Perceptions of thermal environments in dementia friendly dwellings

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Abstract

This study follows on from a research project that developed guidelines for the Universal Design (UD) of Dementia Friendly Dwellings for People with Dementia, their Families and Carers. Research findings point to the need for thermal environments that support people with dementia and do not provoke stress, agitation or anxiety. Using semi-structured interviews and qualitative analysis of people with dementia this paper aims to provide insight into the questions of appropriate thermal environments. The qualitative analysis is supported by example simulated indoor environment studies that investigate comfort in common thermal environment provision scenarios in the homes of people with dementia. This paper focuses on the thermal environment, its impact on people with dementia, its therapeutic value, and its role in encouraging engagement in everyday activity.

Findings from the interviews emphasize that control over their own internal environment is a priority for people with dementia. A strong preference for naturally or passively conditioned environments over mechanical conditioning is evident. Preferences are expressed for naturally ventilated environments enabling occupant instigated air movement. Repeated emphasis is placed on familiar elements including the fire and hot water bottle. Little desire is expressed for information feedback or technological displays.

Keywords: Dementia, Thermal Comfort, Dementia Friendly Dwellings, Care Residence

1 Introduction

It is estimated that 47.5 million people globally live with dementia (WHO, 2012). This number is expected to triple by 2050. In Ireland, there is approximately 48,000 people living with dementia and two-thirds of these live at home in the community. It is reported that up to 87% would prefer to live at home rather than in care facilities (Pierce et al., 2015). This is supported by the Irish National Dementia Strategy which aims to ensure that people with dementia can live at home and in their communities for as long as possible (Department of Health, 2014). However, as it stands the design of housing and the provision of indoor environments presents considerable issue for people with dementia, and in turn challenges for building designers in terms of providing appropriate dwellings.

TrinityHaus Research Centre in collaboration with the Trinity College Dublin’s Dementia Services Information and Development Centre undertook a comprehensive participatory research study involving people with dementia and those who work with, and care for, people with dementia. This research resulted in the development of guidelines for the Universal Design (UD) of Dementia Friendly Dwellings for People with Dementia, their Families and Carers (Grey et al., 2015). A key guideline deriving from this research emphasizes the provision of an environment that is easy to interpret and calm, with particular attention given to the reduction of acoustic and visual disturbances. Similarly research points to the need for
thermal environments that do not provoke stress or anxiety in people with dementia, but are consistently comfortable.

The objective of current comfort standards is to ensure only a minority of occupants are dissatisfied (Brager et al., 2015). However in the context of dwellings for people with dementia it is important that thermal environments achieve much higher comfort levels since occupants may not request help or express adequate response in the case of discomfort. They may not or be incapable of taking adaptive action via active clothing or metabolic change (Hyde, 1983) and prolonged discomfort may result in significant impacts to health and well-being. It is proposed that the built environment has a fundamental effect on a person with dementia, which is probably much greater than for people without a cognitive impairment (Marshall, 1998). However, specification of thermal environments, and evaluation of thermal comfort, of people with dementia are a significant challenge given the nature of the pathology, which results in reduced thermoregulatory capacity that affects thermal sensation, and damage to brain tissue that also impacts on the perception of environments. In addition, people with dementia may have thermal preferences that change over time due to their progressing pathology (van Hoof et al., 2010a). Also they may find abstract ideas difficult to comprehend. As van Hoof (2010) states the concept of thermal comfort is vague for people with an unknown 'state of mind'. Documented research is anecdotal in the main due to ethical constraints of scenario testing on people with dementia.

As a first objective; through distinction of sensation and perception, this paper aims to investigate the role these two concepts play in the context of comfort for people with dementia. The study is focused on private dwellings, where people with dementia will often spend a significant proportion of their day due to the limiting nature of dementia. Questions initially raised during the guideline development project for Dementia Friendly Dwellings are pursued through semi-structured interviews with a small sample set of people with dementia. This initial work will form the basis for a larger investigation of comfort, priorities and concerns. A second objective aims at assessing the fundamental thinking behind the provision of thermal environments and comfort conditions for people with dementia. Care facilities and housing for older people, or people with dementia often prioritise functional and safe environments (Davis et al. 2009), and thereby risk becoming sterile and monotonous. This paper develops from the basis that older people have a more sophisticated understanding of their thermal environments than is often acknowledged (Tweed et al. 2015). This paper advances this concept for those with and without cognitive dysfunction that is often observed in older people (Brayne, 2007). It proposes that thermal comfort and its means of provision is central to an ecological approach to design, which can enhance quality of life and encourage pleasure, curiosity and engagement.

To date, extensive publication of research focused on thermal environmental intervention, design of homes and care facilities for people with dementia, and review of the relevant medical, nursing and care literature, have been undertaken by the research group of Joost van Hoof (van Hoof et al., 2010b)(van Hoof et al., 2010a). This seminal research work outlines comfort concerns and solutions for designing for people with dementia (van Hoof et al. 2010, 2013). This study builds on this research, and the growing body of recent research, and investigates alternatives to the common thinking on comfort. This is achieved through the evaluation of novel contemporary ideas of thermal comfort provision that propose a move away from the common provision of thermal monotonous environments (Brager et al., 2015) and instead activate pleasant physiological sensations of allethesia. This contextual
evaluation allows for insightful investigation of ethical, therapeutic and operational aspects of thermal environment provision for people with dementia. If people with dementia are to remain living in the home then (as an example question) is it better to define tight control of thermal environments or, recognize that there remains a variety of thermal preferences and expectations and that people should be able to take action to achieve comfort. Such issues may be at the core of occupant satisfaction, and allow for enhanced experience of life with dementia.

2 Background

2.1 The multi-sensory environment of home

The interaction of light, air and sound with the form and materiality of architectural space is of the very essence of the architectural imagination (Hawkes, 2008). The significance of light and sound, in achieving visual and acoustic comfort conditions, are recognised in the design guidelines for dementia friendly dwellings (Grey et al. 2015). Both are key to the orientation, way-finding and cueing for the occupant with dementia, but also can create unwanted disturbances of glare and background noise. Well-considered thermal environments can offer the same potential benefits, and encourage activity. In contrast poorly conditioned environments can result in prolonged discomfort and even hypothermia or heat stress. This paper focused on thermal comfort and hence air; temperature, humidity and movement are essential.

Contemporary sustainable, and low-energy, building typologies aim to define a comfort condition by constraining these parameters in a narrow range. Thermal environments become static, uniform, neutral, even boring and monotonous (Brager et al. 2015). Seminal thinkers on thermal comfort have long advocated for a greater variety of thermal experience within buildings, and have shown through extensive field studies that such dynamism is preferred by occupants (Brager et al. 2015; de Dear 2015). Distinguished architectural theorists agree that “every touching experience of architecture is multi-sensory” (Pallasmaa, 2005) and “the most vivid, most powerful experiences of architecture are those involving all of the senses at once” (Heschong, 1979). However, the pragmatic and mechanical processes of climate modification and comfort engineering create environments far removed from the complex sensory experience advocated by Hawkes (2008) or Pallasmaa (2005).

This reductionist approach to comfort limits the opportunities that might otherwise be presented by a more sensory and contextually flexible architecture (Henshaw and Guy, 2015). Proponents of salutogenic design dismay at how architecture, when considered in the context of care, often lose its considerable manipulative power as it becomes subservient to its parts (Golembiewski, 2012). The priorities of residential care are often ‘the passive provision of a safe, caring environment’ with a focus on designing for the purpose of control, to affect or diminish behavioural difficulties.

Presently, people can typically spend up to 17 hours a day in their homes, increasing to 20 hours a day for older people (Bluyssen, 2009). To compound this, the impairments of dementia will often further restrict activity outside the home, in this way the internal home environment becomes the main setting for many people’s lives and frames the vast majority of their sensory experiences. If this is the case, and if sensory stimulation, including varied thermal experiences, is a key part of the human condition, then there is a greater onus on the home to provide rich and meaningful sensory experiences.
2.2 Dementia and the environment of home

While people will experience dementia in very different ways, common symptoms will include high levels of anxiety and stress, and increased sensitivity to the social and built environment (Marshall, 1998). This increased sensitivity stems from a reduction in the individual’s ability to understand the implications of sensory experiences (Sloane et al. 2002). As many authors put it “problem behaviours may be exacerbated by inappropriate environments” (Van Hoof, 2012).

Marshall (2009) points out that people with dementia are typically older, and therefore may also have to deal with age related impairments such as mobility, visual, and hearing difficulties. These impairments may then be exacerbated by dementia as the person may fail to comprehend, or compensate for these difficulties.

While some authors caution against the effectiveness of design in terms of treating dementia (Van Hoof, 2012, Warner, 2003), other authors pronounce the value of a well-considered environment for people with dementia and its ability to offer therapeutic treatment (Marshall, 1998), enhance the quality of life (Cohen and Weisman, 1991) and positively impact behavior, stress and anxiety. Concepts of salutogenic design have grown out of the hypothesis of salutogenesis first introduced in 1979 (Antonovsky, 1979). Antonovsky asked the question, “How can this person be moved toward greater health?” Salutogenic design purports to improve the occupant’s health by providing them with a well-designed environment. New ideas in cognitive neuroscience are proposing cognition to be less rational and more associative than has traditionally been assumed (Dickinson, 2012) – of particular importance with a view to the design of the built environment for people with reduced cognitive ability.

When environment is considered in relation to the development of dementia it is commonly accepted that cognitive impairment is not caused by environmental design (Van Hoof, 2012). However, more recent research has challenged the theory that environment is distinct from the development of dementia, and instead proposes that it may be a contributing factor entangled with brain pathology, lifestyle, and socioeconomic status (Lock, 2013). In this context, the thermal environment is not proposed as a primary effector but shares a causal relationship with socio-economic factors including (fuel) poverty, which impacts indoor environments, thermal comfort conditions and occupant physical and mental health (Clinch and Healy, 2004). Lock (2013) outlines how research focused on dementia causing Alzheimer’s disease has been overly focused on the localization theory, which proposes that dementia onset is related directly to brain pathology defined by a build-up of amyloids, plaques and tangles. Lock pronounces the lack of consistent causality between observed brain pathology and people exhibiting signs of dementia and calls for a greater focus on environmental factors in the development of dementia.

The quality of home environments is a determinant of human health and well-being, demonstrated by studies from varied disciplines (Webb et al., 2013). The widespread presence of sub-standard, inefficient buildings in much of Europe, particularly housing, represents a significant public health concern. Irish housing has long been considered to be thermally sub-standard where a high proportion of occupants live in fuel poverty (Healy and Clinch, 2004), (Curtin, 2009) and face an increased risk of mortality and morbidity. Respiratory health is particularly affected by sub-standard housing, particularly for the old and vulnerable (Webb et al., 2013), with high levels of condensation, mould and damp reported. People living
in cold conditions for prolonged periods are also reported and hence enduring thermal discomfort in their own home for much of their lives.

2.3 Comfort in the home

Many people with dementia continue to live at home, and hence thermal comfort is provided through traditional, commonly passive means, which in many cases may involve non-centralized heating, and without designed ventilation. In such home environments people essentially live abiding by the adaptive comfort model, although as described, often in substandard and unhealthy conditions. However, there is strong rational for maintenance, with improvement, of these modes of environment conditioning. A change to mechanical conditioning or even to constrained conditions including tight temperature set-points or highly reactive space heating systems may overcompensate and create confusion and disorientation. As O’Keeffe states; “our ability to locate ourselves in a space or area, to know if its morning or night, windy or wet, hot or cold, is based on our experiencing changes in our environment consistent with being outside.” (O’Keeffe, 2014)

The adaptive comfort hypothesis argues that contextual factors and past thermal history influence building occupant’s thermal expectations and preferences (Nicol and Humphreys 2002). Therefore, when designing dementia friendly dwellings, there are strong reasons to maintain familiarity with known means of heating and ventilation, notwithstanding that mechanical and high-tech alternatives may offer more controlled conditions. The adaptive comfort model recognizes three categories of adaptation to achieve thermal satisfaction; physiological, psychological and behavioural adaptation. All these adaptive response methods may be affected by dementia.

The experience of comfort can vary with age and health amongst other parameters, and dementia is entangled with both. These variations are due to changes in our nervous sensitivity (sensation) and/or our cognitive processing of stimuli (perception). Both sensation and perception may be impaired by dementia. Although intimately related, sensation and perception play two complimentary but different roles in how we experience and interpret our thermal environments. Sensation refers to the process of sensing our environment through touch, taste, sight, sound and smell. Raw sensory information is sent to the brain. It is processed and perceived by the mind. This process allows us make sense of the environment around us and interpret, amongst an array of sensations, our comfort levels. The sensation of temperature for example activates sub-cutaneous receptors embedded in the dermis layer of the skin. However, it is our perception of this sensation that enables pleasure or displeasure. The concept of thermal allosthesia presents an interesting interaction of these systems. It proposes temporal and spatial variations of thermal conditions, result in hedonic and pleasurable sensations that are generated by the dynamic response of thermoreceptors. These transient effects may be of great benefit to people with dementia in their experience of environments and enable orientation, promote engagement and activity.

Ageing results in changes in the senses to varying degrees, for instance, thermoregulatory capacity is significantly affected, while physiological changes can also result due to inactivity and reduced metabolism (Havenith. 2001). However, dementia can change how people interpret what they sense. This is highly individual depending on the neuropathological changes and sensory loss an can fluctuate depending on time of day, medication management and the social and physical environment (Bakker 2003).
Dementia and the Available Opportunities for Comfort

As discussed, the tendency in residential care architecture is to focus on the safe and functional, to the detriment of variety and familiarity (Davis et al. 2015). Such environments tend toward managed and homogenous thermal environments, resulting in thermal monotony and a dearth of experience of spatial and temporal thermal variations.

At the previous Windsor Conference in 2014, presented five new ways of thinking, or paradigm shifts, for designing or operating buildings to provide enhanced thermal experiences. These include shifts from active to passive design, from centralized to personal control, from still to breezy air movement, from thermal neutrality to delight, and from system disengagement to improved feedback loops. As with the majority of comfort literature, these are proposed as comfort opportunities in the non-domestic environment, but are here evaluated in the context of dementia friendly dwellings.

These proposed alternatives aim to shift toward more thermally dynamic and non-uniform environments that brings pleasure and energizes building inhabitants, while requiring less energy to provide thermally comfortable environments. This moves the focus from the commonly designed thermal monotony (which is energy intensive to achieve) to a more adaptive model of living, breathing architecture that responds to local climate context.

Methodology

This study is based on: i) findings from a recent research project which looked at dementia friendly dwellings from a universal design approach (Pierce et al., 2015); ii) a literature review; iii) semi-structured interviews, and finally iv) scenario simulation testing.

Semi-structured interviews were carried out on a one-to-one basis with four female and one male participant, all aged between 79 and 82. All of the interviewees are living with early stage dementia and reside at home in their own houses, either alone or with family members. The interviews were conducted in Rose Cottage, which is a Dublin based Dementia Resource Centre run by the Alzheimer’s Society of Ireland.

A questionnaire was used to structure the interview and this contained an initial section to collect general information and overall levels of thermal comfort satisfaction within the home. This was followed by five subsequent sections focused on the following: level of personal control over thermal comfort; preference for still air conditions or air movement; preferences for constant or varied temperatures; natural or mechanical ventilation; and finally preferences for information feedback regarding comfort conditions. The interviews were carried out in conjunction with centre’s coordinator and following the interviews a brief group discussion was held with all attendees of the centre, which consisted of a group of 12 individuals.

Common means of thermal environment provision in Irish homes were investigated through simple scenario testing. Simulations were carried out using the DesignBuilder CFD analysis tools based on the EnergyPlus building physics platform.

Findings and Discussion

The paradigm shifts proposed by Brager et al. (2015) provide a framework to examine alternative approaches to thermal comfort for people with dementia. These authors are not only suggesting wider temperature parameters, but also connecting thermal conditions to ideas around person control, environmental perception, pleasure and variety, closer
alignment with natural climatic conditions, and the provision of increased feedback. If the needs of people with dementia are carefully considered within these strategies, can they contribute to a more enriched dementia friendly environment?

These issues were discussed as part of the interviews outlined in the methodology, and the feedback from the interviewees, which is presented in Tables one to five (names changed for anonymity), is examined in the context of the five strategies as set out by Brager et al. (2015). This investigation draws on the literature and the simulation exercise, to examine the implications for dementia friendly design, bearing in mind the various design issues associated with supportive and sensory enhanced environments for people with dementia as previously discussed.

5.1 General findings from interviews

Before the five strategies are examined in detail, some general findings from the aforementioned interviews are outlined to set the context for specific participant feedback.

All of the participants lived in their own terraced or semi-detached, three or four bedroom dwellings, which had been built in the early 1970s. The participants moved into these houses when they were newly built, and have raised their families and remained there since.

Three of the interviewees live alone; one lives with his wife and two adult sons, while the other has one adult son living with her. Four of them have gas or oil powered central heating, while one has an open fire with a back-boiler that heats radiators throughout the house.

As mentioned in the methodology, there were a number of initial questions in the interview to elicit overall levels of comfort and satisfaction within the home. In general the interviewees reported that they are fairly satisfied with the level of heating and ventilation in their homes but stated that other occupants or visitors to the home often find it either too warm or too cold.

5.2 From Centralized to personal control

A key element here is the use of personal control systems (PCS), such as desktop fans or radiant foot warmers, to allow people control their local thermal environment. Other examples might include hot water bottles, electric blankets, or a specific section within a room such as fireplace or inglenook. It can also refer to the opening of a window for ventilation or cooling. Table 1 presents the responses with regard to questions regarding personal control over their thermal environment.

As mentioned above, all of the interviewees stated that other occupants within their home, or visitors, often found the house to be either too warm or too cool. Looking back to the literature, it is reported that older people and in particular people with dementia may experience temperature differently or have alternative comfort requirements compared to other occupants within a space. In the context of a typical dwelling, where other occupants may include younger adults or children, the potential for conflicting thermal requirements is a real possibility. In these circumstances the provision of greater flexibility, such as more localized or person-centred thermal comfort, may be more appropriate.

It also emerged that many of the interviewees liked the flexibility and enjoyed the experience of being able to light fires, or use hot water bottles or electric blankets in colder conditions - “I love to light a fire”.... it’s very homely” (Agnes). The importance of the open fire to older occupants is well recognized in the literature (Neven et al., 2015).
Autonomy for people with dementia to “take initiative and make choices for their lives and care” is a key issue for Lawton (2010), and for Calkin (2001), who describes “Personal Control” as a central component to person-centred therapeutic design. In contrast, highly controlled environments, with an emphasis on health and safety, have been shown to have a negative impact of the quality of life of older people (Torrington, 2007). In this regard Innes (2011) refers to research (Chalfont, 2007)(Chalfont and Rodiek, 2005) which proposes “...a move away from design intended for control, surveillance or to diminish behavioural difficulties to considering how environments can encourage curiosity and engagement in everyday activities.” (Innes et al., 2011)p.548. With this approach in mind the provision of greater individual control over the thermal environment for people with dementia may not only allow them adapt their thermal environment to their specific needs, but also provide a level of control that reinforces autonomy, personal control and engagement with everyday activities.

Table 1. Survey of personal control over thermal comfort.

<table>
<thead>
<tr>
<th></th>
<th>Agnes</th>
<th>Liz</th>
<th>Margaret</th>
<th>Sean</th>
<th>Yvonne</th>
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<tr>
<td>Do you think it’s a good idea to let the temperatures with a house vary a little bit and then use more localized heat sources (i.e. hot water bottle) to warm you up?</td>
<td>Yes – “I love to light a fire ... it’s very “homely” - she loves the glow, warmth, sound etc</td>
<td>Yes - but not a key concern</td>
<td>Not really</td>
<td>Yes – likes to use electric blanket or hot water bottle often finds his feet very cold at night / also takes care to dress appropriately for the seasons</td>
<td>Yes-but not a key concern-likes to use a hot water bottle</td>
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<tr>
<td>Do you like being able to easily open a window or door to let in some fresh air or cool the place down?</td>
<td>Yes – definitely – likes the “feeling of freshness”</td>
<td>Yes – but her house is a bit exposed and if it is windy at all it can blow in fairly hard - she also lives near motorway so traffic noise can be an issue</td>
<td>Yes – but sometimes it can be too cold outside to do that</td>
<td>Yes – definitely – “there is nearly always a window open somewhere”</td>
<td>Yes – would open it in winter</td>
</tr>
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</table>

During the interviews the issue of personal control was a very important issue for the participants. They valued being able to open a window, light a fire, or fill a hot water bottle as needed - “I’m very happy with the current situation because I’m in control” (Agnes)

Of course, this personal control must be carefully designed to ensure that the actions of any individual do not compromise safety and health as discussed by van Hoof (2010). This is where good design underpinned by knowledge and universal design is required (Maki and Topo, 2009).

5.3 From still to breezy air movement

Most of the interviewees enjoy a gentle breeze coming through the window when external weather conditions permit, and some of them stated a preference for having windows open all year around. While an open window and a gentle breeze was associated with freshness, there were also concerns about noise from passing traffic and drafts in more exposed locations (see Table 2).

Brager et al. (2015) refer to the refreshing effect of breezy air movement and the positive impact on perceived air quality, and while these factors will benefit people with dementia, there may be other potential benefits, which were not articulated during the interviews.
Table 2. Survey of preference for still conditions or little breeze within home.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agnes</th>
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<th>Margaret</th>
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<th>Yvonne</th>
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<tr>
<td>Do you like a bit of air movement within the house (not including a draft)?</td>
<td>Yes</td>
<td>Yes - but can be problems with wind and sound (see Table 1)</td>
<td>No real preference</td>
<td>Yes – likes the idea of fresh air coming in</td>
<td>Yes</td>
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<tr>
<td>If so, would you prefer this during warmer weather?</td>
<td>All year if conditions are right</td>
<td>Not really in winter</td>
<td>See above</td>
<td>All year if conditions are right (see note about windows being open all yr above)</td>
<td>All year</td>
</tr>
<tr>
<td>Do you like a gentle breeze coming in through a window or door at certain times?</td>
<td>Likes to open windows to let in air - enjoys the “feeling of freshness”</td>
<td>Yes but can be problems with wind and sound (see Table 1)</td>
<td>No real preference</td>
<td>Yes – see above</td>
<td>Yes</td>
</tr>
<tr>
<td>Or do you prefer very still conditions where you don’t feel any air movement within the house</td>
<td>No</td>
<td>No</td>
<td>See above</td>
<td>No</td>
<td>No</td>
</tr>
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</table>

If properly managed, air movement against the skin will produce a pleasant sensory stimulation in line with Calkin’s (2001) call for ‘Maximal positive stimulation’. If this air movement is perceived as a natural breeze it may also provide a therapeutic connection to nature:

“Connection to nature can be understood in many forms, from passive stimulation by natural sensations, made possible by simply stepping outside or opening a window (e.g. the wind, sunshine or birdsong)” (Gibson et al., 2007)p57

Air movement within a dwelling, for instance in the form of a breeze coming through a window, may represent a “familiar, domestic” environment as advocated by Marshall (1998). Such air movement might also be used as part of a building’s cueing system. According to Judd (1998) cues provide “encouraging and confirming clues to assist wayfinding” (p.16) and while cues are typically visual, Judd argues that the other senses can also be employed to provide cues for people with dementia. In this regard Hall discusses how people with visual impairments use air movement around windows to navigate and also to “maintain contact with the outdoors.” (Hall, 1988) p.59

5.4 From thermal neutrality to delight

In a similar manner to a breeze or air movement, thermal variations may contribute to positive sensory stimulation or provide way-finding cues within the dwelling. As above, Hall discusses alternative wayfinding strategies, and in terms of thermal perception, he points out how people with visual impairments use the radiant heat from objects to help them navigate. In terms of people with dementia, who will often depend on a variety of senses to compensate for cognitive impairment (Marshall, 2009)(Nygard, 2009), any sensory cue that provides information or helps with orientation or wayfinding will be a benefit.

This issue regarding environmental cues and navigation was not discussed in the interviews, but instead questions were asked about the pleasure derived from different thermal experiences (See Table 3). Generally the interviewees preferred a cooler bedroom and this was typically associated with being wrapped up warm in bed, or the use of an electric blanket, or hot water bottle – “I like a hot water bottle, there’s something comforting about it” (Yvonne).
Table 3. Survey of preference for constant and fixed temperatures or greater variety and range.

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<tr>
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<tr>
<td>Do you like all rooms within the house to be the same temperature?</td>
<td>No real preference - however stated that she probably likes bedroom to be cooler</td>
<td>No real preference but would probably like constant enough temperature throughout house</td>
<td>Usually has bedroom a bit cooler</td>
<td>Likes a cooler bedroom and then uses electric blanket / hot water bottle – complained about feet getting cold in bed</td>
<td>Maybe a cooler bedroom – “I like a hot water bottle, there’s something comforting about it”</td>
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<td>Or do you like slightly different temperatures, such as a cooler bedroom or kitchen and a warmer sitting room or bathroom?</td>
<td>Likes a slightly cooler room</td>
<td>See above</td>
<td>See above</td>
<td>See above</td>
<td>Yes see above</td>
</tr>
<tr>
<td>Do you get any pleasure from experiencing different temperatures within the house?</td>
<td>See note about fire in Table 1</td>
<td>Not really</td>
<td>Not really</td>
<td>Enjoys sitting by a warm fire and to wrapped up warm in a cool bedroom</td>
<td>Enjoys a hot water bottle in bed</td>
</tr>
<tr>
<td>Do you get any pleasure from feeling air movements within different parts of the house, such as a breeze in a certain room or location?</td>
<td>See note about windows and freshness in Table 2</td>
<td>Yes but can be problems with wind and sound (see above)</td>
<td>Not really</td>
<td>Yes – see notes above</td>
<td></td>
</tr>
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</table>

5.5 From Active to passive design

Passive design buildings are typically more climate responsive, utilise natural ventilation, and offer greater levels of individual control. Therefore passive design, which offers greater personal control, and more connection with nature and natural cycles, may provide dementia friendly design benefits for the reasons outlined in previous sections.

During the interviews the participants conflated the issue of control and the opening of windows, with the subject of natural ventilation, and therefore the same answers were often given for each. Table 4 outlines some of the key responses and again that the issue of control is important. A perception of freshness was associated with natural ventilation, while one participant explained how they enjoy the sound of birdsong through an open window.

Table 4. Preference for naturally ventilated home or mechanical ventilation using fans or air conditioning.

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<tbody>
<tr>
<td>Would you like if the house was ventilated naturally using air coming in through open windows or vents?</td>
<td>Yes – see note about windows and freshness in Table 2</td>
<td>Yes but can be problems with wind and sound (see above)</td>
<td>Yes - but might have concerns about security and remembering to close them</td>
<td>Yes – likes to be able to control things and adjust the conditions to his preferences.</td>
<td>Yes – has window open all year</td>
</tr>
<tr>
<td>Do you think this approach would give you a better sense of connection with nature, the seasons, or outside weather conditions?</td>
<td>No explicit answer to this but likes the breeze coming in</td>
<td>No real comment</td>
<td>No real comment</td>
<td>Yes – but mostly about fresh air coming in.</td>
<td>Like a breeze and birdsong etc.</td>
</tr>
<tr>
<td>Or would you prefer if the house was cooled and ventilated by mechanical fans or air conditioning?</td>
<td>No - quite definitively</td>
<td>No</td>
<td>No</td>
<td>No – and wouldn’t like the idea of a fan or mechanical vent making noise, especially at night.</td>
<td>No</td>
</tr>
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</table>

Concerns were expressed about traffic noise and other external sounds, while another interviewee spoke about problematic drafts entering the house through open windows. These concerns highlight the challenges presented by passive ventilation in many homes.
whether this is through windows, trickle vents, or passive wall vents. In this context, Sinnott (2016) draws attention to the problems associated with passive wall vents, and finds that occupants often perceive the air ingress as uncomfortable and as a result these vents are frequently sealed or taped up. While variations in thermal conditions within a dwelling may be acceptable, or even desirable (i.e. a cooler bedroom) sharp temperature differences within a room or cold air movement perceived as a draft will be considered as a discomfort for many people (Kinnane et al., 2015). As a brief exploration of this issue the following scenario simulations show the ingress of cold air through a passive wall vent during windy conditions and the resulting localized conditions of discomfort as evaluated using Fanger’s PMV. Cold air dumping can result in dramatic variation in thermal conditions and create extreme discomfort (Kinnane et al., 2014). For people with dementia this may be difficult to comprehend and create anxiety, stress and possible excessive adaptive actions.

![Figure 1: (left) Cold air ingress through passive through-wall vent and (right) resulting thermal localized discomfort due to passive through-wall vent.](image)

As evident from Table 4, the interviewees were not favourably disposed towards mechanical ventilation as an alternative to natural ventilation. While a lack of experience with mechanical ventilation may explain some of this, it was interesting that one participant expressed concerns about the potential for noise generated by fans or mechanical ventilation. Noise has been identified as major problem for people with dementia (Judd 1998) and therefore the design of any mechanical or natural ventilation system must take cognisance of this and ensure a silent running system. This will have added significance for bedrooms as sleep disturbance may be an issue for some people with dementia.

5.6 From system disengagement to improved feedback loops.
The issue of occupant information feedback was difficult to discuss as most of the interviewees had no experience with such systems and therefore saw little advantage (See Table 5 below). One of the participants had a thermostat within their house that gave temperature readings and this appeared to have some influence over her behaviour.
Table 5. Preference for information and feedback of heating and ventilation or less information feedback allowing control to automatic systems

<table>
<thead>
<tr>
<th></th>
<th>Maisie</th>
<th>Mary</th>
<th>Rose</th>
<th>Seamus</th>
<th>Sheila</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would you like if there was some easily read and easily understood information about room temperature or other thermal conditions displayed somewhere within the house so you are aware of what is going on?</td>
<td>No real interest</td>
<td>No real comment - but has a thermostat that gives temperature information and finds that useful and will sometimes be an influence in terms of adjusting the heating</td>
<td>No</td>
<td>No real benefit for him</td>
<td>No real interest</td>
</tr>
<tr>
<td>Or would you prefer if temperature, ventilation or other information about the thermal conditions was not displayed and the buildings systems just managed things without having to bother you?</td>
<td>See above</td>
<td>See above</td>
<td>No preference</td>
<td>Likes it as it is</td>
<td>No – see above</td>
</tr>
<tr>
<td>Would you find such information comforting or helpful in terms of giving you a sense of control?</td>
<td>No – see above</td>
<td>Might be useful for others so they can see the room is warm enough</td>
<td>No comment - See above</td>
<td>No comment - See above</td>
<td>No – see above</td>
</tr>
</tbody>
</table>

Beyond the responses received in this research, the issue of information feedback to people with dementia is a complex one. Nygard (2009) argues that while people with dementia have the same rights as everyone else to access technology, she advises that it may be better to limit the provision of technology within a dwelling to avoid unnecessary confusion. The benefits of feedback through building management systems or in-home displays requires further research. However, research shows that when presented with technology or devices within the home, older people with memory impairments will make great efforts to understand, and learn about the technology (Nygard 2009).

As a consequence, Nygard argues that such technology should always actively involve the user and provide a sense of autonomy. Technology should provide reassurance while supporting the users remaining abilities and supporting decision making. It should be reminiscent of solutions known to the user and provide legible and accessible information that requires minimum learning and interaction.

Involving a person with dementia in the status of the thermal environment and providing greater levels of occupant feedback has its challenges in terms of design. However, if greater levels of personal control are offered, then information feedback, in line with Nygard’s recommendations, will need to be carefully designed to provide relevant, usable, and clearly legible information that avoids information overload and supports the person with dementia.

6 Concluding remarks
This paper argues that the thermal environment within the home is an important issue for people with dementia for a number of reasons. Firstly, given that an older person with dementia will often spend a large proportion of their time inside their home, greater significance is placed on the quality of their thermal environment. Secondly, due to potential thermoregulatory and cognitive issues, a person with dementia may experience their thermal conditions in a very different way to others, and if coupled with communication difficulties, can lead to frustration and anxiety for the person with dementia. Thirdly, if conditions are right for the person with dementia, then thermal factors such as warmth, coolness, or air...
movement, can have a positive stimulating influence leading to a more familiar setting with an enriched multi-sensory environment. Finally, flexibility, occupant control and adaptive comfort play a crucial role in dementia friendly design where personal control and autonomy are critical to the creation of a supportive and therapeutic environment.

It is also proposed that the alternative thermal comfort strategies presented by Brager et al. (2015) represent a framework to consider the thermal needs of people with dementia. In this regard, findings from the literature review and interviews provide some valuable insights, while also presenting some interesting challenges. Responses emphasize that control over their own environment is a priority for people with dementia. A strong preference for naturally or passively conditioned environments over mechanical conditioning is evident. Unsurprisingly interviewees place significant value on familiar elements including the open fire and hot water bottle, and these are emphasized as preferred adaptive measures. Preferences are expressed for naturally ventilated environments enabling occupant instigated air movement. Little desire is expressed for information feedback or technological displays; although this may be partly attributable a lack of experience or knowledge with such technologies. People with dementia should retain control over their own internal environmental conditions as this is behaviorally advantageous and ethically preferable. Removal of control may result in feelings of anxiety and in extreme situations may lead to a misunderstanding of personal well-being and ultimately to risks of hypo or hyperthermia. Consideration should however be given to the use of a temperature range limiter on heating and cooling controls to ensure extreme conditions are avoided.

All of the investigated strategies offer greater levels of autonomy and control which move away from the risk-averse attitude to people with dementia that according to Marshall further disables people (Marshall 2009). These strategies also engender greater engagement with the world through everyday occurrences and natural rhythms which may have therapeutic benefits for people with dementia. It can be argued that sensory design, including thermal conditions, can help create more embodied and orientating experiences for people with dementia and support Pallasmaa’s assertion that:

“Architecture reflects, materialises and eternalises ideas and images of real life. Buildings and towns enable us to structure, understand and remember the shapeless flow of reality and ultimately, to recognise and remember who we are.” (Pallasmaa, 2012)

References


Pierce, M., Cahill, S., Grey, T., Dyer, M., 2015. Research for Dementia and Home Design in Ireland looking at New Build and Retro-Fit Homes from a Universal Design Approach: Key Findings and Recommendations. The Centre for Excellence in Universal Design at the National Disability Authority, Ireland.


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