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Instructions Not Included: Dementia-Friendly Approaches to DMI Design

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ABSTRACT

The development of bespoke musical tools such as many accessible digital musical instruments (ADMI) can necessitate specific design constraints. Within a field which often promotes out of the box thinking and new interactions with experimental technologies, how do we design for user groups where these notions of interaction will be less familiar, and/or increasingly challenging due to the progression of cognitive decline?

The relationship between age and the use of technology is understood within the wider context of human computer interaction (HCI), however, how this applies specifically to musical interaction or contributes to a 'dementia-friendly' approach to digital musical instrument (DMI) design is drastically underrepresented within the NIME community. Following a scoping review of technology for arts activities designed for older adults with cognitive decline, we ran a series of involvement activities with a range of stakeholders living with, or caring for those living with dementia. Consolidating the knowledge and experience shared at these events, we propose five considerations for designing dementia-friendly digital musical instruments. We illustrate our approach with a range of new instruments co-designed to enable increased interaction with music for people living with dementia.

Author Keywords

Dementia Friendly Design, ADMIs, NIME, DMIs, Enaction

CCS Concepts

•Human-centered computing → HCI design and evaluation methods; Accessibility design and evaluation methods;

1. INTRODUCTION

Dementia describes a set of symptoms including difficulties with memory, problem-solving, or language, that are severe enough that they interfere with doing everyday activities. Research shows that frequent and sustained engagement with music can have a positive impact on older adults' wellbeing in general, [8, 7], and for those living with dementia it can help them to reconnect with past interests and their sense of self [2], stimulate awareness of the present moment, as well as past memories [5, 4], enhancing the quality of their day to day life.

A recent scoping review [26] of the use of technology for arts-based activities in older adults living with mild cognitive impairment or dementia demonstrates a wealth of good yet isolated approaches to the design of digital tools. Frid [11] reviews the ADMIs presented at NIME, SMC and ICMC conferences, highlighting a distinct lack of representation for the needs of this group, however demonstrates the positive power and growing presence of ADMIs for those with physical impairment.

In this paper we outline the progress of a research journey exploring the design and iterative development of advanced musical technologies created specifically for people living with dementia. Through a serious of involvement activities, working alongside a group of adults with a range of physical and cognitive abilities, we are exploring the challenges and barriers to musical interaction that are posed by cognitive decline. We feel we are not alone, and would like to start a conversation within the NIME community about how to develop assistive musical interfaces that help older adults engage with music.

We present five initial design considerations, that have developed from conversations with our stakeholders during playful musical interactions with digital musical instruments. We demonstrate our approach to dementia-friendly DMI design through the construction of a range of ADMIs used in our involvement activities.

2. BACKGROUND

2.1 Adults living with Dementia and the Arts

As of 2022, approximately 55.2 million people across the world are living with dementia, with sharp rises predicted over the next few decades [46]. Despite increasing acknowledgement that music can be a powerful aide in the daily lives of those living with or caring for someone living with dementia, the devices used to interact with music are often limited and the theory behind their design disparate.

2.1.1 Technology, dementia and the Arts

A recent scoping review [26] investigating the use of technology for arts-based activities in older adults living with mild cognitive impairment or dementia highlights a wide range of (mainly) prototype devices in use. The review discusses 51 technologies currently in use, 28 of which are music fo-

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cused. The majority of these technologies (n=19) are for 'listening' to music and provide access to playlists and simplified listening devices. Of the 9 devices intended for 'music making', 3 use games controllers (Wii / PlayStation / AirSticks), 5 are computer screen / tablet based, and only 1 is a tactile object.

Another exception is Treadaway [38], who introduces 4 examples of tangible multi-sensory objects developed through a series of ludic workshops with those living with dementia. The authors reflect "one of the most pressing challenges facing designers today is how to create appropriate, useful and safe designs".

2.1.2 Accessible Digital Musical Instruments

Although small in number and specific in nature, the notion of accessible digital musical instruments (ADMIs) is growing in NIME literature [11, 12, 10, 24]. Frid [11] surveys the history of ADMIs presented at the NIME, SMC and ICMC conferences, discussing multiple notions of 'accessibility' in digital instruments. The author uses the term ADMI to denote a wide range of both 'adapted / adaptive' ([14, 23]) and 'inclusive' instruments [44]. The paper identifies 30 reported ADMIs with wide ranging approaches and destinations. In contrast to the devices in use with those living with dementia reviewed in our scoping review [26], the majority of the ADMIs reviewed by Frid prioritise tangible interaction [20] with very few (<10%) relying on touch screens or computer based interfaces. The paper concludes that the majority of these are intended for the physically disabled and younger age groups, with only two examples of ADMIs focused at the elderly, and only one with a focus on those living with dementia. Favilla and Pedell [9] discuss the design of dementia friendly instruments implemented on touch screen devices. Although deemed successful in the experiences they enabled, the authors reflect on the need for one-two-one scaffolding to facilitate access to the technology. Building on Frid [11], Ilsar and Kenning [19] chart the development from DMI to ADMI, reflecting that "ADMIs free the music maker from relying on screen, keyboard and mouse-based interfaces" showing its ability to lead to "greater opportunities for exploration, improvisation, empowerment and flow through music making for people living with disabilities."

So how do we design ADMIs for older adults potentially living with some degree of physical impairment and increasing challenges from the progression of cognitive decline? Within HCI, awareness of the relationship between age and the use of technology continues to grow [16, 41, 15], with dementia focused [13] and "age-friendly" [28] approaches discussed, however this lacks presence in the approaches reviewed in the development of this paper. Leading disability and music charities Drake Music [1] and the OHMI Trust [2] champion the cause for those with physical disabilities in the UK, however there seems to be a lack of similar provision for those living with cognitive issues or comorbidity.

Ward [44] discusses design considerations for digital musical instruments for users with complex needs in SEN settings, referencing a range of existing design frameworks from NIME ([22, 29]) and wider HCI ([18, 42]) backgrounds. The authors present 18 design considerations developed through literature review and practice based work. The author's wider review of Music Technologies used in Music Therapy for a range of clients with complex needs [43], calls for the *"development of accepted, common guidelines from experts in the field... to includes the need to create a taxonomy of understanding (to codify the pitfalls, methods, and potentials) incorporating the vocabulary, structure, and architecture of technology (specifically of handheld music devices) into clinical practice".*

2.2 A/DMI Design Theory

Music technology can provide unique opportunities to access music making for those with complex needs [44]. Digital tools provide the ability to augment and support physical and cognitive impairments in unique and specific ways so as to address varied challenges to inclusion. Through its slow move away from traditional HCI style investigation, NIME research provides a platform for more player focused and experience based approaches to understanding and designing for music specific interaction.

2.2.1 Player centred approaches to design

Rodger [35] explores how instruments contribute toward meaningful musical experiences, claiming "instruments are better understood in terms of processes rather than as devices, while musicians are not users, but rather agents in musical ecologies". The authors replace the standard HCI evaluation frameworks with an alternative approach incorporating ecological, psychology, enactivism, and phenomenology. These notions of player and experience centred design are promoted by Morreale [29] through the MINUTE framework, and later echoed by Ward [44] as she calls for "focus not only on the instruments being designed, but also the system as a whole and the system in relation to the context of use".

2.2.2 Experience and Enaction

Varela [40] focused on the lived experience, and the mind's ability to enact meaning from interaction with its environment through sensorimotor exploration. Varela states the enactive approach consists of two key points: (1) perception consists in perceptually guided action and (2) cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided.

Essl & O'Modhrain [6] define enaction as "the necessary and close link between action and perception", linking their concept of enaction to tacit knowledge, stating it to be "inevitably dependent upon embodied knowledge, the kind of knowledge that is derived from being and acting in the world". The authors propose an enactive approach to the design of new tangible music instruments, stating the design intention to "retain the familiar tactile aspect of the interaction so that the performer can take advantage of tacit knowledge gained through experience with such phenomena in the real world". O'Modhrain [31] states: "Enactive interfaces are desirable because they allow the user to utilise their preconceived knowledge of interacting with the world when using the interface".

More recently greater understanding of the perception of materials used in the design of DMIs highlights the further potential for lived experience and tacit knowledge of the world around us to guide and suggest musical interactions, delving in to the hidden language of sensors [33, 30], materials [34, 47] and controls [21].

3. METHODOLOGY

Presented below are five design considerations for dementia-friendly DMI design. These considerations have been devel-

[1] https://www.drakemusic.org/
[2] https://www.ohmi.org.uk/

oped from an extensive scoping review [26] of technologies in use today with those living with dementia, and just under a year of consultation with community partners and stakeholders, including those living with dementia, their carers, and surrounding support agencies. Our work to date includes the development of a group of instruments that begin to explore the wants and needs for musical interaction of people living with dementia. The design considerations detailed below are consolidated from a series of four involvement activities run with our stakeholder groups. In these activities, we i) discussed the broad aims of the research, and ii) trialed the range of instruments developed. This latter activity prompted further discussion on experiences and realities for the different stakeholders in relation to diverse caring contexts. The outcomes below incorporate these discussion points as well as the reflections of the research team on these activities.

In terms of setting and method for our work, we take influence from the experience based approaches reviewed above [35, 29, 44] and propose that embedding this in the design of DMIs for people living with dementia unequivocally points toward a co-design process. Involving people living with dementia in all stages of the design process allows us to better define the parameters of agency required within each musical interaction, the range of contexts the interaction may be applied to, and to appreciate the diversity in how individuals may respond to each interaction.

3.1 Instructions Not Included: Dementia-Friendly DMI Design

3.1.1 Accessibility through tangible design

Overcoming the initial hurdle of new technology for those living with dementia can be challenging due to a range of different experiences (and confidence) levels, further complicated by physical, cognitive, and/or mental health comorbidity. Following the success of tangible approaches to interaction found in reviews of ADMIs [11] and wider art objects [38, 37, 36], we avoided screen based and obvious computer oriented interactions where possible. We found this approach widely fostered within the ADMI community [44, 43, 19].

Materials and objects speak volumes, which can be handy for those without a manual. We attempted to remove confounding language provided by obvious sensor layers [33], and invited interaction through familiar and safe materials [34]. We found the use of playful and inviting devices that promoted risk-free tangible interaction though design successful in overcoming initial barriers to interaction. We have had success building from robust natural materials and incorporating inviting tactile surfaces such as varnished wood or silky fabric. Our intentions were to provoke and suggest interaction with technology based on understandings of the natural world.

3.1.2 Promote obvious interaction

Digital interfaces by nature can quickly become overwhelming due to their reliance on epistemic knowledge [27]. Clasper [1], writing as a person living with dementia, reflects on the progression of cognitive decline and it's increasing challenge to interactions with devices such as TV remote controls, radios and CD players.

We suggest controls should be minimal and suggest obvious interactions as effectively demonstrated in [32]. We activity tried to remove interactions based on epistemic understandings and prioritise ones that borrow from the tacit and the phenomenological. This was achieved through the use of culturally known tangible forms [17] which incorporate gesture and interaction strategies to enable the ability to borrow from a lifetime of tacit knowledge.

Incorporating sensibilities of enactive design fostered within NIME literature [6, 45, 31] has the potential to enable users to borrow from familiar 'choreographies' [39] and interaction paradigms. Interface controls can reinforce, and be reinforced by the overall instruments design and wider context [21]. Through our involvement activities we found combining the first two considerations in objects that provoked playful interaction and explained their use through common metaphors successful: handles that could only be wound, a large arcade button that invited pressing, long throw sliders incorporated into a 'mixing-desk' analogy. This approach is also well exemplified in the 'Hug' or 'Steering wheel' multisensory interfaces reviewed in [38].

3.1.3 Player centred multi-modal feedback

Feedback is a benchmark of interaction, and potentially even more important when working with this demographic due to notions of confidence and autonomy. In group (or even individual) music making situations, purely sonic recognition of interaction can be lost in the noise. Successful interactions should be sign posted and clearly demonstrate a response. This need is highlighted in the desires of participants living with a range of physical and cognitive abilities reviewed in [25], where additional bi-modal feedback channels were specifically requested to support interaction.

As highlighted by Ward [44] in her work with participants with complex needs, due to potential impairment of some sensory channels, designing feedback is a unique, person centred, multi-modal activity that should be informed by the instrument, the player and the situation.

Through our involvement activities we found rewarding user input with both auditory and visual cues to be successful. In many cases when we deactivated the visual cue the remaining sonic cue was missed, and the particular control quickly abandoned.

3.1.4 Provide extension without adding complexity

Building a relationship with a musical instrument traditionally takes time and the development of motor skill. Both of these elements can be uniquely problematic for those living with dementia, necessitating the need not just for assistive technology, but the right technology, designed specifically for the user and context of use [35].

Fostering enaction through design and rewarding interaction with feedback is the start of a musical experience, but from here the experience should develop and provide reward, and often some challenge. MacRitchie [25] found increasing the complexity of musical timing could provided greater reward, however some of our stakeholders warn increasing challenge for those within declining conditions is not always the answer, and for some can trigger have a negative response to the experience.

Ward [44] also reflects on similar notions of expression and constraint, recommending making experiences scaleable and configurable using dynamic interfaces.

3.1.5 Provide a safe and intuitive escape

Interactions have the potential to cause anxiety and at times can place some users in distress. We have observed this in a range of ways from reactions to songs in playlists, to in-

dividuals becoming self conscious of their role in a group setting, or simply because the stimulus or interaction becomes overwhelming.

To address this while providing agency and independence to users, we have trialed a safe stop control that is clearly signposted and tested by users early in the development of their relationship with a device.

Figure 1: Involvement Activities - The 'hacked' Hug

4. IMPLEMENTATION EXAMPLES

The following three examples illustrate our journey toward dementia friendly digital musical instruments.

4.0.1 The 'In C' Box

The In C Box (fig.1) is an arcade machine analogy which enables its user/s to proceduraly generate a composition using Terry Riley's score, In C. Each of the coloured buttons represents a musical voice, whose part is advanced one cell in the composition each time it is pressed. A ring of LEDs around each button provides feedback for the part playing, as well as responding to successful interactions. The central button is a safe stop. The devices explores notions of agency in the composition process for those without musical training, or with cognitive or physical barriers to performance.

The In C Box embodies all 5 of our design considerations. As a minimalist composition the piece was a great talking point in our involvement activities, and raised some questions about musical style, preference and situation. The idea for the SliderBox discussed below developed to address some of these points.

Figure 2: The 'In C' Box

4.0.2 The Slider Box

The Slider Box (fig.2) is a 'mixing desk' analogy which enables its user/s to combine prerecorded stems of familiar performances to create a recognisable piece of music. The Slider Box was designed to be used in reminiscence therapy sessions, where the active process of selecting and combining stems of familiar music from the past creates cue points for conversation, memories and reminiscence. The music selected for inclusion can be targeted towards familiar styles or time periods based on a knowledge of the user/s.

We wanted to borrow from known interaction metaphors and in previous involvement activities the 'Mixing-Desk' was discussed as a familiar musical, technological and cultural object. Within this design space, considerations were made from visual and dextral impairment. The interface was kept as uncluttered as possible with no additional interface elements than the 8 sliders, which were spaced farther apart than commonly found and later colour coded to provide some differentiation within a repeating interface.

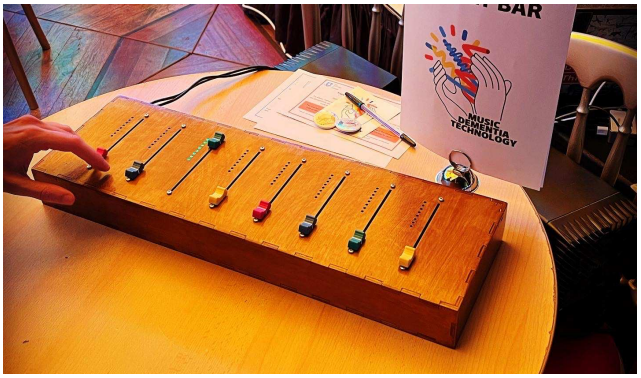

Figure 3: The SliderBox

4.0.3 The [...hacked] Hug

Building on the outcomes of a successful involvement activity using the Hug [38], there was a desire to make the device more interactive. We used similar 'Huggable' teddies as design prototypes, and embedded a range of sensor modalities to probe interaction as well as a more powerful speaker and a haptic transducer to facilitate a wider range of feedback.

We explored notions of comfort and intimacy mediated through musical and sonic interactions and uncovered the desire for personalisation and sharing of the experience with others.

Figure 4: The Hug (right) [38], and our 'hacked' soft tech

Figure 5: Involvement Activities - In C Box

5. CONCLUSIONS

This paper identifies a growing need for the development of specific design theories for instruments made for those living with dementia and cognitive decline. We have provided an extensive review of the current provision and highlight some interesting and successful approaches to similar challenges from surrounding research areas. The theory behind ADMIs has grown greatly in the last 4 years thanks to awareness and opportunity afforded through NIME research, and we hope to play a part in extending this body of research and aiding future designers to create empowering musical interactions for those living with dementia.

To start the conversation, and to share our work with the community, we propose 5 initial considerations for the design of dementia-friendly digital musical instruments.

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7. ETHICAL STANDARDS

The current work has involved multiple stakeholders in consultancy and involvement activities, as set out in [3]. Contact with stakeholders was made via established groups in the community for people living with dementia. On presenting our research aims at regular meetings with these groups, members who confirmed they wanted to be further involved in our research were emailed and asked if they wanted to participate in the subsequent involvement activities. The activities detailed here aimed to gather opinions on the direction of research and identify priorities for design rather than to collect specific interaction data. Further stages of the project will increase the level of engagement of stakeholders in further co-design processes where opportunities for deployment in diverse settings and recording of interaction data will be prioritised.

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