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ABSTRACT
This paper presents new touch-screen collaborative interaction models for people with dementia. The authors argue that dementia technology has yet to focus on group musical interactions. The project aims to contribute to dementia care while addressing a significant gap in current literature. Research includes observations and two system trials exploring contrasting musical scenarios: the performance of abstract electronic music and the distributed performance of J.S. Bach’s Goldberg Variations. Findings presented in this paper suggest that dementia people are able to successfully perform and engage in collaborative music performance activities with little or no scaffolded instruction.

Author Keywords
Dementia, touch screen, collaborative interaction, music

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

DEMENTIA AND TOUCH SCREEN TECHNOLOGY
Dementia can affect people at any age and be attributed to injury or disease. Defined as a syndrome, it is a collective name for several degenerative brain disorders, which include Alzheimer’s disease (the most common form of dementia), dementia of the Lewy Bodies, and frontotemporal dementia (Vink et al., 2003). Dementia is progressive and eventually fatal. It significantly affects memory, cognition, behaviour and emotion. The number of people with dementia in Australia is currently estimated at 220,000. Yet this number is expected to drastically rise over the next three decades to 1.13 million (Brodaty & Cumming, 2010). Australian communities, families, health care providers and Governments will be severely stretched in the future years as the health system accommodates a four-fold increase in dementia cases.

Music therapy is playing an active role in the care of people affected by dementia in Australia and worldwide. It is used to control mood, problem behaviours and to avert the need for certain pharmacological and physical treatments. Music has been demonstrated to provide meaningful engagement for people with dementia (Sherratt, Thornton, & Hatton, 2004) and is appreciated even through the later stages of the disease. There is growing evidence to demonstrate musical memory’s robustness, which is oftentimes spared by the disease (Cuddy & Duffin, 2005). Music therapy has also been demonstrated to have a positive impact on speech content and fluency (Ingram, 2012).

Music therapy aims to “promote communication, relationships, learning, mobilisation expression, organisation and other therapeutic needs” (Vink et al., 2003, pp.2). Both receptive (music listening) and active types of music therapy (where participants are actively involved playing instruments) are tailored to suit the individual’s particular needs (ibid). Music therapy sessions are often carried out in groups embracing improvisation and reminiscence activities.

Studies such as (Waycott et al., 2013) demonstrate how touch screen tablets, such as the iPad, can be effective in care facility and home environments for older people. Touch screen technologies have been used to support reminiscence, aid recall, increase interpersonal interactions, promote intergenerational relationships, improve staff and resident relationships and improve quality of life. Easier to use than a computer and more portable, the use of touch screen technology “encourages increased interpersonal interaction and a positive social environment.” (ibid pp.27). Touch screen technologies are also playing a role in dementia care (Upton & Upton et al., 2011) and are used in our research as musical instruments.

MUCH MORE THAN A XYLOPHONE
Digital music controllers such as Jazz Mutant’s LEMUR have long demonstrated the touch screen’s potential for multi-modal interaction. More recently iPad apps such as Thickett, (Interval Studios, 2013) and Trope & Bloom, (Chilvers & Eno, 2009 & 2011 respectively) demonstrate vividly the touchpad’s potential to transcend conventional instruments with stunning graphical rendering (sonification) of sound and physical gesture.

Other apps allow the user to create powerful and expressive controllers for digital music. Apps such as Midi-touch transmit the traditional serial music protocol (MIDI) over WiFi, but TouchOSC (Fischer, 2008-13) can transmit the Open Sound Control protocol, which offers a huge improvement over both performance timing and expressive bandwidth. These apps are suited to collaborative (Blaine & Fels, 2003) or multi-user (Jordà, 2005) performance situations where a number of separate iPad performers transmit together to a single host computer (laptop). This computer produces the resultant
sound, which is then amplified for the musicians and audience. The gathering of controllers to a single host computer creates opportunities where many musicians can actively contribute to the formation of just one sound, texture or part in the musical fabric. The computer system often contributes as an active agent in the creative process composing melody, harmonization, mixing sounds or engaging random and generative processes. The success of a system depends on the balance of complexity and expressivity (Blaine & Fels, 2003) and on how well the participant is engaged and encouraged (Jordà, 2005).

At present there are very few published studies investigating music interaction with dementia users (Topo, 2008; Riley et al., 2009). Collaborative and multi-user music studies with dementia participants have yet to be published. Although the ExPress Play, prototype iPad app developed by (Riley et al., 2009) can accommodate multiple user interaction, no observations of this feature in action have been provided thus far.

It is generally understood that touch screen tablets in dementia care require a scaffolded (one-to-one mentoring) interaction approach (Upton & Upton et al., 2011). Although this may demonstrate itself over time to be the most appropriate model for dementia user interaction, we challenge here scaffolding based on a one carer to one dementia user model. Collaborative and multi-user music activities offer an effective solution, where a single caregiver can mentor an entire group/ensemble of dementia musicians simultaneously.

RESEARCH DESIGN

We designed a project to collaboratively engage a group of older adults with dementia using a range of music applications. Participants in our study consisted of an activity group of 12-14 elderly people with dementia and their carers organised by the Wyndham City Council. The group met at a community centre facility during their routine Friday morning iPad session and activities. The group’s 12 iPads were managed via a sync/recharge station and a central computer. Interactions and performances were recorded for study comparisons.

The study involved three stages:

1. Preliminary observation of participant interactions with existing music apps
2. Evaluation of iPad Controller 1 (Electronic music synthesis)
3. Evaluation of iPad Controller 2 (Distributed performance of J.S. Bach’s Goldberg Variations)

For stages 2 and 3, a separate laptop computer was used to host music sound and interaction software. A portable speaker system was connected to this computer for the participants to hear.

Data was collected in various forms, initially through journaling observations and voluntary interviews, and then by recording iPad gestural control data and video. Stage 2 and 3 iPad controller software was designed in TouchOSC and set to transmit to a single host laptop computer. The host computer software was composed in Max5 alongside data recording and analysis software engines.

STAGE 1. INITIAL OBSERVATIONS

The first visits to the centre were spent getting to know the group of participants. We began by introducing them to the iPad through games and a number of music apps the centre had already installed on their tablets. These music apps consisted of the Tiny Piano (http://www.tinypiano.com/) and Rhythm Pad apps (http://rhythmpad.com/). Neither of these applications kept any of the participants engaged for very long (approx 5 minutes). Through observations we concluded the main reasons for this were:

1. Screen controls and objects were too small (both to see and locate with fingertip)
2. iPad speaker sound was too quiet
3. The sounds had a blunted expression (i.e. same attack and dynamic)
4. Interaction was limited to one-shot triggering of sound samples

Many participants in the group also suffered from other age-related conditions including:

1. Poor vision, due to macular degeneration and glaucoma (restricted fields of vision)
2. Hearing loss
3. Loss of touch and tactile sensitivity (tactile agnosia)
4. Motor tremors and mild spasms restricting fine motor control (apraxia)
5. Short and limited attention span
6. Cognitive impairment and mild aphasia

People with aphasia experience gaps in their recognition of speech, words, letters, symbols and numbers. As it is caused by degenerative disease and or injury, one patient’s expression of aphasia is often unique (Wan et al., 2010).

We observed at the beginning of each session that many of the participants could not find or remember how to switch their iPad on. However, once the tablets were turned on and displaying the log-in window, all participants would remember the swiping gesture to “slide and unlock” the tablet screen. This observation may suggest a useful link between gestural interaction and memory.

We also observed a number of participants who had difficulty making capacitive contact with the touch screen surface. We are not sure whether this was due to the moisture content of their surface skin, the amount or distribution of pressure, or a combination of these.

STAGE 2. ELECTRONIC SYNTHESIZER CONTROL

Riley, Alm, & Newell (2009) discuss the importance of engaging older people with dementia without patronising them. We also wanted to develop an expressive and nuanced interaction that could be practised and enjoyed for extended periods. We designed an instrument with the minimum of controls yet very responsive to touch and gesture. We were also unable to ascertain the true control potential of the participants so we began with creating a
simple controller in TouchOSC (see fig.1) coupled with a very unusual yet expressive sound engine in Max5.

Figure 1. iPad Controller 1, Joystick and 9 Buttons

The system produced a large array of abstract yet expressive sounds including tones, whines, chortles, groans, roars, whistles and pops. First a sound is selected, using one of the nine buttons. Then by moving the x/y control pad, a range of transformations and modifications could be made to the sound in real-time.

“Sound is very good—very interesting. I like this!” says one of the participants who loved the controller. The participant played with the app for well over an hour and had never played music nor heard any electronic sounds before. The care-staff were all very surprised to see his enjoyment and engagement in the activity.

Fig.2 The Author & Client Jam on some Fat Electronic Pads

The simple layout required a minimum in scaffolding/mentoring, which consisted of an informal jam session where participants would observe the author’s gestures before exploring their own sound making. The facilitation of a separate loudspeaker greatly aided the enjoyment of music making. “Many different sounds and things you can do” commented the participant. A trace of x/y control pad movements over 5 minutes (see fig 3. left) compared to the author’s (see fig 3. right) demonstrates a methodical exploration.

We discovered right-handed players would sometimes accidently activate the buttons with their palm or other fingers while playing the x/y pad. One participant commented how the controller bore no resemblance to any musical instrument.

Figure 3. Five Minute Trace of Jam session (participant’s interaction on the left and author’s on right side)

STAGE 3. BACH’S GOLDBERG VARIATIONS

Responding to this and yet following a similar design, another prototype controller was laid out in TouchOSC. This time the buttons were arranged to resemble a piano keyboard. The x/y control pad was located in the lower right and an additional speaker panning control added. The controller was also rendered in four different colours, green, orange, red and purple (see fig.4 Controller 2-green).

In this trial the iPads were distributed and mapped to control the expression of a pre-recorded piano performance of Bach’s Goldberg variations. This pre-recorded MIDI performance was data-stripped in real-time. The x/y pad was mapped to control the attack (loudness & brightness along the x-axis), while the duration of each note was mapped to the y axis, (notes being shortest towards the bottom of the screen). Two participants would work together, each iPad controlling either the bass (left-hand) or treble (right-hand) parts. This distribution of performance roles allows the participants to take on the role of interpreting the performance, without having to learn to play all the notes.

The keyboard was used to select different sounds ranging from acoustic grand pianos, forte piano, harpsichord, guitar, harp etc together with a range of modern electric pianos, Wurlitzers and clavichords. The sounds were equalised, blended and mixed with reverberation.

Once again, great care was taken to reward the participant’s movements with rich and responsive sonic detail. The quality of the engagement again was evident with participants commenting on the beauty and richness of the music and the quality of the experience. Also, there was no need for explanation, demonstration sufficed. After a period of exploration the authors would simply encourage the participants to listen to each other and play.
At this point the interaction would change, as each participant listened and adjusted to one another’s dynamics, touch and expression. Often players would adjust their note durations to be the opposite, accentuating their own parts in the mix (see fig. 5).

**CONCLUSIONS**

This study identifies a number of key challenges in the design of software for older people with dementia. It has developed new iPad controllers and interactive music software aimed at engaging people with dementia. Results from two trials establish that older people with dementia can successfully participate in collaborative music performance activities for extended periods (up to 90 minutes) with little or no scaffolded instruction. Although the project offers a design approach that can be adapted to a wide range of musical styles and scenarios, it suggests that careful attention to sound, collaborative interaction and touchscreen control are essential for success.

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