

# Wayfinding for People With Dementia: The Role of Architectural Design

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## Abstract

**Objective:** This paper provides an overview of the available literature on architectural wayfinding design for people with dementia in nursing homes. The results were to be summarized and substantiated through an interdisciplinary interpretation, taking into account changes in the orientation process of people with dementia.

**Background:** Spatial disorientation and declining wayfinding abilities are among the early symptoms of dementia, limiting a person's ability to perform activities of daily living (ADLs) independently and ultimately, perhaps leading to institutionalization. A prerequisite to maintaining residents' quality of life in a nursing home is their ability to orient themselves within their new environment.

**Approach:** The available literature on wayfinding design for people with dementia in nursing homes was reviewed. Two aspects of interventions for residents' wayfinding abilities were identified: the design of the floor plan typology and environmental cues.

**Results:** The design of the physical environment plays a major role in supporting the wayfinding abilities of people with dementia. The floor plan design of a nursing home in particular

has a significant influence on residents' spatial orientation and wayfinding. Additional interventions such as signage, furnishing, lighting, and colors are additional supporting features but they cannot compensate for an adverse architectural design.

**Conclusions:** For the creation of a supportive, dementia-friendly environment, both aspects of architectural design must be considered. Design guidelines to support the wayfinding abilities of people with dementia were developed to synthesize both.

**Key Words:** *Dementia, wayfinding, orientation, architecture, nursing home*

## Introduction

Finding one's way is an essential ability and a prerequisite for autonomy and independence, thereby promoting self-sufficiency and self-esteem. However, spatial disorientation and declining wayfinding abilities are among the frequently mentioned early symptoms of dementia. In 2002, the prevalence of dementia among individuals aged 71 and older was 13.9% and comprised 3.4 million individuals in the United States (Plassmann et al., 2007). The prevalence increases dramatically with age: approximately 5% to 8% of individuals over the age of 65, 15% to 20% of

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individuals over the age of 75, and 25% to 50% of individuals over the age of 85 years are affected (Kawas & Katzman, 1999).

By definition of the American Psychiatric Association (APA, 2007), the essential features of a dementia are multiple acquired cognitive deficits that usually include memory impairment and at least one of the following phenomena in the absence of a delirium that might explain the deficit: *aphasia* (inability to speak), *apraxia* (disorder of motor planning), *agnosia* (inability to recognize objects, shapes, persons, etc.), or a disturbance in executive functioning (the ability to think abstractly and to plan, initiate, sequence, monitor, and stop complex behavior). Dementia of the Alzheimer's type, commonly referred to as Alzheimer's disease, is the most common dementia, accounting for 50% to 75% of the total number of cases, the percentage increasing with age (APA, 2007).

The reason for spatial disorientation in dementia might be found in memory deficits (Monacelli, Cushman, Kavcic, & Duffy, 2003), visuospatial deficits (Liu, Gauthier, & Gauthier, 1991), and dementia-specific changes in orientation strategies and in the loss of planning abilities (Passini, Rainville, Marchand, & Joannette, 1998). Getting lost in unfamiliar locations is already mentioned at Stage 3 of the Global Deterioration Scale (GDS) (Reisberg, Ferris, de Leon, & Crook, 1982). The GDS is a seven-stage rating scale used to assess whether a person has cognitive impairments that are related to dementia. It ranges from no cognitive decline (Stage 1) to severe dementia (Stage 7).

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***A decline in orientation limits a person's ability to perform daily activities independently; therefore, it is a prime reason for institutionalization.***

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Stage 3 indicates a mild cognitive decline. Spatial skills in familiar environments might remain intact at this point (Liu et al., 1991). At Stage 4 of mild dementia, disorientation also can occur in familiar locations. A decline in orientation limits a person's ability to perform activities of daily living (ADLs) independently (such as self-care, including feeding oneself, bathing, dressing, and grooming, as well as work, homemaking, and leisure). Therefore, spatial disorientation is a prime reason for institutionalization (McShane et al., 1998).

The prevalence of dementia in nursing home admissions was found to be 50% (Magaziner et al., 2000); among those already residing in a nursing home, it was 62% (Matthews & Dening, 2002). Residents' ability to orient themselves within the nursing home is a prerequisite for maintaining quality of life (González-Salvador et al., 2000; Hoe, Hancock, Livingston, & Orrell, 2006). This paper provides an overview of the available literature on wayfinding design for people with dementia. If particular studies involved enrolling only people with a diagnosis of Alzheimer's disease, this is noted. However, this should be regarded with caution because the definitive di-

agnosis of Alzheimer's disease requires both the clinical syndrome and microscopic examination of the brain at autopsy (APA, 2007).

But with Alzheimer's disease accounting for the majority of the total number of cases of dementia and an even greater proportion of cases in the higher age ranges (APA, 2007), it can be assumed that in all studies the majority of participants were people with dementia of the Alzheimer's type. Additionally, the focus of this literature review will be on nursing homes because most of the empirical evidence available is from those settings. Also, the majority of people with dementia are institutionalized at some point during their disease (Gaugler, Kane, Kane, Clay, & Newcomer, 2002; Hébert, Dubois, Wolfson, Chambers, & Cohen, 2000). Design guidelines for dementia-friendly environments that promote wayfinding and spatial orientation conclude the article.

### **Wayfinding in Dementia**

The process of finding one's way includes knowing where you are, knowing your destination, knowing (and following) the best route to the destination, recognizing the destination upon arrival, and finding the way back (Brush & Calkins, 2008). Even the first step of this process can be challenging. As Örluv points out, people with dementia suffer from "disorientation to an extent that has made independent living impossible [but it] does not preclude a remaining capacity to approach, in a constructive and systematic way, the issue of where one is" (Örluv, 2010, p. 39). Further steps in the wayfinding process are, as Diaz Moore, Geboy, and Weisman (2006) stated,

"conditioned by the innate physical and perceptual-cognitive abilities of the person as well as by the spatial and sensory information provided by the environment in which the person finds herself" (p.117). From these factors the authors derived four areas of transaction critical to successful wayfinding, each of them essential to success:

1. Cognitive ability to process spatial information
2. Cognitive ability to process sensory information
3. Physical ability to ambulate the spatial organization
4. Physical ability to perceive sensory information

However, with old age and the symptoms of dementia all four areas of transaction can be compromised: cognitive abilities may be limited because of dementia, and physical abilities may be reduced by sensory impairment, such as poor vision. Therefore, a supportive design of the environment is needed. Furthermore, the lack of good wayfinding abilities may be related to other negative symptoms of dementia, such as wandering (or restless walking): poor performance on simple wayfinding goals and global wayfinding strategies were the deficits most associated with wandering.

How problems with spatial orientation are related to wandering behavior is not yet understood; further research on the matter is necessary (Algase et al., 2004). Yet supporting the wayfinding abilities of people with dementia is an important therapeutic goal of environmental design. Although people

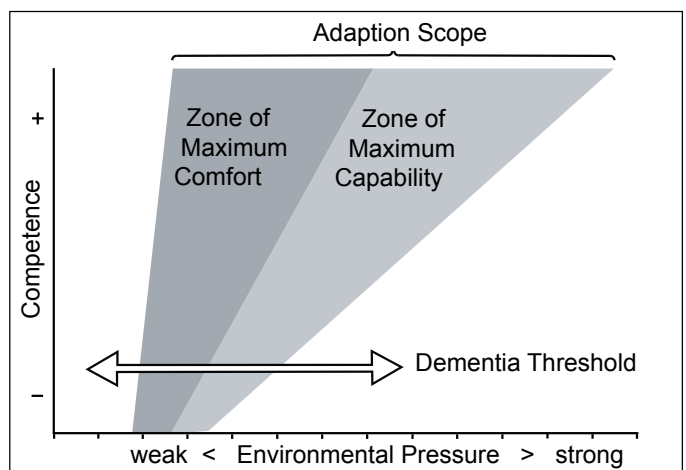
with early Alzheimer's disease show little difference in orientation when compared with healthy subjects (Jheng & Pai, 2009), a compensating environment becomes increasingly important as dementia progresses. Even nursing home residents in advanced stages of dementia are able to find certain destinations within their nursing home—if the environment encompasses supportive design features (Marquardt & Schmieg, 2009; Passini, Pigot, Rainville, & Tétreault., 2000), which is discussed in this article. These environmental design features relate to the variables of the environment identified by Weisman (1987), which also relate to each of the transactions by Diaz Moore, Geboy, and Weisman (2006). They include architectural differentiation, signs, floor plan configuration, and perceptual access. Through design considerations each of these variables can contribute to facilitating the experiential attributes defined above and thus support successful wayfinding. Other interventions to promote spatial orientation and wayfinding include the use of location maps and behavioral training techniques (McGilton, Rivera, & Dawson, 2003).

### **Dementia-Friendly Design**

Not only wayfinding abilities are affected by architectural design. Many other symptoms of dementia, such as agitation, aggression, and temporal disorientation are targeted by environmental interventions that are implemented in nursing home design. Residents' well-being and behavior also can be supported by a physical environ-

ment designed to be dementia-friendly. Ecological gerontology explains this relationship through established models such as person-environment fit. This model describes the degree to which a person or his or her personality is compatible with the environment, a prerequisite to using one's full potential (Kahana, 1982).

The Environmental Docility Hypothesis, however, indicates that people who are subject to restrictions on their health or cognitive ability cannot always adapt the environment to their specific needs. Therefore, they are more dependent on the external environment (Lawton & Simon, 1968). This implies that people with dementia have a lesser capacity to regulate environmental factors, so their environment should be designed in such a way that it meets their specific needs. Figure 1 suggests a dementia threshold that accounts for a



**Figure 1.** Dementia threshold.

*Source:* Gutzmann, H. (2003). *Therapeutische Ansätze bei Demenzen*. In C. Wächtler (Ed.), *Demenzen. Frühzeitig erkennen, aktiv behandeln, Betroffene und Angehörige effektiv unterstützen*. Stuttgart, Germany: Thieme. Reprinted with permission.

***Environmental interventions that promote wayfinding can be implemented on two levels: the design of the floor plan typology and environmental cues, which comprise signage, furnishings, lighting, colors, etc.***

diminished ability to adapt (or *adaption scope*) to environmental stress: with increased competence, an individual’s adaption scope for environmental stress increases. The competence of people with dementia is limited by a dementia threshold, thus resulting in a diminished ability to adapt to environmental stress.

By means of therapeutic environmental design, which considers the limited ability of people with dementia to adapt to their environment, their well-being and functionality can be affected positively (Day, Carreon, & Stump, 2000; Day & Calkins, 2002; Tilly & Reed, 2008). Physical features such as small group size, residential design,

privacy, safety, and accessibility have been empirically linked to a higher level of independence, less agitation and aggression, and fewer psychotic problems (Chafetz & Namazi 2003; Namazi & Johnson 1992; Smith, Mathews, & Gresham, 2010; Zeisel et al., 2003). The appearance of a therapeutic environmental design in nursing facilities has been published in design books and articles and is mostly based on extensive practical experience and qualitative research (Brawley, 1997; Cohen & Weisman, 1991; Diaz Moore, Geboy, & Weisman, 2006; Judd, Marshall, & Phippen, 1998; Warner, 2000). The most significant criteria resulting from these publications are shown in Table 1.

***Architectural Features That Promote Wayfinding***

Environmental interventions that promote wayfinding can be implemented on two levels: the design of the floor plan typology and environmental cues, which comprise signage, furnishings, lighting, colors, etc. Even common materials that can be manipulated or used, such as groceries, water, and materials for handicrafts, can support residents’ orientation (Topo & Kotilainen, 2009). The architectural design of nursing homes has been the subject of some empirical studies, but only five that focus on the design of floor plans were identified. An overview of these studies and additional interventions for residents’ orientation that are discussed later in this article are shown in Table 2.

**Table 1.** Criteria of a Therapeutic Environment.

<b>Legibility</b>	<b>Familiarity</b>	<b>Autonomy</b>	<b>Sensory Stimulation</b>	<b>Social Interaction</b>
logical room syntax	biographical reference	barrier-free, compensating environment	encouragement	privacy
furnishing	homogenous and small groups	safety and security	avoidance of overstimulation	belonging
fixtures and fittings	noninstitutional character	orientational cues	access to the outdoors	communication

**Table 2.** Interventions for Residents' Orientation: Features of Floor Plan Typology and Environmental Design

Intervention Level	Design features that... support residents' orientation	interfere with residents' orientation
Building structure	<ul style="list-style-type: none"> <li>• <i>Small scale</i> (Marquardt &amp; Schmiege, 2009; Netten, 1989)</li> <li>• <i>Direct visual access to relevant places</i> (Marquardt &amp; Schmiege, 2009; Passini et al., 1998; 2000)</li> <li>• <i>Simple decision/reference points, serving as spatial anchor points</i> (Elmstahl et al., 1997; Marquardt &amp; Schmiege, 2009; Netten, 1989; Passini et al., 1998; 2000)</li> <li>• <i>Places with different and also legible function and meaning</i> (Marquardt &amp; Schmiege, 2009; Netten, 1989; Passini et al., 1998; 2000)</li> <li>• <i>Spatial proximity of kitchen, dining, and activity rooms</i> (Elmstahl et al., 1997)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Long corridors</i> (Elmstahl, Annerstedt, &amp; Ahlund, 1997; Netten, 1989)</li> <li>• <i>Changes of direction in the circulation system</i> (Marquardt &amp; Schmiege, 2009)</li> <li>• <i>Repetitive elements</i> (Marquardt &amp; Schmiege, 2009; Netten, 1989)</li> </ul>
Environmental design	<ul style="list-style-type: none"> <li>• <i>Signage (pictograms, resident's name, portrait photograph, photographic labels)</i> (Gross et al., 2004; Namazi &amp; Johnson, 1991; Nolan, Mathews, &amp; Harrison, 2001; Nolan, Mathews, Truesdell-Todd, &amp; VanDorp, 2002; Passini et al., 1998; 2000)</li> <li>• <i>Personal items on doors</i> (Namazi, Rosner &amp; Rechlin, 1991)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Information clutter</i> (Passini et al., 1998)</li> </ul>

### Design of Supportive Floor Plans

One of the first empirical studies that concentrated on wayfinding for people with dementia in nursing homes was conducted by Netten in 1989. Included in the study were 104 residents from 13 nursing homes. Their wayfinding abilities were measured by analyzing which places they were able to find unaided, those that they needed some help locating, or those for which they had to be taken the whole way. The main distinction among the floor plan typologies of the nursing homes was that six of them were group homes, meaning that ADLs such as eating and sleeping

were confined to a distinct area for a particular subgroup of residents. The seven other homes in the study were called communal homes, characterized by a single dining area where all residents ate. In these homes, larger sitting areas tended to be concentrated in one area of the home, away from the bedrooms. Long corridors were another frequently found characteristic of the communal homes.

Results showed that residents who had longer routes (as in the communal homes) had more difficulty finding their way around. Also, the num-

ber of exit points from a route was correlated with the tendency of residents to get lost. Repetitive elements, such as a large number of doors in a corridor, were confusing as well. Simple decision points and a larger number of zones (places with different functions and meanings), such as were found in the group homes, supported residents' wayfinding abilities.

Elmstahl et al. (1997) investigated psychiatric symptoms in people with dementia ( $n = 105$ ) after admission to group living units with three different floor plan designs: 14 with a corridor-like design, one with an L-shaped design, and three with a square or H-shaped design. Although symbols for orientation were used in the units, this study demonstrated that architectural design influences the ability to orient. Residents in the L-shaped floor plan had less disorientation than the others at the 6-month follow-up. After 1 year, the residents in the corridor-like designed units had more dyspraxia, lack of vitality, and disorientation of identity. The spatial proximity of the kitchen, dining room, and activity room in the L-, H- and square-shaped units was also identified as a supportive feature.

The size of the unit (total area) and the activity area or other indoor public rooms were not related to confusion or disorientation. However, because all of the buildings analyzed were group living units and the number of residents was six to eight people, only minor variance was expected in terms of total unit area. Contrary to the recommendations in most guidelines, creating a more homelike unit did not seem to reduce the

degree of confusion or disorientation. However, this study substantiated the association between the architectural design of floor plan layout with residents' orientation, as well as the importance of spatial anchor points.

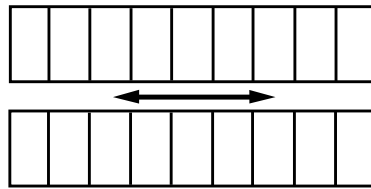
Passini and colleagues conducted two studies exploring the wayfinding abilities of people with Alzheimer's disease, one with 14 patients and 28 controls in a hospital (Passini et al., 1998) and another with 6 patients and 10 staff members in a nursing home (Passini et al., 2000). These are the only studies that included wayfinding tasks in which residents had to go to another floor of the building.

In the nursing home investigated (Passini et al., 2000) the cafeteria was situated on the ground floor, requiring the use of elevators. This proved to be a major barrier to most residents. Therefore, the staff of the institution tended to take the residents to their destinations if they went outside the living quarters of the home. From these findings it becomes evident that all places relevant to residents should be located on the same floor.

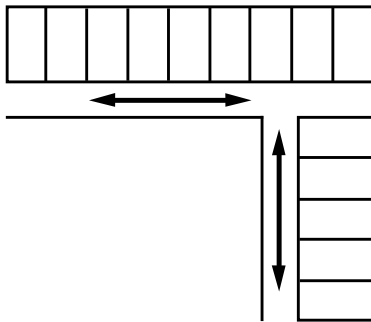
Further, the results of both studies (Passini et al., 1998; 2000) showed that most participants were incapable of developing an overall plan to solve a wayfinding task and made their decisions on explicit architectural information. Passini and colleagues identified two groups of architectural features that affect wayfinding: those related to the spatial organization of a setting, and those that provide the wayfinding person with the information necessary for the decision-making process.

According to their studies, the most important architectural information for wayfinding in people with Alzheimer's disease comprises the identification of reference points and places. An articulated and distinctive architectural environment, direct visual access to the common room, simple circulation routes, and small-scale settings were identified as supportive architectural design features in nursing homes. Monotonous, repetitive architectural features such as long, undifferentiated corridors interfered with residents' wayfinding abilities.

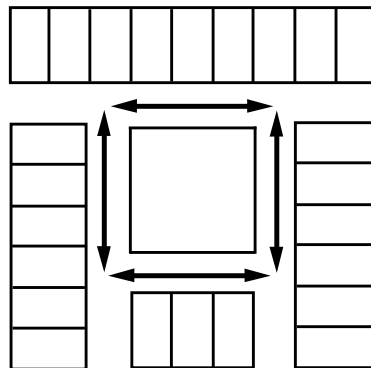
Passini and colleagues also highlighted the importance of reference points in wayfinding tasks. Reference points can be spaces with distinct functions, such as the nursing station or the living room, as well as elements like furniture or decorations. Their essential characteristics are distinctions in form, function, and if possible, meaning from other environmental elements in the home. Signage also was mentioned as an important supportive element, when architectural and interior design features were not sufficient to provide the necessary information.



**Figure 2.** Straight circulation system.



**Figure 3.** L-shaped circulation system with a change in direction.



**Figure 4.** Continuous path around an inside courtyard.

Marquardt and Schmiege (2009) investigated the wayfinding abilities of 450 residents (mild dementia,  $n = 91$ ; moderate dementia,  $n = 183$ ; and severe dementia,  $n = 176$ ) in 30 nursing homes. The number of residents per living unit in the homes varied from 8 to 35 people. The layout of the circulation system was the most distinctive variation in the floor plan typologies, and three major typologies were identified: straight circulation systems ( $n = 14$ , Figure 2), layouts that featured one shift in direction (e.g., L-shaped circulation systems,  $n = 9$ , Figure 3), and continuous paths around an inside courtyard ( $n = 7$ , Figure 4).

In the study, the impact of the characteristics of the floor plan typology of a nursing home on a resident's wayfinding abilities was measured by assessing which destinations (e.g., the common room/kitchen, the resident's individual bedroom, and the bathroom) they were able to reach independently. Results showed that the number of residents and the size of the living area constitute the most significant factors of a resident's orientation: wayfinding results were best in small units with 8 to 10 residents.



The most thought-provoking result of the data analysis concerning the architectural features of the floor plans is that the layout of the circulation system significantly affected the residents' orientation and was identified as the most influential environmental factor on a resident's wayfinding abilities. In straight circulation systems, residents were able to find their way better than in any layout that featured a shift in direction, such as L-shapes. Numerous shifts in direction, such as continuous paths around an inside courtyard, interfered further with residents' wayfinding abilities.

This effect on the resident's wayfinding abilities was found to apply to all places analyzed in the homes. Well-supplied eat-in kitchens with large dining tables were found to have great importance for residents as spatial anchor points: most residents, even people with severe dementia, were able to locate such places. Again, in straight structures, this location was found more easily than in any other typology. Another contributing factor was the provision of only one eat-in kitchen—both the ability to track down this place and overall orientation in the nursing home increased.

### **Implementation of Environmental Cues**

Whereas the studies presented so far have focused mainly on the architectural layout and floor plan design of the nursing homes, others targeted a resident's immediate environment. Signs and pictograms were identified as useful in supporting the identification of the bathroom (Namazi & Johnson, 1991). Decorating residents' bedroom doors with personal items increased their

ability to identify their own rooms (Namazi, Rosner, & Rechlin, 1991). Also, many people with moderate-to-severe dementia are able to identify written names and photographs of themselves. Identifying their own belongings, names, and photographic labels also can be of help (Gross et al., 2004). A combination of multiple cues was found to be even more helpful, for example a portrait-type photograph of a resident as a young adult, a sign stating the resident's name, and personal memorabilia in a display case outside the room (Nolan et al., 2001; 2002).

Information clutter, such as wayfinding signage among meal plans and staff announcements, should be avoided because people with dementia are incapable of extracting the relevant information (Passini et al., 1998). It also should be noted that the height of signage needs to be adapted to the downward gaze of many elderly people (Namazi & Johnson, 1991). Placing signage on the floor could be an option but should be implemented very carefully and preferably tested beforehand. People with dementia might perceive dark patterns or decisive separations of one area from another as three-dimensional and be afraid of the steps or "holes" in the floor (Passini et al., 2000; Namazi, Rosner, & Calkins, 1989).

Safety aspects also have been studied in relation to wayfinding design, especially ways to prevent residents from using exit doors. Interventions that proved useful included the use of mirrors on doors (Mayer & Darby, 1991) and a horizontal grid of black tape on the floor in front of the door (Hewawasam, 1996). It also was helpful to

reduce cues for exiting, such as hiding the door knob behind a piece of cloth or blocking the view through the glass window of a door, using a blind (Dickinson, McLain-Kark, & Marshall-Baker, 1995).

Environmental interventions to promote wayfinding are best utilized when they are combined and address different senses. In this manner, an age-related impairment of one sense (e.g., vision) might be compensated for by another (e.g., hearing). The idea of multiple cueing can be extended to cues for the date, time, and place (Bowie & Mountain, 1997). The ability to discriminate colors is affected in Alzheimer's disease, with most errors in the blue and green areas and fewer in the yellow and red areas (Wijk et al., 1999). Vivid color coding may enhance short-term memory and improve functional ability (Cernin, Keller, & Stoner, 2003). Most important, sufficient lighting has been shown to be a central aspect of a supportive environment (Noell-Waggoner, 2002) and also to have a major influence on residents' wayfinding abilities: the more light (both artificial and natural) there is in a nursing home, the more residents are able to find their way around (Netten, 1989).

Several studies focused on the positive effects of artificial bright light (2,000 lux [lx]) and also of outdoor natural light on people with dementia, both of which lead to positive effects, including increased sleep duration and less aggressive and agitated behavior (Calkins, Szmerekovsky, & Biddle, 2007; Riemersma-van der Lek et al., 2008; Sloane et al., 2005, Sloane et al., 2007).

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The therapeutic value of lighting also has been questioned (Forbes et al., 2004). However, from the existing empirical evidence and practical experience in nursing homes, it becomes evident that sufficient lighting (500 lx of ambient light, up to 2000 lx in activity areas) is a prerequisite for good vision and, therefore, for being able to see and interpret the environment—whether it is the perception of the size and shape of rooms or of cues for orientation—because all these elements are prerequisites to wayfinding and spatial orientation within a nursing home setting.

So far, all aspects of environmental design to promote orientation have focused on wayfinding, and thus on mobile residents. However, reduced mobility is among the frequent noncognitive symptoms of dementia (Wancata, Benda, Meise, & Windhaber, 2003). When designing nursing home environments, the needs of immobile residents must be taken into account by allowing for visual access to activity areas from their bedrooms or a sitting area close by.

***Support of Outdoor Wayfinding***

Some guidance is available on the design of outdoor areas and gardens in nursing homes (Rodiek

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***The explanation for these Results can be attributed to changes in the orientation process of people with dementia.***

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& Schwarz, 2008). However, there has been very little empirical research on designs to support the wayfinding abilities of people with dementia. The location of a garden or balcony at a nursing home has been investigated by Marquardt & Schmiege (2009). Results showed that with an increasing number of residents per living area, the number of residents able to use outdoor areas independently decreased. Organizational factors are assumed to play an important role here, but architectural features also determine the location of an outdoor space. If it is accessed from the eat-in kitchen, the outdoor space seems to be more accessible to the residents, compared with access from any other point of the circulation system. If a terrace or a balcony with a sitting area that accommodates a larger number of residents is located close to the exit from the living area, the ability to locate the outdoor space increases significantly.

Public outdoor wayfinding was investigated by Sheehan, Burton, and Mitchell (2006) in a sample of 13 community-dwelling elderly with early dementia and 10 healthy controls. Results of this study also showed that people with dementia generally performed worse on wayfinding tasks, even in familiar areas. However, people with de-

mentia and controls identified similar features in the physical environment, and no significant differences in the use of landmarks or other features of the physical environment were identified. Although no difference in the basic use of signs was found between the groups, the study showed that people with early dementia might be more dependent on adequate signage to perform wayfinding tasks.

Mitchell et al. (2003) identified potential design solutions that would enable older people with dementia to continue to negotiate and use their local neighborhoods by applying current knowledge of best practice for internal environments to outdoor environments. From their findings, familiarity, legibility, distinctiveness, accessibility, comfort, and safety seem to have a major influence on the wayfinding abilities of people with dementia. In urban design, this would mean that small street blocks with direct, connected routes and good visual access, a varied urban form and architectural features, and distinctive, unambiguous environmental cues could enhance successful orientation and wayfinding.

### ***Interpretation of the Studies' Results***

The studies presented here produced different results regarding whether floor plans designed as straight corridors interfere with residents' wayfinding abilities (Elmstahl et al., 1997; Netten, 1989) or not (Marquardt & Schmiege, 2009). The reason for this controversy might be found in the fact that the length of corridors, lighting intensity, architectural differentiation, natural light, views to the outside, and other sensory stimulation have

not been measured. However, all of the studies identified the importance of good visual access.

The explanation for these results and also for the outcomes on floor plan typologies can be attributed to changes in the orientation process of people with dementia. Their overall decline in spatial orientation and wayfinding performance is caused by their impaired cognitive spatial skills, including mental spatial representation (Liu et al., 1991). These internal representations of the environment in one's mind are called cognitive maps, which are a prerequisite to orient oneself and to the successful location of places.

A cognitive map contains environmental information on places that lie beyond the perceptual range of vision (Kitchin, 1994). The mental visual representations of those objects, places, and routes are produced by an area of the brain called the *precuneus*. Because it is involved with visuospatial processing and memory, it is called the mind's eye (Fletcher et al., 1995). Because there is an overall decline of cognitive abilities in dementia, it is expected that the prerequisite to orientation, which is cognitive mapping, also is limited. However, this might not be the case in the early stages of dementia, because in most studies, those peoples' level of orientation is still very high. With the progress of dementia, orientation declines, and it is hypothesized that this can be ascribed to the fact that the cognitive map deforms and breaks apart, causing deteriorating orientation.

Recent functional MRI studies of the neural basis of personally meaningful, autobiographical men-

tal visual images have demonstrated a cerebral network including the mind's eye (Donix et al., 2010; Poettrich et al., 2007). This map and mental visual images have been shown to play a very important role over the entire life-span (Donix et al., 2010) and in preclinical Alzheimer's disease (Poettrich et al., 2007). Furthermore, these studies showed reductions in the metabolism of the brain, including in the area of the precuneus, the mind's eye. This implies that with advancing dementia, residents may encounter great difficulty in retrieving a mental visual image of a place that they cannot see, rendering them unable to generate, maintain, and use a cognitive map.

Concerning the layout of circulation systems, the importance of direct visual access to all places relevant to residents becomes evident. Another impedimentary aspect of several changes of direction in a hallway is that it takes longer to track down a place and, during that process, the aim of the trip undertaken may soon be forgotten. However, a central corridor can have negative effects on the vitality of residents, as found in a study by Elmstahl and colleagues (1997). Therefore, sensory stimulation through natural light and views to the outside, through spaces that promote interaction and communication, and others need to be integrated into linear corridor designs.

The absence of a cognitive map can be partially compensated for by using other kinds of orientation strategies. Residents may orient themselves allocentrically, from one decision point to the next. In straight circulation systems, this orientation strategy can be efficiently and successfully used

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## ***Four guidelines could be implemented in all designs to support the wayfinding abilities of people with dementia.***

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because only simple directional vectors between the point of origin and destination are required. To navigate changes of direction within the corridor, several subsequent vectors are required. This implies that allocentric orientation strategies cannot be used efficiently in more complex structures or that multiple cues are needed for orientation.

As it has been shown in the preceding studies, such cues are most effective if they serve as spatial anchor points with a function or meaning that is relevant to the residents. The fact that a small number of spatial anchor points (e.g., having only one eat-in kitchen) is a supportive design feature also may be ascribed to cognitive mapping: a less detailed cognitive map that is easier to generate, maintain, and use would be the result. Further differentiation between similar elements—which becomes increasingly difficult with advancing dementia—is no longer necessary.

### ***Recommendations for Design and Conclusion***

From the findings of the studies discussed here, it can be hypothesized that floor plan designs significantly support the spatial orientation and wayfinding of people with dementia. Although they play an important role in such people's orientation, interventions such as signage, furnish-

ings, lighting, and colors cannot compensate for an adverse architectural design (Elmstahl et al., 1997; Marquardt & Schmiege, 2009; Passini et al., 1998; 2000). For the creation of a dementia-friendly, supportive environment, the synthesis of both aspects of architectural design must be considered. The following four guidelines could be implemented in all designs to support the wayfinding abilities of people with dementia:

1. *No need for new or higher skills.* Because of their cognitive decline, people with dementia are limited in the ability to perform higher skills or learn new skills. Therefore, the navigation of the floor plan of a dementia-friendly setting should not require higher skills, such as reading and interpreting signage. Also, the typology of the building should be a familiar design and not require the acquisition of new orientation strategies, as it does, for example, in typologies with continuous paths. A simple, clear layout of the floor plan and well-defined, geometrically simple rooms are structural prerequisites to successful orientation and wayfinding in nursing homes.
2. *Allow visual access and overview.* Because of the degeneration of their brains, people with dementia cannot mentally represent spatial situations that they cannot see directly. Therefore, all places relevant to them should allow for visual access, and it should be possible for them to oversee their entire immediate living environment.
3. *Reduce decision making.* It becomes increasingly difficult for people with dementia to make a hierarchical decision. Therefore, crossing hallways and several changes in direction should

be avoided. People should be led intuitively and not be required to choose from different options to plan a route. If a floor plan typology that features changes in the direction of the circulation system is the only design option at a site, a meaningful reference point should be incorporated. Placing an eat-in kitchen or dining room at the point where direction changes in the circulation system constitutes an excellent reference point that can serve as a spatial anchor point for residents. Further, to identify and locate rooms with a similar meaning or function, distinctions in size, shape, color, and lighting must be articulated.

4. *Increase architectural legibility.* The function of rooms and other spaces, as well as the behavior that is expected and appropriate there, can be made clearly legible by means of size, proportion, materials, and furnishings. In this manner, distinctive places that can better be memorized and located are created, thus promoting residents' spatial orientation and wayfinding.

The empirical studies presented here identified features of nursing home designs that provide good orientation for dementia residents, and guidelines for a dementia-friendly design were established. However, additional research is needed to better understand the relationship between architectural design and human behavior. Also, the operational requirements of nursing homes in relation to floor plan typologies of facilities need to be investigated. Because of the overall aging of society, the further development of an evidence-based architecture for people with dementia will become increasingly necessary.

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