playfulness in Care**

Engaging with Vita and everyday sounds evoked emotional and lively responses from residents, such as laughing or displaying increased forms of interest and focus.

**Agency and Discovery**

When presented with Vita, residents were prompted to explore the artefact by fiddling slightly with the embroidered patterns with their fingertips [R2-3, 14-15], feeling the edges of the cushion [R1-4, 7, 9-10, 14-15, 17-18] or drumming [R8-9, 14]. Residents were actively exploring the six touchpads with their hand in order to ‘guess’ and explore all the sounds that were hidden in the cushion [R2-6, 8, 10-11, 14-15, 18]. When doing so, they displayed increased interest and attention in response to exploring the different sounds [R3-4, 10, 14-15]. It was observed how several residents became very curious about Vita, as they found it peculiar that sounds emerged from inside a cushion [R4, 6, 15-16, 19]. However, this feeling of curiosity encouraged participants to further explore the sounds from Vita. For example, R4 concentrated on exploring all the different touchpads and tried to recognize each hidden sound:

R4 explores the touchpads again with her hand flat on Vita. Upon hearing DayOut_ChurchBells, she says: “I hear music!” She continues to explore and says, “It’s strange!”[...] R4 explores further and after a while asks: “how does such a dog get in a cushion?”

This discovery evoked several joyful responses, such as laughing and mimicking the sound out loud. As described above, R4 was very interested in exploring Vita. Upon hearing the Play_Cartoon sounds, she produced a strange noise which seemed to mimic the sound she heard:

*While playing the Play_Cartoon sounds, R4 turns to me and says: ‘That's mama!’ Again, she plays Play_Cartoon and turns back to me and looks surprised. While smiling, her eyes go back and forth, scanning the room. She looks at the pillow and makes the same sound again: “Mama... Papai!”*

Some residents were also startled by the sounds and pulled their hands back upon hearing something, or were insecure and worried they would “break” Vita [R5-6, 15, 18]. For instance, R15 eventually felt comfortable in exploring Vita; however, she first needed to be reassured that nothing could go wrong with the artefact:

*R15 moves her other hand away from Vita: “I won’t do this. Suppose it falls on the floor, then it’s my fault!” C15 and I [researcher] explain to her that she can’t do anything wrong and that she certainly cannot break the device. R15 further explains: “I don’t like things like that, I always lose.”*

**Pretending and Acting Playfully**

Most residents experienced a sense of excitement and playfulness while interacting with Vita and listening to the everyday sounds [R1, 3-4, 6-8, 10, 14-16, 18]. After making associations with the sounds, residents imagined that the thing or object that was making the sound was present in the space, or hidden inside Vita [R5, 10, 14-15]. These imaginations provided scope for playfulness and pretending, as the caregiver went along with the imagination of the residents, e.g., “There is a dog in the cushion!”, with residents [R4, 13] putting their ear to Vita to better hear the sound that was hidden inside. In this context, these responses were not seen as confusion as the participants’ remarks were not off-topic. These responses could be interpreted as jokes or playful remarks based on their appropriateness and timing. For instance, this playfulness was also observed during a session with R15 and the researcher, when R15 wanted to get the sound out of Vita:
Upon hearing Play_Cartoon, R15 looks surprised and says: “oh haha, a chicken...” Among the cartoon sounds, a fart sound is heard, and her eyes open wide: “oh!” I ask jokingly if it was her. She looks at me and clearly says no, then starts to laugh loudly: “No, I was shocked! Haha!” Then she hears her personal Cat sound, after which she imitates it: “woof, meow. I really want to get it out! So that they can walk here. How should I do that?” And she picks up Vita and looks at it: “Because that is possible, you know!”

Furthermore, the exploration of Vita offered cues for teasing and making jokes that were related to the sounds the residents were listening to. These playful interactions between caregivers, residents, and the researcher resulted in an enjoyable and informal atmosphere during everyday activities in the communal room:

C4 takes Vita from the couch and places it on the table where R4 and R5 are sitting, and first hands it to R4. They listen to the Play_Bubbles when the other caregiver starts joking: “Are you peeing in your pants?” “No, it’s the pillow!” says R4 while laughing. “That’s what they all say!” jokes the caregiver, and they laugh together.

Everyday sounds facilitated by Vita were able to stimulate curiosity, and the act of exploring and guessing sounds offered opportunities for playfulness, imagination, resulting in an informal and pleasant atmosphere in the residential care environment.

Role in Everyday Care
The thematic analysis gave insight into the various contexts Vita was used in, and how these influenced the interactions with Vita.

Scheduled Individual Sessions
Vita was used during scheduled individual care activities during which professional caregivers would socially engage with the residents: “I try to give someone a bit of daytime activity at their bed. Something the resident wants to hear and talk about.” [C5] These sessions took place in either an empty room or in the private room of the residents [R10, 14, 16]. Furthermore, these individual sessions were also used to activate the residents by letting them engage with various sensory stimuli: “then I try to stimulate or relax the senses.” [C5] Vita served as a means for facilitating these sessions: “And I often look for things that you can do with them, like with lights and sounds or something extra.” [C2]

In-between Moments in Everyday Care
Vita was also used during everyday care moments that were not scheduled care activities, but situations where one of the caregivers thought it might be useful. These spontaneous sessions mostly took place in the common living area. For instance, in between scheduled activities the residents were often bored, which would often lead to a general sense of unrest: “a bit of boredom, after lunch or dinner... they have nothing to do, and then they get bored and start watching each other and often irritate each other.” [C4] During these moments in between activities, residents would often remain seated in the common living space at the dining table. By using Vita, the caregivers aimed to provide a fun activity to stimulate positive interactions between the residents: “because otherwise you will irritate each other, and now it was more like ‘look how nice it is’ and ‘do you also want to try it’ and laugh together.” [C7] This resulted in a shared activity for relieving boredom, which also influenced the general atmosphere in the communal room. These interactions were also noticed by other residents, who became curious and wanted to see what was happening: “because of course we had a lot of fun at that table and then others looked at what we were doing, and I asked them if they wanted to sit with us, but then they said ‘no’, they just looked from a distance. And that resulted in general interest, which was also positive!” [C4]

Distractions in the Care Environment
The physical care space was a source of distraction for three residents [R14-15, 18]. For instance, R14 was at one point focusing on a picture of her family on the wall of her private room. Other sounds present in the space could confuse residents in thinking these sounds from another source originated from Vita. For example, R15 mistook the sound of the creaking door of the communal space as if it had been triggered by Vita: “A door that is closed by the wind?” [R15]. Other residents present in the communal space also represented forms of distraction, making it difficult for some residents to engage with Vita. For instance, R15 was interacting with Vita when a group of other residents came in the communal space and disrupted the setting:

... in the meantime, the other residents are returning from an activity. Suddenly there is a lot of noise and buzz and R15 is distracted as a result and no longer has attention for Vita and me. Two residents who come in are singing aloud to each other, and R15 says: “It’s all a bit much right now!”

Moments of Unrest
The exit interviews revealed how caregivers also tried using Vita in moments of unrest [C2-4, 7 13-14]. However, the caregivers indicated that residents [R1, 5, 14-15, 19] did not want to interact with Vita when they were feeling stressed or angry: “If she is super restless, you just can’t calm her down. Eventually, she calms down by herself, you can’t do interventions on that.” [C2] A similar situation was observed by the researcher during a group session in the communal space. One of the residents was stressed because she was waiting for her husband, and she was worried her husband might have forgotten her (see Figure 8). While other residents were sitting at the table and interacting with Vita, she stood up to find the exit to go home. When offered Vita, she did not display any interest in interacting with it:

R6 is interacting with Vita at the table together with R5, C4, and C9, but R5, who is sitting next to R6, looks a bit angry. R5 is stressed because her husband is still not here, she also does not want to take her medication because she doesn’t know why. [...] When R5 is asked to interact with Vita, she shows little interest and only touches it for a few seconds.
were willing and seeking acknowledgment. Both individual as in a group, and was found most useful in facilitating meaningful and social activity when the residents Our findings indicate how Vita was used in everyday care, her as she laughs, almost teasingly at the others at the table. She hears the Play_dog again. opens to play with the pillow. She agrees, and I put the pillow on and R5 is joining us at the table. I ask her if she also wants her eyes wide and quickly pulls her hand away from the pillow. “Is he going to bite?” she says jokingly and starts to laugh and shake her hand, pretending that the dog had bitten her as she laughs, almost teasingly at the others at the table.

Our findings indicate how Vita was used in everyday care, both individual as in a group, and was found most useful in facilitating meaningful and social activity when the residents were willing and seeking acknowledgment.

**DISCUSSION**

The results presented above provide insight into how the selection of everyday sounds represented through Vita cued meaningful conversations, facilitated nonverbal connection with the caregivers, and provided opportunities for curiosity and playfulness in the everyday context of dementia care. Furthermore, our findings identified how Vita was used both during scheduled activities in one-on-one sessions, and in spontaneous moments to relieve boredom and activate residents in between scheduled care activities. We further discuss these insights in relation to existing literature and outline implications for design to integrate sound-based interventions in long-term residential dementia care.

The everyday sounds facilitated by Vita were able to evoke associations in the form of verbal responses that served as a conversation starter. This cueing of conversation is similar to the use of media in reminiscence therapy [2,13,72]. However, in reminiscence sessions, media such as images or videos are used to prompt memories and responses from people in early to mid-stages of dementia. While these types of sessions often rely on visual stimuli [2,22,48], the results of this study provide examples of how everyday sounds can evoke similar responses *in-situ* that are specifically related to sound. In addition, we observed how sounds could be misheard or misinterpreted while still evoking meaningful associations, memories, or emotional responses. This mishearing of sounds can be attributed to the inherent quality of sound and how different listeners interpret audio signals differently [59] based on their current mind-state or past experiences [15]. For people with advanced dementia, this interpretative step offers an associative perspective to enable them to assign personal meaning to sound, without being confronted with an inability to identify or remember specific events, places, or people [2,34]. This is why the ambiguous character [32] of sound makes it a suitable modality for technologies in dementia to provide associative and open-ended cues for conversations and responses that do not need to be authenticated in terms of ‘truth’.

Initiating and facilitating conversation is key to nurturing relationships between caregivers and residents in a care home setting [22] as people, including those with advanced dementia, are social beings, actively seeking out and engaging in social interactions [43]. Our findings suggest that by facilitating everyday sounds, technologies for people with dementia can accommodate an enjoyable and informal atmosphere with room for teasing, pretending, and acting playfully. While existing research tends to focus on reminiscence [3,48,73], our findings indicate how exploring unfamiliar sounds can result in curiosity, which affords opportunities for discovery in an environment where meaningful experiences are considered scarce [57]. These playful interactions facilitated by Vita were able to create a general sense of inclusiveness and social belonging among the residents. Furthermore, Vita was also used during individual sessions in care spaces with fewer sources of distraction and stimuli from other residents. Therefore, sound-based interventions such as Vita can offer opportunities for shared explorations of sound, resulting in intimate interactions between the caregiver and the resident, both in verbal and nonverbal responses [45].

Our results illustrate how residents with less verbal communication capacity express their reactions to sound through bodily responses [47], such as smiling, laughing, closing or opening eyes, mumbling, or imitating sounds. By engaging and responding to these nonverbal responses, caregivers were able to establish a mutual nonverbal communication and connect with the residents. This use of Vita in the care homes reveals new opportunities for sound-based interventions to initiate embodied connections between caregivers and people in advanced stages of dementia. Furthermore, touch and proximity play a role in these interactions, as caregivers and residents often explore Vita together. This is similar to music sessions where a sense of intimacy and shared movements are key in providing social participation [58]. Sound-based interventions are therefore not necessarily replacements for current care activities, but they support, supplement, and provide new opportunities for social connectedness between residents and caregivers.
Implications for Design
We further outline implications for designing sound-based interventions in long-term residential dementia care.

Meaningful Experiences in Everyday Care
Researchers studying soundscapes in care environments [8,17,36] have explored the potential of sound to remediate perceived behavioral disorders [23], change mood [9], and reduce stress and agitation [36]. However, our findings indicate that caregivers hardly used Vita in cases where such behavior was actively observed, as initial attempts to reduce agitation with Vita were unsuccessful. These findings offer a different perspective to literature [4,17] that positions sound or music as a therapeutic solution for agitated behavior. With Vita, caregivers mainly offered the residents meaningful activity, for instance, in between organized activities to avoid boredom. The use of Vita in context is in line with the notion of ‘Experience-Centered Design’ (ECD) [57]. Whereas initial research in HCI on dementia mainly focused on assistive technologies to address the symptoms of dementia [6,21,55], ECD offers an alternative perspective by addressing the individual experiences of people with dementia, and the role of design to enrich these experiences [30,71]. Similarly, selecting and representing sounds from everyday life provides opportunities for meaningful activities and social engagement in everyday care settings [40]. In the care home context, we also emphasize the role of the professional caregivers in providing these experiences as a person-centered approach in daily care practice [69]. While highlighting meaningful responses of the residents, we do not position everyday sounds as a solution for every individual, but as an additional tool for caregivers to enrich the everyday experience in care homes.

Situated Nature of Sound
Based on our results, the optimal selection of audio content for sound-based interventions in dementia care greatly depends on the personal and social context in which it will be used. As people living in residential care homes either prefer engaging with sound individually or in a group, designers should address these social dynamics in care homes by designing adaptable audio content [40] for both personal, intimate settings, as well as informal and playful group settings. We therefore argue that sound-based interventions should be able to provide access to both personal and general sound content. While personal sounds provide a sense of familiarity, general sounds can stimulate curiosity and discovery by offering new experiences in the present that do not necessarily rely on recapturing past experiences [42]. Our results show how residents were engaged in discovering sounds by exploring the general sound sets of Vita. These findings are in line with research suggesting that general content is more likely to stimulate more extended responses than personal content by allowing a broader scope for conversational topics [22]. Therefore, sound-based interventions should be able to facilitate these explorations by offering a wide variety of audio content to counter fatigue in interaction and provide space for discovery and opportunities for new experiences ‘in the now’ [56].

Embracing of Ambiguity
Research on reminiscence therapy indicates the value of social interactions during therapy sessions [73], as the sharing of evoked responses is more meaningful than the response itself [13]. However, as people move on into the advanced stages of dementia, recapturing memories and sharing these experiences becomes increasingly difficult [45]. We have reported how Vita offered an alternative way to stimulate social connectedness as residents and caregivers engaged in each other’s company and acknowledged bodily responses to the everyday sounds that were played. In addition to reminiscence, everyday sounds can be less prescriptive and create ambiguous cues that are open to interpretation and thus establish opportunities for mutual connection beyond verbal communication. Sound as a medium in this space can embrace both ambiguity and universal cues to elicit meaningful responses and embodied connectedness. We therefore challenge generalized preconceptions of using sound in care environments, such as stress relief and reminiscence and argue that design-based interventions should consider highly personal and situated responses to sounds.

CONCLUSION
In this paper, we present insights from a field study that explored the relevance of everyday sounds in care homes for people with dementia through re-presenting selected sounds using Vita. The findings contribute to existing literature by reporting how everyday sounds in dementia care can stimulate social connections by eliciting meaningful conversations, as well as nonverbal responses. Furthermore, we have outlined design implications for sound-based technologies for use with people in advanced stages of dementia in real-life care settings. We aim to broaden the discussion on the use of sound to manage behaviors defined from a purely medical point of view, extending applications of sound to care settings by offering alternative perspectives that address social connection as well as individual and group experiences related to sound. However, more research is needed to build on these explorative findings and to further investigate the potential importance of everyday sounds in dementia care practice. With this work, we aim to inspire future design research in day-to-day care settings that involve both people with dementia and their caregivers.

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