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Decreasing spatial disorientation in care-home settings: How psychology can guide the development of dementia friendly design guidelines

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Abstract

Alzheimer's disease (AD) results in marked declines in navigation skills that are particularly pronounced in unfamiliar environments. However, many people with AD eventually face the challenge of having to learn their way around unfamiliar environments when moving into assisted living or care-homes. People with AD would have an easier transition moving to new residences if these larger, and often more institutional, environments were designed to compensate for decreasing orientation skills. However, few existing dementia friendly design guidelines specifically address orientation and wayfinding. Those that do are often based on custom, practice, or intuition and not well integrated with psychological and neuroscientific knowledge or navigation research, therefore often remaining unspecific. This paper discusses current dementia friendly design guidelines, reports findings from psychological and neuropsychological experiments on navigation, and evaluates their potential for informing design guidelines that decrease spatial disorientation for people with dementia.

Introduction

There are currently 820,000 individuals with dementia in the UK and with increased life expectancy, this figure is expected to rise to more than one million by 2025 (Alzheimer's Society 2015a). 60-80% of all dementia cases are of the Alzheimer's disease (AD) type (Alzheimer's Association, 2015). Declines in navigation and orientation skills are among the first symptoms of AD, and appear to be quite stereotypical in people with AD (Pai & Jacobs, 2004). Whilst people who experience the milder symptoms of AD can often remember familiar environments, learning new environments becomes especially difficult (Lithfous, Dufour, & Despres, 2013). It is therefore unfortunate that 80% of people living with dementia eventually move from their well-known environment into assisted living or care-home environments (Alzheimer's Society, 2015b). To enable care-home layouts to be learnt with ease, environments need to be designed such that they support spatial orientation. Improvements in design layout could compensate for impaired abilities and reduce disorientation for those with dementia. This would also improve quality of life and wellbeing, allow for the highest possible degree of independence to be maintained, reduce the work load of the carers and ease the transition of moving into care-homes (Marquardt & Schmieg, 2009).

Despite multiple dementia friendly design guidelines being readily available (Yates-Bolton, Yates, Williamson, Newton, & Codinhoto, 2012), only a minority discuss the importance of alleviating disorientation and design-led improvements; these often come from professional practice, and are rarely backed by empirical or experimental evidence.

We will argue that design guidelines could be improved if informed by the in-depth understanding of the (neuro-) psychology of navigation and the effects that AD has on cognition; we will discuss how future research can contribute to this process. Improvements to care-home design could compensate for impaired navigation abilities and support residual orientation skills which would alleviate the disorientation experienced by those with AD.

We will begin by reviewing current dementia friendly design guidelines that relate to navigation and orientation.

Dementia friendly design guidelines

It has been argued that designing an environment for people with dementia will result in well-designed environments for all (Marshall, 2001). Whilst it is not obligatory for care-homes to be "dementia friendly" in their design, many organisations are trying to adopt designs that increase well-being for the resident, reduce work load for the carer, and to meet (and often beat) the standards of competing care-homes. Some guidelines and frameworks that refer to what constitutes dementia friendly environments are readily available via the web and in print form. The majority of these focus on ways to enhance person-hood, visual appearance and ways to aid memory, as these factors have been found to increase well-being in the residents (Kitwood, 1995; Lynch, 1960).

Only a handful of these guidelines though, report issues surrounding spatial (dis-)orientation in detail (Dementia Services Development Centre, 2011; Lewis et al., 2010a; Mitchell, Burton, & Raman, 2004; The King's Fund, 2013); Few take into account the specific impairments in orientation and navigation reported in (neuro-)psychological research.

Design tools that discuss ways to alleviate disorientation will be reviewed in turn. (See Table 1 for an overview of the tools discussed and their contributions towards orientation facilitation).

The Dementia Audit Tool (DAT)

The DAT contains a series of resources aimed at carrying out self-assessments in environments used by people with dementia. Both for refurbishments and new builds, users can identify areas for improvement which can then be formally assessed by a member of the DAT team (Dementia Services Development Centre, 2011). The professionals who devised this tool have also contributed towards similar tools addressing “Improving the design of housing for people with dementia” and “Design for people with dementia: an overview of building design regulators they also have a “Dementia Design Checklist”, together with Health Facilities Scotland , that comprises of both internal (e.g. bedroom, communal areas) and external (e.g. garden) environment features that they raise as being important design aspects for people with dementia (Health Facilities Scotland, 2007a). When using the Dementia Design Checklist, an accreditation scheme is offered whereby complying care-homes receive gold, silver or bronze “stars” recognising their efforts in being dementia friendly. Whilst this tool identifies many key environmental aspects (e.g. colour contrast, lighting), there is little direction on how environmental design could improve orientation and wayfinding for residents. The Dementia Design Checklist states “There should be landmarks to assist people with finding their way to areas e.g. their bedroom, such as furniture, plants, wall hangings, artwork and generally items that are attractive and interesting" (Health Facilities Scotland, 2007a, p.11). Landmarks are only mentioned once and referred to in a broad sense; more specificity and research is needed to know which specific landmark qualities are most helpful in guiding navigation.

EVOLVE

The EVOLVE design toolkit, initially created to facilitate extra care housing design, is a recent and successful tool (Orrell et al., 2013) which can be used in multiple care-home settings. It was developed by analysing literature reviews, policy guidelines, reviews of recent buildings, design guidance, building surveys, quality indicators, focus groups with extra care housing residents and their relatives, and expert consultations (Lewis et al., 2010a). EVOLVE is particularly useful in well-being and quality of life research, highlighting correlations between design principles and quality of life -for people with dementia (Orrell et al., 2013). However, orientation and wayfinding is mentioned only twice in this toolkit, and the guidelines remain rather generic. Specifically, in the overview document of the tool, Lewis et al. (2010a) highlight "memorable features that help people to navigate their way around the building" (p.8). The EVOLVE circulation section stipulates the need for "distinctive internal landmarks at less than 30m along the travel routes" (Lewis et al, 2010a, p.7).

Enhancing the Healing Environment (EHE) assessment tool

The Enhancing the Healing Environment (EHE) assessment tool (The King's Fund, 2013) emphasises the users' and their carers' perspectives and how they interact with the environment. This tool has been field tested by 70 care organisations and is currently used in hospitals and care-homes.

The tool includes a section on ways to “promote orientation”, highlighting the use of signage, avoiding mirrors, and briefly mentioning the use of landmarks. For example The King's Fund (2013) state “Are pictures/objects and colour used to help people find their way around?” (p.8) suggesting that the implementation of colours and objects that serve as landmarks can help people when navigating.

Environmental Audit Tool (EAT)

The Environmental Audit Tool (EAT) (Fleming, 2011), includes 72 items that fit within 10 main design principles, including that environments should “Be simple with good visual access” and “Provide for planned wandering.” (p.109). Although this tool has been empirically shown as robust in measuring the quality of environmental design for people with dementia, it offers little guidance on ways to reduce disorientation or support successful wayfinding for people with dementia.

Moreover, in one of his design papers, Fleming, one of the authors of the EAT tool, draws attention to the limited empirical evidence supporting the use of signage and memorabilia to guide orientation (Fleming & Purandare, 2010):

> Perhaps surprisingly, the evidence for the beneficial effects of signage is not strong (Hanley, 1981; Namazi and Johnson, 1991b) and weak empirical support was found for the use of the display of personal memorabilia as aids to orientation (Namazi et al., 1991) (Fleming and Purandare, 2010, p.111).

This may be a reason why orientation has not received much attention within the EAT tool.

NHS Scotland Wayfinding document

The NHS Scotland Wayfinding document (2007) is an in-depth guidance tool containing multiple ways to promote effective wayfinding and signage within healthcare facilities. The document focuses on the benefits landmarks have in aiding wayfinding: "prominent landmarks for people to notice, remember and recognise, internally and externally" (Health Facilities Scotland, 2007b, p.15) and highlights that environments without landmarks may lead to disorientation (Health Facilities Scotland, 2007b). As well as emphasising the importance of wayfinding, it also illustrates how multi-facetted aspects the problem of wayfinding is. For example, discussions on how environmental features influence decision making, how to give effective route descriptions and ways that could hinder orientation are also included. The latter is particularly interesting as it emphasises the way people use language, an issue that has not yet been addressed empirically.

Excellence in design; optimal living space for people with Alzheimer's disease and related dementias

Devised by architectural firm Perkins Eastman, this guideline includes a wide spectrum of design principles, surrounding safety and security, entry and egress, active engagement and wayfinding, aimed to help those with a dementia, particularly those with AD (Chmielewski & Eastman, 2014). Their wayfinding chapter holds that "Spaces should be distinct, both in appearance and overall layout. Repeating or mirroring floor plans can be confusing for some people, since they may perceive households as the same." (p.16). This guideline also discusses landmarks providing more detailed information than most other guidelines:

> At each decision-making point, such as hallway junctions, there should be orienting landmarks to help with wayfinding. Since distinctive cues are more memorable than subtle changes (e.g., a change in colour finish), landmarks should be unique and varied, such as recognizable objects, artwork, or a view to a specific outdoor feature. (Chmielewski & Eastman, 2014, p.16).

These more detailed descriptions provide more specific direction of how, and where, wayfinding aids should be present.

Additional architectural research suggestions for dementia friendly design

Architectural features of complex built environments generally affect navigation and orientation. For example, navigation performance, decreases with increasing floor plan complexity (O'Neill, 1991). On the other hand navigation performance is facilitated when (1) visual access is increased, (2) there is a degree of architectural differentiation, (3) with improved floorplan configuration and (4) when signs and room numbers are used consistently within the environment. (Arthur & Passini, 1992; Emo, Hoelscher, Wiener, & Dalton, 2012; Weisman, 1981; Werner & Long, 2003). Passini and colleagues therefore, argue that the ease of wayfinding within a built environment should be a vital factor of a building's design (Arthur & Passini, 1992; Passini, 1984).

While architectural form and structure have been discussed in dementia friendly design guidelines and research reports reviewed above, this section will focus on evidence from the field of architecture in more detail.

Floor plan and structure

An environment's layout and structure is generally accepted as having an impact on orientation abilities. Many of the dementia friendly design guidelines have emphasised this as an important factor to improve wayfinding and orientation for people with dementia (Dementia Services Development Centre, 2013b; Mitchell, Burton, & Raman, 2007; Passini, Pigot, Rainville, & Tetreault, 2000). However, only a limited number of studies from the realms of architecture have systematically studied how the structural features of built environments impact on orientation and navigation in people with AD.

To decrease spatial disorientation in people with dementia, circulation systems should be simple (Marquardt et al., 2011b; Marquardt & Schmieg, 2009). Elmstahl, Annerstedt, & Ahlund, (1997), for example, identified that L-shaped floor plans led to less disorientation in comparison to corridor or H shaped environments (see Figure 1). The easiest floor plans though are straight circulation systems, with no changes in direction (Marquardt & Schmieg, 2009).

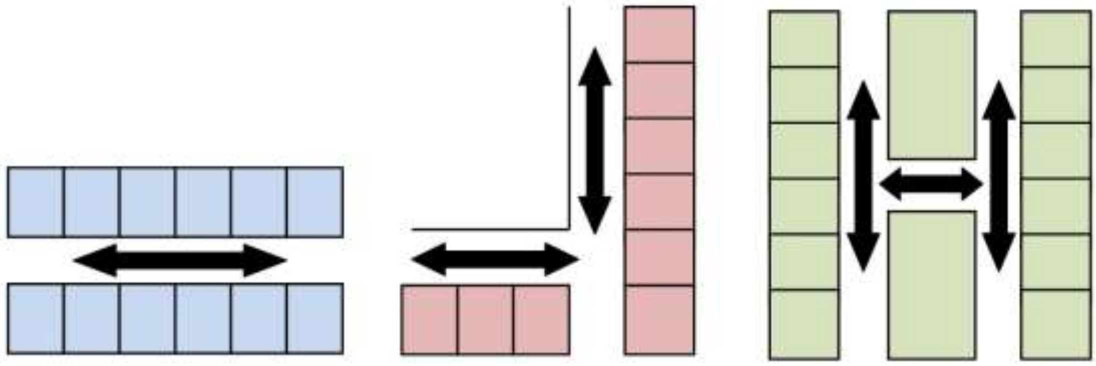

Figure 1. From left to right, a straight layout system, an L-shaped corridor (with a change in direction) and an H-shaped corridor.

Marquardt and colleagues found that spatial layouts that are more connected to the whole spatial system (intelligible) as opposed to environments that are broken up by rooms, stairs and circulation areas (convexity) affected people with dementias ability to complete activities of daily living (e.g. eating, sleeping). Specifically, environments with higher "convexity" and those that were more broken up, supported participants' daily activities better (Marquardt et al., 2011a). While care-home design often addresses components of the environment that relate to the accessibility both within and outside of the care-home (e.g. ramps, door width and stairs), modifications that assist cognitive function for those with memory problems are often not considered (HM Government, 2010). Marquardt and colleagues argue that inaction to modify existing environments results from scepticism about the benefits design can have on cognitive functioning (Marquardt et al., 2011b).

Table 1. Guidelines and papers that discuss ways to alleviate disorientation for people with dementia, and the specific environmental features that they cite.

Tools & papers	Layout/Structure	Landmarks	Colour	Other wayfinding aids stated
DAT Tool	✓	✓	✓	Memory boxes
EVOLVE Tool	✓	✓	✓	
EHE Tool	✓	✓	✓	Signage, memory boxes, avoiding mirrors
EAT Tool	✓			
NHS Scotland wayfinding document	✓	✓	✓	How routes are described
Excellence in design	✓	✓	✓	
Utton, (2009)		✓	✓	
Mitchel, Burton and Raman(2004)	✓		✓	How routes are described
Marquardt (2009)	✓			Signage
Passini et al., (2000)	✓	✓		

Interior design features: landmarks and colour

In addition to the structural form of the building, architects also discuss the use of colour and landmarks. Utton (2009), for example, describes two dementia friendly care-home projects where “a combination of feature wall colour contrasts, large and distinct paintings, and wall-mounted light fittings aid orientation and help with wayfinding” (p.383). As such design features are easy to implement in already existing built environments, it is vital to provide empirical evidence to demonstrate that they can guide orientation and navigation in people with dementia. Moreover, it is important to develop a detailed understanding of how these design features exactly impact on orientation and navigation skills.

Other reports have highlighted the importance of giving appropriate route directions. Mitchell et al. (2004), for example, state that “Older people with dementia continue to plan and visualise proposed routes and tend to use landmarks and other visual cues rather than maps and written directions as wayfinding techniques” (p.2). This again emphases the importance landmarks have in promoting successful wayfinding and navigation in people with dementia. However, simply adding additional landmark or objects in the environment could result in “information clutter” which could have detrimental effects on orientation (Passini et al., 2000). More empirical research is needed to understand how much orientation and navigation cues are optimal in compensating for declining orientation and navigation skills in people with dementia.

Interim conclusion

Design guidelines and architectural studies highlight the importance of similar environmental features when it comes to decreasing spatial disorientation in people with dementia, specifically the structural layout and the availability of landmarks. Only few sources give specific direction regarding the type of landmarks that should be used, as well as where they should be positioned (e.g. decision points). Another aspect frequently mentioned is to design areas such that they are memorable, salient and easily distinguishable from other areas. However, empirical evidence demonstrating the effectiveness of these manipulations and how exactly they are used for navigation in people with dementia is limited. To develop an in-depth understanding of how good environmental design can compensate for dementia-related orientation deficits and to improve dementia friendly design guidelines, it is therefore crucial to systematically manipulate environmental factors using experimental design approaches. This is where psychological and neuroscientific research can come in.

The psychology of navigation

Psychology and neuroscience have studied navigation and orientation for decades (Maguire et al., 2003; Moser, Kropff, & Moser, 2008; O'Keefe, Burgess, Donnett, Jeffery, & Maguire, 1998; Taube, Muller, & Ranck, 1990; Tolman, 1948). Psychology has investigated the mental representations as well as the cognitive processes involved in successful navigation and different navigation tasks. Cognitive neuroscience, in turn, has described different types of neurons coding spatial information (place cells, grid cells, and head direction cells) and the contribution of different brain areas to navigation. Together, these disciplines have developed a comprehensive theory and an in-depth understanding of the principles of navigation.

It is beyond the scope of this paper to provide an in-depth overview of theories of navigation in psychology and neuroscience, thus we will focus on landmarks and their role in navigation. We will then report some of the findings into the effects of AD on navigation behaviour, before discussing ways in which (neuro-) psychological research can inform dementia friendly design guidelines in the future.

Landmarks: definition, properties and functions

A substantial part of the navigation research focuses on the role of landmarks in supporting and guiding navigation and while different definitions exist, a landmark is typically defined as an object or (sensory) feature in the environment that is used to identify a specific location to guide navigation.

The majority of the design guidelines discussed above highlight that landmark objects needs to be easily seen, recognised and need to enable someone to establish their location. These properties are also reflected in landmark models in psychology. Stankiewicz and Kalia (2007) state that landmarks need to be (1.) persistent, i.e. they need to be present when the navigator returns, (2.) they need to be salient, i.e. navigators must be able to recognise the landmark when returning to the same place, and (3.) they need to be informative, i.e. they need to carry information about the position of the navigator and the action to be taken to move towards a destination (Stankiewicz & Kalia, 2007).

It is important to note that landmarks serve different functions in navigation depending on the exact nature of the landmarks, the actual navigation task, and the context (Chan, Baumann, Bellgrove, & Mattingley, 2012). An in-depth understanding of these landmark functions is paramount in developing, improved and more specific dementia friendly design guidelines.

Landmarks as beacons. The most basic way in which landmarks can guide navigation is if they function as beacons. Landmark-beacons are situated close to the actual target location. If this spatial relationship is memorised, recognition of the beacon can lead navigators close to the goal. Beacons have been shown to be particularly efficient navigation cues when learning complex and long routes (Waller & Lippa, 2007). Moreover, older participants show a preference for navigation strategies that utilize beacons over other route learning strategies (Wiener, de Condappa, Harris, & Wolbers, 2013) which may suggest that beacon-based strategies are more resilient to age-related changes in navigation abilities than other navigation strategies.

Landmarks as orientation cues. When asked to name landmarks, most people think of the Eiffel Tower, Big Ben, the Sydney Opera or the Golden Gate Bridge. These landmarks are visible from a large distance and are therefore, often referred to as global landmarks. Global and distant landmarks provide "compass like" orientation information, as local movements do not change the spatial relationship between the navigator and distant global landmarks much (Steck & Mallot, 2000). In other words, even if navigators get lost in the local environment, global landmarks provide them with compass-like directional information for the whole environment, which can be used to facilitate reorientation and navigation.

Landmarks as associative cues. One of the most prominent everyday navigation tasks is that of navigating familiar routes, for example when commuting from home to work and back. When navigating such – often overlearned – routes, landmarks are thought to serve as associative cues: the recognition of a landmark triggers the movement response required to continue along the route, for example “Turn right at the church” (Trullier, Wiener, Berthoz, & Meyer, 1997; Waller & Lippa, 2007).

However, when learning a novel route, not all objects in the environment are equally likely to be remembered. Specifically, in order to be remembered, landmark objects need to be positioned at navigationally relevant locations, i.e. decision points (Aginsky, Harris, Rensink, & Beusmans, 1997; Janzen & van Turennout, 2004; Schinazi & Epstein, 2010). Moreover, the positioning of the landmark can affect whether or not it is used as a beacon, or an associative cue (Waller & Lippa, 2007). Not all objects make equally good landmarks: uniqueness, saliency and how easily nameable a landmark is, affect how likely it is to be selected as a landmark (Klippel & Winter, 2005).

Place recognition. One of the most fundamental functions of landmarks is to help us recognize places we have visited before. Place recognition is a crucial component of successful navigation as it allow us to orientate and localise ourselves in the environment. The actual landmark information used to recognize is often referred to as local position information and can range from views that are specific to a particular location (Gillner, Weis, & Mallot, 2008) single unique objects or even configurations of landmarks (Mallot & Gillner, 2000; Steck & Mallot, 2000; Waller, Friedman, Hodgson, & Greenauer, 2009).

Landmarks & cognitive mapping. Integrated representations of space, often referred to as cognitive maps, provide information about the spatial relationships between various places in the environment. Cognitive map-like knowledge of environments allows us to relate our current location (place recognition) to other locations in the environment which are beyond the current sensory horizon. While route knowledge guides navigation only between the start and the destination of the route, cognitive maps allow for flexible and goal directed navigation, the planning of novel routes and shortcutting behaviour (Wiener, Ehbauer, & Mallot, 2009). Landmarks are often described as an organising principle of cognitive maps (Presson & Montello, 1988), as they serve as the fundamental building blocks and reference points.

How AD affects navigation

The effects of AD on navigation have been described in a now growing body of literature: typically, AD, as well as amnesic mild cognitive impairment (MCI), is associated with severe declines in navigation skills, particularly with the ability to learn novel environments or new routes through unfamiliar environments (deIpolyi, Rankin, Mucke, Miller, & Gorno-Tempini, 2007; Pengas et al., 2010). These navigation impairments are explained by the substantial overlap of the network of brain areas involved in successful navigation and the network of brain areas that are affected already during the earliest stages of AD (for a recent overview, see Lithfous et al., 2013). Tasks that assess spatial memory ability (e.g. route learning tasks, landmark location tasks) are particularly sensitive to the effects of early AD and prodromal amnesic MCI. In fact, it has been argued that these tasks can be used to discriminate AD from other forms of dementia such as semantic dementia, suggesting that spatial memory tests could be used as clinical tools for the early and differential diagnosis of dementias (Bird et al., 2010; Pengas et al., 2010).

The most prominent navigation paradigm used in studies investigating the effects of typical and atypical ageing is that of learning a novel route through an unfamiliar environment. While a substantial body of research has studied the effects of typical ageing on route learning abilities (Head & Isom, 2010; Wiener et al., 2013; Wiener, Kmecova, & de Condappa, 2012) fewer studies have tested people with AD. The results of those that have, demonstrate marked impairments in route learning (Bellassen, Iglo, Cruz de Souza, Dubois, & Rondi-Reig, 2012; Cushman, Stein, & Duffy, 2008; Pengas et al., 2010). However, in the context of this paper it is important to note that not all aspects of route learning are affected equally by AD. For example, Cushman and colleagues guided participants (young group, older typical ageing group, older with MCI group and older with AD group) along a relatively complex route in a hospital setting and asked them afterwards to solve a series of different tasks (Cushman et al., 2008). These tasks included, among others, retracing the route (route learning), recognising whether or not particular photos were taken on the encountered route (photo recognition) and locating photos or short videos taken from along the route (photo or video location). By comparing performance between the four participant groups, Cushman and colleagues isolated the effects of typical and atypical ageing. While the deleterious effects of ageing and AD were reflected in performance declines from the young to the older group to the MCI group and the AD group, this decline was not the same for all subtasks. The most severe AD-related declines were found in tasks that required integrated representations of space or cognitive maps (video and photo location) while other tasks such as the photo recognition task were less affected. While such findings suggest AD related difficulties in learning spatial properties of novel routes, other aspects of route knowledge seem fairly resilient to AD related declines. Understanding how these aspects of route knowledge can be used to help guide orientation, is of paramount importance for the development of improved dementia-design guidelines.

Ways forward

While (neuro-) psychological research has led to the development of comprehensive theories of landmarks and navigation, our understanding of how AD affects navigation is still limited. Most investigations into AD-related orientation and navigation impairments do not systematically address different navigation tasks or the different functions landmarks play in successful navigation. Many of the more recent studies rely on computer graphics or virtual environments technology (Cushman et al., 2008; Kessels, van Doormaal, & Janzen, 2011; Pengas et al., 2010). While such technologies allow for full control of the stimuli or environmental cues in the scene, and allow researchers to isolate the impact of single cues, the environments often lack the detail and richness of real environments. Finally, most experiments in cognitive (neuro-) psychology are single session experiments, and results frequently suggest that people with AD cannot successfully learn novel environments in such a short time-span. While such approaches are appropriate to study the orientation and navigation processes and components that are affected by AD, they may underestimate the orientation and navigation abilities in real world settings. Moreover, these approaches may not be the most suitable approaches to investigate how we can improve dementia friendly design guidelines in order to minimise spatial disorientation in residential sheltered living or care-home settings.

We believe that combining methods from psychology and social sciences provides an advantageous way forward to improve dementia friendly design guidelines. For example, rather than testing participants' abilities to learn unfamiliar environments – a task people with dementia do not face on a daily basis – it may be fruitful to assess what environmental cues or features they use for navigation once they have learned an environment. This may require multi-session experiments, in which participants learn unfamiliar environments over several experimental sessions. An alternative approach would be to assess people's knowledge of their own environment, for example, several months after moving into a retirement, sheltered living or care-home environment. In addition, qualitative interviews with the residents may reveal (1) orientation strategies that people with AD use to compensate for decreasing navigation abilities, and (2) which cues they select for navigation. Finally, knowledge from such investigations needs to be translated into design suggestion, ideally in close collaboration with professionals such as carers, designers and architects, to improve dementia friendly design guidelines.

Conclusion

In this paper we have highlighted the need for greater specificity in dementia friendly design guidelines that address orientation and navigation. Although many guidelines discuss the importance of landmarks, few give specific examples of how they should be implemented in actual environments. We argued that theories of orientation and navigation, as well as research approaches used in cognitive psychology, can be used to inform the improvement of dementia friendly design guidelines in order to minimise spatial disorientation.

More research should focus on the impact different landmark features have on orientation for people with AD and mild memory difficulties; this will allow more precise and effective environmental manipulations supporting orientation to be implemented.

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