School of Informatics

Informatics Research Review
Current state of research into tangible technologies for Reminiscence Therapy involving People with dementia.

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Abstract

Dementia is an irreversible, progressive syndrome typically affecting older adults by negatively impacting their cognitive abilities. Research commissioned by the Alzheimer's Society in 2013 estimated 7.1% of the population over 65 years of age had dementia, with an estimated 1 million individuals living with dementia by 2025 (Prince et al., 2014). This literature review explores the research of tangible technologies in Reminiscence Therapy for People with Dementia and provides a set of shortcomings and lessons for future work. Tangible technology embedded in objects provide the individual something physical to hold on to and manipulate while stimulating their memory, giving rise to reminiscence.

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1 Introduction

Dementia is an irreversible, progressive syndrome typically affecting older adults by negatively impacting their cognitive abilities. Research commissioned by the Alzheimer's Society in 2013 estimated 7.1% of the population over 65 years of age had dementia, with an estimated 1 million individuals living with dementia by 2025 (Prince et al., 2014). People are now living longer and the population is aging increasing the number of dementia cases and increasing demand for care and therapy (ONS, 2019).

Reminiscence Therapy promotes engagement and interaction in People with Dementia (PwDs) to improve their Quality of Life (QoL) and stimulate their cognitive functions. Reminiscence Therapy involves the use of 'memory-aid materials' that are chosen specifically to stimulate reminiscence. These materials are a mix of the physical and digital; the purpose is simply to stimulate the PwD's memory. This use of mixed media memory-aids is an opportunity for the use of tangible technology - graspable physical objects that interact with a system through the natural human actions of touch, grasp and movement.

This literature review explores the current state of tangible technologies within Reminiscence therapy; aiming to answer 3 key questions:

1. What are the research approaches and usages of tangible technology within Reminiscence Therapy?
2. What are the shortcomings in tangible technology research involving PwDs?
3. What are the design lessons for future tangible technologies for Reminiscence Therapy with PwDs?

1.1 Background

The literature reviewed here assumes a level of knowledge of dementia, Reminiscence Therapy, and the concepts of tangible technology. Provided here is enough information on these subjects for understanding of the findings presented in the literature review section.

What is dementia? Dementia, from the Latin adjective 'demens' meaning 'out of one's mind', is the name given to a collection of symptoms (a syndrome) that depict a decline in an individual's mental capacity, typically including the loss or weakening of memory functions. Dementia can be caused by many different illnesses, and symptoms can vary by cause.[1] The onset of dementia is currently considered irreversible within the bounds of modern medicine, and will continue to progress throughout the individual's life. Dementia is most typical in older adults, leading to it being a consideration in end-of-life care plans. The impact of dementia on these individuals has a large, negative affect on their social and personal independence, leading to a marked decline in their Quality of Life (Gouras, 2009).

Quality of Life (QoL) is used to determine a PwD's well-being and is used to measure the impact of an approach or solution. Although there are many different definitions and measures[2], all monitor common areas of focus: affect (mood), self-esteem, physical functioning, social relationships and environment, (Ettema et al., 2005).

The stage of dementia is measured in PwD's through the use of scales to categorise the PwD's

[1] The symptoms of dementia can vary by cause, a full breakdown of symptoms and causes can be found on the NHS website here: `https://www.nhs.uk/conditions/dementia/symptoms/`

[2] Quality of Life is a often multiply defined concept that has various measures. An accessible starting point can be found here: `https://www.alzheimers.org.uk/dementia-professionals/dementia-experience-toolkit/working-with-data/quality-life-scales-and-measures`

stage of cognitive decline; from early (or mild) to late (or severe). Early stages will see the individual suffering from: short-term memory loss; confusion in everyday situations; and difficulty following conversations or finding words. Late stage dementia sees: severe memory problems, such as an inability to recognise close family members or remember the location of their home; loss of the ability to communicate by speech; extreme behavioural and psychological problems such as aggression, agitation or wandering. Note here that there is a clear ability gulf between those in the early stages and those in the late stages, affecting the requirements from carers and participation in therapies.

The Mini-Mental State Examination (MMSE), (Pangman et al., 2000), is an alternative medical measure for testing cognitive impairment. The test scores individuals from 0 to 30 with 0 being worst and 30 being best; a score lower than 24 indicates a level of cognitive impairment and possibly dementia, (Fountoulakis et al., 2000). While this measure is widely used in medical works, it has not seen high uptake within the literature considered in this review, other than (Lazar et al., 2014).

It is important to note that individuals with dementia are considered a highly vulnerable group within research ethics and so require a professional assessment of their ability to provide informed consent on a case by case basis. Informed consent can also be given by legal guardians or primary carers (Allen, 2017). Depending on the stage of dementia, this has an affect on the capability methodologies for user research and evaluation.

What is Reminiscence Therapy? Reminiscence Therapy (RT) attempts to improve the QoL of PwDs through the act of reminiscence - the act of remembering past events and sharing these memories with others. This form of therapy promotes discussion of these past experiences as a means of combating isolation and depression, and increasing use of cognitive functions in an effort to reinforce self-identity and positive feelings - leading to the improvement in the PwD's Quality of Life (QoL).

Reminiscence Therapy is often aided by the use of tangible objects, such as photographs, music, and historic items, that are presented to the person with dementia to elicit a response from them. These materials are sourced from the individual's past and can either be personal to them or general to a specific window of time(Woods et al., 2018). In most cases, these objects are from the individual's formative years as recall in older adults tends to favour these memories (Morris, 1994). Objects can be personal: such as family photographs, voice recordings or favoured jewellery; or more general: such as music, pictures of landmarks, or television programmes.

RT requires facilitation and delivery by carers and family members, and can occur in a group or individual setting. This presents a gap in care facilitation and delivery that is an opportunity for the application of technologies that are suitable for PwDs.

What is tangible technology? Tangible technology aims to utilise the object and environment manipulation ability inherent in humans to enable novel and accessible interaction with computer systems. Building on Mark Weiser's 'Ubiquitous Computing' concept that outlines the vision to integrate computing into everyday objects, (Weiser, 1999), Tangible User Interfaces (TUI) were first proposed by Hiroshi Ishii and Brygg Ulmer in 1997, (Ishii and Ullmer, 1997). Since then tangible technology has seen use in education, entertainment, and healthcare settings, with a growing body of work related to use with children; (Woodward et al., 2020), (Mironcika et al., 2018), (Gohlke et al., 2015).

The main benefit of tangible technology comes in the form of physical placeholders for icons, '*phicons*', embedding interactivity into the environmental context of the user. This allows interaction in a manner that is natural to the user through the moving of these physical interfaces,

'*Tangible Interaction*' (Ishii and Ullmer, 1997), removing the need to develop the specific fine motor skills required for a standard graphical user interface (GUI).

1.2 Selection of Literature & Approach

This literature review focuses specifically on research into tangible technologies as they relate Reminiscence Therapy. To qualify for review here papers must inform technologies for RT that are interacted with primarily through the technologies tangibility. This review does not focus on research into technology for dementia care such as virtual reality (Wolf et al., 2018), touch screens (Astell et al., 2010) , or voice interfaces (Wolters et al., 2016).

2 Literature Review

The literature review is organised by first reporting the findings of a similar review of RT-technology from 2014 as a basis for evaluation, (Lazar et al., 2014). The evaluated literature is then divided into 2 subcategories. **'Memory by Proxy'** focuses on the use of tangible technologies as interactive proxys for objects that have been lost or are unavailale to the PwD. **'Resonant Interfaces'** focuses on tangible technologies that are designed to engage the PwD through a form of repetitive movement, such as rocking or swaying their arms.

2.1 Foundations for review - (Lazar et al., 2014)

This literature review sets its foundation on the findings of (Lazar et al., 2014), a well-sourced, systematic literature review regarding the use of ICT in Reminiscence Therapy for PwDs. The aim of that review was to explore the kinds of technology in use with RT and their specific purposes. It provides useful basis and context of the state of RT-technology in 2014, enabling an appraisal of the progress of research into RT-technology, and specifically the research into tangible RT-technology.

The texts considered in Lazar's review were drawn from the ACM Guide to Computing Literature (1954 - September 2013), PsychINFO (1908 - September 2013) and PubMed (1966 - September 2013) repositories. To gather all potentially relevant literature, first the repositories were searched for texts containing both the keywords "dementia" AND "reminiscence". These texts were then reduced by the criteria that it must: focus on a RT intervention; be written in English, and have PwDs as the target. The RT intervention must also make use of ICT; defined by the authors as: "*electronic technology used to present, access, or manipulate media (e.g., computer, cassette player, TV)*" (Lazar et al., 2014).

Most RT-technology in the literature as of 2014 was used for the conveyance of multimedia prompts to the PwD, acting as memory-aid triggers for RT. There is only a single mention of texts that include anything resembling a tangible technology, that of (Wallace et al., 2013). This shows that there was not much appetite for tangible technologies for dementia care at the time.

Prior to outlining the shortcomings that will inform the this review, criticisms of (Lazar et al., 2014) must first be addressed. The authors identify that the systematic review is limited by 3 factors: small sample sizes used when designing and testing; limited description of the RT method used; lack of details on how outcomes varied by the PwD's stage of dementia. There is also a possibility that RT-technology research existed at the time but was not included in the

repositories or did not use both the search keywords.

Shortcomings found in the Literature prior to 2014. While there is no direct indication of use of tangible interaction or tangible technologies other than an early predecessor in (Wallace et al., 2013), the shortcomings of the technologies used with RT are salient for this review as they are summative of issues in the RT-technology literature prior to 2014, providing a basis to evaluate progress since.

1. **Over reliance on Case Studies** - An indication of the state of research in 2014 of some significance was that the majority of the studies analysed in the review were case reports; signifying that research in the area was still young and hadn't matured to a point allowing more generalised research.
2. **QoL not in use for evaluation** - *"few studies looked at health outcomes, such as impact on mood and cognition, or a comprehensive evaluation of wellness or engagement, also signifying the early state of the research"*,(Lazar et al., 2014). From this it can be seen that the Quality of Life measures were not in use at this time to evaluate if solutions had an impact on PwDs.
3. **No standard disclosure of solution specifications** - Lazar et al. identifies that there was no standard between studies regarding the degree of detail reported of the technology used, with some reporting specifics and others not at all.
4. **No standard disclosure of PwD's stage of illness** - this is perhaps the most prominent issue. There is a mix of scales and measures used; disclosure of illness stage can use the MMSE, Early-Late, Mild-Severe or do not discuss the PwDs stage of progression at all, leading to lack of certainty as to the applicability of findings for PwDs.

All literature will be analysed against these shortcomings to determine if the field has progressed to address these issues.

2.2 Memory by Proxy

2.2.1 TopoTiles (Bennett et al., 2015a)

According to (Bennett et al., 2015a), a difficulty PwDs face is that of access to personal materials and places that can be used to enable RT. Objects can become lost, degraded or damaged over time. PwDs living in a care home setting may not have many belongings with them when they arrive; thereby restricting their use for RT. There is also difficulty with using highly-personal objects in group RT sessions as this typically leads to singular engagement from the objects owner while disengaging the other PwDs present.

(Bennett et al., 2015a) attempts to provide a remedy to these problems through the use of tangible technologies for storytelling. Bennett et al. outline 2 principles to inform the work: (1) the use of '*proxy objects*' that can take the place of lost or unavailable objects; (2) the use of '*ambiguity*' of the object's physical form and relationship to any digital aspect to prompt sharing of different interpretations among PwDs.

Taking a 'co-design' approach, a series of 'storytelling sessions' were held with PwDs that explored non-digital memory-aids tied to geographic locations, aiming to take advantage of 'place attachment theory' - the theory that places can have meaning based on the lived experiences that occur in their vicinity and that memories can be tied to these locations, (Tuan, 1974). During this initial research, the tangible memory-aid objects were favoured by residents as they had something to hold on to when a memory passes, and giving them a way to 'fish it out', showing the benefit of tangibility in this form of care.

Based on these findings from non-digital tangibles, the Bennett et al. created 'TopoTiles', a prototype system that consisted of hexagonal tiles that held 3D or 2D representation of meaningful geographical landmarks, as seen in Figure 1. Similar to earlier connected memory work by (Barthel et al., 2013), these hexagonal tile contained RFID tags that would cause a base station to play audio of recorded stories from the PwDs, soundscapes and photos. The authors envision these tiles being built up over timesimilar to a jigsaw; allowing for shared tangible interaction to be rewarded with the RFID triggered component.

Figure 1: *TopoTiles (Bennett et al., 2015a)*

Results from the study show that proxy objects had the potential to fail in circumstances surrounding 'ownership' of an object. When used in a shared setting, tangible technology should convey that it is ownerless. The ambiguous requirement is beneficial to shared reminiscence but that it may require a specific design skill to ensure that the tangible technology doesn't settle into having a singular meaning.

The 'TopoTile' concept was designed as a prototype solution following the principles of 'proxy objects' and 'ambiguity', however there is no evaluation carried out with the PwDs. Due to this, there is no evidence that this concept had measurable effect of improving QoL or specifics of if it benefited the participant's at different stages of dementia. There is also little holistic consideration given to the prototypes location within the wider care plan for PwDs, investment is required from caregivers to facilitate the use of the prototype but this is not discussed. While the 'TopoTile' is described in detail, the base station is not described in any detail, technical or aesthetic.

2.2.2 Tangible Prototyping & Models of Interaction (Huber et al., 2019)

Due to the difficulties of designing and evaluating solutions with dementia, such as unresponsiveness or inability answering introspective questions, (Huber et al., 2019) takes a modified user-centric approach with the PwDs. It's important to note that the approach also encorporates the context of the care facilities and the care staff therein, although the primary focus is that of the PwDs.

Initial research took place across 2 weeks during which the research team interacted with and observed PwDs located in 2 care facilities. Taking this ethnographic approach views reminiscence as an activity that takes place across the day, not just during RT sessions, although the main goal is still memory-aid triggered reminiscence as in RT.

The results of this initial phase provide an insight into the lived experiences of PwDs, although the description of the process is brief and the analysis could have been further elaborated on. Supporting the use and possibilities for tangible technology in dementia care, (Huber et al., 2019) found that physical interaction with objects is important to PwDs. They will walk to an object to interact, showing that there is a possibility for stimulation when an object that is aesthetically interesting.

3 tangible prototypes were then produced that would be appropriate for the expected motor skills of an elderly PwD, Figure 2. They aided in the delivery of *generic* memory materials such as historical and geographical photographs and audio, for similar to the reasons to '*ambiguity*' and '*proxy*' outlined in (Bennett et al., 2015a).

The first prototype, a 3D printed 'pyramid' with speakers and a screen on the base, was designed

Figure 2: *3 Tangible Prototypes: 'Pyramid', 'Drawers', and 'Jukebox', (Huber et al., 2019)*

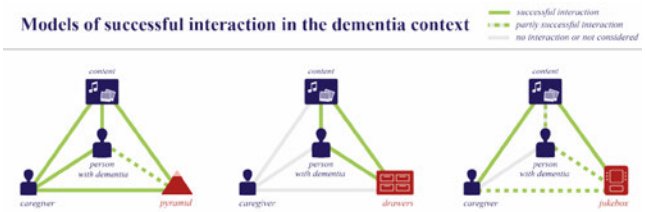

Figure 3: *Models of successful interaction between PwD, Carer, Prototype and Multimedia for: 'Pyramid', 'Drawers', & 'Jukebox', (Huber et al., 2019)*

to respond to changes in it's orientation and interaction with it's turnable point. Designed for individual or group sessions, the 'pyramid' would display images from a domain - such as a gardening, traveling, animals - and play matching sounds. Rotating the 'pyramid' 90 degrees changed the image and rotating the turnable point would change the domain.

The second prototype, 'Drawers', took the form of a chest of drawers with each drawer containing non-digital tangible objects of a similar domain with screens mounted to the front displaying images to advertise that domain. The prototype was designed to be used by the PwD by themselves while wandering to increase their self-efficacy.

The third prototype 'Jukebox' was based on an old style jukebox. The box contained speakers and a front facing screen, with large buttons that would be easy for PwDs to interact with. Each button would activate a corresponding playlist of songs in a particular genre, with images being displayed on the screen. Group or individual usage is not specified.

Evaluation of the 3 prototypes was carried out in the same setting as the initial research. Huber et al. state that the detection of 'reminiscence and meaningful moments' stimulated by the prototypes was 'identified and interpreted' by 'experience evaluators', though there is no disclosure of who the evaluators are or what methods they used to evaluate.

The 'Pyramid' was deemed to be the most successful of the designs as a memory-aid, triggering emotional responses from the PwDs. As seen in Figure 3, 'Pyramid' was found to enable interaction between caregiver and the PwD, whereas the 'Drawers' and 'Jukebox' do not. This highlights that the tangible prototypes created were only successful when they promoted interaction between the prototype, caregiver and PwD.

The findings, however, ignore a key part of the interaction model, that of the researching observers. When performing covert observation, 'Drawers' was found to not be successful in attracting PwD attention but when the observers took an active role in interacting with the caregiver and PwD, there was seen to be more engagement. This omitted role is important to consider in the interaction model as there is an influence from the observer in this scenario. There is also no consideration for interactions *between* PwDs, something that is important in social RT activities.

The paper does not specify the stage of dementia of all participants, instead testing generally with those PwDs present in the care facilities. There is disclosure in specific cases, such as when testing with the 'Jukebox' or the 'Pyramid', that is then used to draw conclusions about prototype suitability for dementia stage, though this is not disclosed for other participants. This is an improvement on the shortcomings highlighted in (Lazar et al., 2014), although lack of consideration for differing stages of dementia during the design stage hampers this. The evaluation also does not discuss the impact of the prototypes on QoL; even though QoL is highlighted as a standard measure in the papers introduction and the dementia specific (Huber

et al., 2017) that incorporates QoL was suggested as a method of evaluation but was not used. The conclusion that prototypes are more likely to be interacted with by PwDs if a steward is present is questionable as there is not enough evidence presented that this was not due to the unsuccessful prototypes ('Drawers', 'Jukebox') being aesthetically uninteresting to PwDs when compared with the more successful 'Pyramid'.

The findings from the user evaluation of the 3 prototypes provide lessons for future endeavours. Tangibles technologies that take a known form are able to take advantage of affordances of use, (Norman, 2013), that are already familiar to the PwD, leading to more intuitive interactions, such as the 'Drawers' prototype. The ability to grasp and hold on should be a key feature in future tangible technologies for RT; this mode of interaction is highly valuable to PwDs, doubly so if they emit some form of warmth. Personal portability is important as this allows free movement for PwDs that may wish to move location or use the prototype with bed ridden PwDs. All multimedia used should convey the same meaning so as not to be distracting from the specific memory-aid. The addition of technology to the tangible should add to the value of the experience. If it is not adding value then there is no advantage over analogue objects.

2.3 Resonant Interfaces

2.3.1 Resonant Rocking Chair (Bennett et al., 2016)

The introductory paper in 'resonant interfaces' for PwD, (Bennett et al., 2016) specifies a form of 'harmonic interaction' that consists of gentle, repetitive oscillations that are appropriate to the motor skills of a PwD.

Working within the sphere of slow computing[3], (Bennett et al., 2016) details the creation of a 'resonant rocking chair' that acts as a tangible user interface that, depending on the frequency of rocking (what they call resonance), will determine the volume that audio is played from an embedded audio device in the chair, Figure 4. This 'resonant interface' approach, first introduced in (Bennett et al., 2015b) is fundamentally different in function from the designs seen in (Bennett et al., 2015a) and Huber et al. (2019) as the emphasis is on slow, gentle repetitive motions as interaction with a tangible technology. The design choice of the rocking chair model for being 'familiar' is supported by the findings in (Huber et al., 2019).

As part of the 'Tangible Memories' project[4], (Bennett et al., 2016) is a continuation of the same ethnographic study and design prototyping with PwDs observed in (Bennett et al., 2015a) above. It's worth noting that the work on 'TopoTiles' is considered part of this ethnographic process in the form of a 'design probe'. To inform what would become the 'resonant rocking chair' prototype, a set of 3 design considerations were drawn from the findings of the 21 month ethnographic study: (1) The device must motivate PwDs to independently interact with it. (2) The device must enable the PwDs to be self-confident in their use and exploration of the device. (3) The device must be continually engaging over a long period of time.

The choice of a rocking chair as the model for the prototype overcame the issues of motivation and inspiring self-confidence in the PwDs as the duality of function allowed the prototype to act as a chair while giving the choice of interaction from a willing participant.

The method of user testing and analysis is not disclosed in the paper but findings are included.

[3]Slow Computing focuses on interaction design for mental rest and reflection. The seminal paper by Hallnäs and Redström explores this from a design and philosophical perspective, (Hallnäs and Redström, 2001)

[4]'Tangible Memories' project publications: https://tangible-memories.com/publications/https://tangible-memories.com/publications/

It is unclear if specific measures such as QoL were used or, if similar to (Huber et al., 2019), 'experience evaluators' interpreted the actions of the individuals. The authors instead include accounts of interaction with the 'resonant interface' successfully provoking reminiscence in the form of storytelling and singing from PwDs that normally are not conversational. The prototype is therefore fulfilling its roll as a memory-aid, although in the lack of disclosure of the methods utilised in the evaluation and analysis process are concerning for the results applicability.

The paper does not disclose the PwDs stage of dementia, something that could have provided a more granular measure of success for the prototype at the different dementia stages. The resulting prototype also relies on the aid of caregivers to facilitate the setup of materials and to help the PwD use it. The authors do mention that future work would extend the prototype to allow the setup of materials to be handled through an app designed to capture stories, or through social media mining, as seen in (Peesapati et al., 2010), to enable mining materials from specific PwDs social media if it is available.

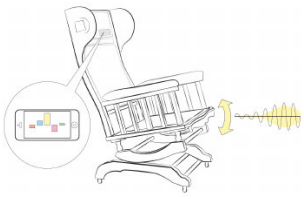

Figure 4: *Resonant Rocking Chair, (Bennett et al., 2016)*

(Bennett et al., 2016) is a step towards what the authors outline as a 'Resonant Home'; the vision of a residential area for PwDs that can provide gentle stimulus to provoke emergent interactions leading to moments of reminiscence.

2.3.2 Props and SwayTheBand (Morrissey et al., 2016)

The most detailed ethnographic study to inform a tangible prototypes of the selection of literature reviewed here, (Morrissey et al., 2016) explores the use of props in the context of participation in group music therapy for reminiscence and identifies the aspects of these props that make them successful or not. While the music therapy is not the primary target of this review, the findings of how PwD interact with props is extremely salient for future work on tangible technologies for RT.

Morrissey et al. (2016) explore how in working with PwDs, the approach to dementia informs the design decisions taken. By treating dementia as a 'disease of cognition' solutions are produced that aim to 'fill the gaps' in cognition. Conversely, by taking an approach that focuses on the PwD's actual 'lived experience', technological solutions produced can have understanding and account for the social, emotional and relational complexities of living with dementia. This shares similarities with Interpretative Phenomenological Analysis from Psychology that has previously been used to better understand complex topics such as the 'lived experience of pain', (Smith and Osborn, 2015). Therefore, when working with PwDs, the focus should be identification of emergent designs that are drawn out from the enrichment of existing interactions.

The ethnographic study focused on non-digital props as 'probes in motion'. These probes were used to gather understanding of the PwDs, providing rich contextualised data for identification of the purpose and requirements of any prototype produced. Highlighted here are the difficulties of using qualitative methods such as Thematic Analysis, (Braun and Clarke, 2006), with PwDs that are mostly non-verbal, as explored in (Huber et al., 2019). Instead gesture and non-verbal queues become important in the rich-data collection process, a harder to interpret form of discourse.

This is the only literature reviewed that discloses specifics about the method used. It details the settings in which the study was carried out, as well as the ethics approval process; something that is noticeably remiss in the other literature even though PwDs are a considered a vulnerable

Figure 5: *Left: SwaytheBand prototype probe in action. Right: Two hands grasping SwaytheBand prototype probe. (Morrissey et al., 2016)*

group. The authors also provide data collection and analysis information. Data used in the study was collected as field notes during the music therapy sessions and then interpreted using Ground Theory (Charmaz, 2014); a method of qualitative analysis that uses inductive query and comparison to produce codes and then categories detailing findings that are 'grounded' in the data.

The 'SwaytheBand' prototype, seen in Figure 5, shares similarities to the 'resonant interface' concept from (Bennett et al., 2016) in that it interacts with the PwD by encouraging them to move to the beat of a song that is represented by the flashing of a light on the prototype. Importantly, this differs from the 'Resonant Rocking Chair' as the initial interaction will be by a carer or researcher handing 'SwaytheBand' to the PwD, rather than their intrinsic motivation to sit in the 'Resonant Rocking Chair'. This difference negates the need for aesthetics that encourage initial interaction, but has the same need to be continually engaging over a long period of time. Morrissey et al. provide clear detail of the technical specifications of 'SwaytheBand' detailing the individual components, connection types and the role of each component. The evaluation of the 'SwaytheBand' prototype with PwDs resulted in a set key lessons. The tangibles should give the feel of being high quality and be interesting and pleasurable to hold. 'Interesting' and 'pleasurable to hold' are lessons supported by (Huber et al., 2019), especially that emitting some form of warmth being valuable to the PwD. They should be 'blank slates', a statement that is supported in (Bennett et al., 2015a) with the need for Tangibles to have '*ambiguity*' to allow the association of participants own interpretations and interactions to the tangible. Any tangible created must allow the PwD choice of interaction; during the evaluation of 'SwaytheBand' certain participants did not wish to use the prototype. Morrissey et al. label this as participating through '*disengagement*' and consider it an important action to be sensitive to in any research, evaluation, or prototype tangible; a consideration that is reflected in the 'Resonant Rocking Chair' Bennett et al. (2016).

The main criticisms of (Morrissey et al., 2016) is the lack of disclosure of participant stage of dementia and the lack of explicit QoL measures in the evaluation stage to monitor positive improvements in line with (Lazar et al., 2014).

3 Summary & Conclusion

Tangible technologies are exciting opportunity to assist in the delivery and facilitation of Reminiscence Therapy for People with Dementia. The nascent object manipulation ability inherent in humans can be engaged through these tangible prototypes to stimulate memories leading to reminiscence, improving the Quality of Life of the PwD. This review explored tangible technology within RT with an aim to answer the questions set out in the introduction:

What are the research approaches and usages of tangible technology within Reminiscence Therapy? The body of literature for tangible technology in RT has increased since

2014, (Lazar et al., 2014). Tangible technology has been used to create interactive and engaging prototypes that have improved the lives of PwDs. Prototypes have been show to be able to act as 'ambiguous proxies' for lost or inaccessible items, allowing PwDs to project their own meaning onto them when undergoing RT. Tangible technology has taken the form of familiar everyday objects, such as a set of drawers or a rocking chair, that embed the reminiscence interaction into intuitive actions. Finally, the concept of 'resonant interfaces' has been applied to tangible technology, allowing for gentle, repetitive movements to create stimulation of memories through interaction with the tangible, a step towards a 'resonant home' environment that allows for ubiquitous, gentle, and calm interaction that stimulates reminiscence.

What are the shortcomings in tangible technology research involving PwDs? Research has persisted in the form of case reports of ethnographic studies with PwDs that inform the creation and testing of prototypes. This indicates that this specific area of study has not progressed in maturity when compared to (Lazar et al., 2014). While individual papers show improvement in disclosure of solution specifications and stage of dementia catered for, there is no agreed standard. QoL measures are still not in explicit use, instead 'experienced evaluators' are used to determine if a PwD is having a positive interaction with any tangible prototype. The lack of disclosure of methodology of both user research and evaluation in some cases has worrying implications for the applicability of prototypes beyond the controlled use of the researchers.

What are the design lessons for future tangible technologies for Reminiscence Therapy with PwDs? A set of key design lessons can be collated from the review literature for future work. A tangible prototype should:

- Be ambiguous in their form - allowing them to be interpreted by the PwD as a proxy for lost or inaccessible objects;
- Use an aestheticaly interesting or familiar form where possible to take advantage of curiosity and affordances of use, (Norman, 2013), that are already intuitive to the PwD;
- Allow grasping and holding should be a primary modes of interaction. The experience of interacting should be interesting and pleasurable to the PwD, especially if it provides warmth;
- Provide freedom of movement so the device can be used with PwDs that may be bedridden;
- All multimedia used should convey the same meaning so as not to be distracting from the specific memory-aid;
- Add to the value of the experience and give the PwD choice if they to interact or not;
- Give consideration in any interaction model to the caregiver, the tangible, the multimedia, the primary PwD, other secondary PwDs that are also interacting. If a researcher or observer is acting in an overt role, this should also be considered in the interaction model.

Limitations. This work is limited by a small number of available samples as the lack of specification of stage of dementia. The non-standardized approaches to user research and evaluation with tangible technologies for RT also add a level of subjectivity in evaluations, comparisons and key findings drawn as direct comparison is not possible.

Future Work. The key finding in the literature, and an area for future work, is the evident difficulty in designing for PwDs as theres' is a uniquely different experience than those without dementia. There have been recent efforts to produce PwD specific design frameworks, such as (Huber et al., 2017), (Morrissey et al., 2017), (Lazar et al., 2017), (Lazar et al., 2018). Examination and evaluation through testing of these in a controlled, systematic manner would inform the production of a standardized framework of design for RT focused tangible technology for PwDs.

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"And the memories of all we have loved stay and come back to us in the evening of our life. They are not dead but sleep, and it is well to gather a treasure of them."

- Vincent van Gogh, The Letters of Vincent van Gogh