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Dementia-Friendly Architecture: Environments That Facilitate Wayfinding in Nursing Homes

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Spatial disorientation is a prime reason for institutionalization. The autonomy of the residents and their quality of life, however, is strongly linked with their ability to reach certain places within their nursing home. The physical environment has a great potential for supporting a resident's wayfinding abilities. For this study, data were collected from 30 German nursing homes. Skilled nurses rated the resident's ability to perform 5 wayfinding tasks. The architectural characteristics of the homes were analyzed and their impact on the resulting scores was tested for statistical significance using the Mann-Whitney U test ($P < .05$). Results confirm that people with advancing dementia are increasingly dependent on a compensating environment. The significant factors include a small number of residents per living area, the straight layout of the circulation system without any changes in direction, and the provision of only 1 living/dining room. These and additional results were transformed into architectural guidelines.

Keywords: spatial orientation; wayfinding; dementia; nursing home; architecture

Introduction

Residents in most German nursing homes are people with dementia.[1] Their well-being and behavior is strongly determined by the design of their environment in these homes. The ecological gerontology explains this relationship through established concepts as the person-environment-fit.[2] The Environmental Docility Hypothesis, however, indicates that people who are subjected to restrictions on their health or cognitive ability cannot always adapt the environment to their specific needs. Therefore, they are more dependent on their external environment.[3] This implies that people with dementia have a lesser capacity to regulate the environmental factors, so their environment should be designed in such a way that it meets with their specific needs. Through this therapeutic environmental design, the well-being and functionality among people with dementia can be positively affected.[4]

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.[5-8] The most significant criteria that result from these publications are shown in Table 1. There are some research findings that are based on available empirical evidence,[9-11] and also a few results regarding the design of floor plans to facilitate wayfinding within the homes.[12-14] Structures that promote orientation and wayfinding in small units with many diversely designed places, direct visual access, and the spatial proximity of the kitchen, dining room, and common room were identified. Many newly built German nursing homes were constructed in the shape of a continuous path around an inside courtyard. This typology was widely recommended by architects as it was deemed to provide safe opportunities for wandering, and also to enhance the resident's orientation with the surroundings. However, this recommendation was not substantiated by empirical findings.

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Table 1. Criteria of a Therapeutic Environment

Legibility	Familiarity	Autonomy	Sensory Stimulation	Social Interaction
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

Aim of This Study

Architectural features that support the resident's residual spatial abilities and promote their mobility and independence were to be identified through an empirical study in selected nursing homes. To implement the results into the design of new or remodeling of the existing facilities, a publication on design criteria would be developed.

Design and Methods

The impact of the characteristics of the architectural structure of a nursing home on a resident's wayfinding abilities can be measured by the destinations they were able to reach independently. Therefore, 5 characteristic routes within the living areas of the home were chosen. To contribute to the resident's independence, the routes had to be a part of the activities of daily living:

(1) To go to the live-in kitchen (in all homes these were open-plan kitchens, featuring a kitchen unit and a dining table).
(2) To identify and go to the resident's individual bedroom.
(3) To go to the toilet (either in the resident's own bathroom or to an additional bathroom within the living area, if provided).
(4) To go outside (into the garden or to a balcony).
(5) To go to the common room.

If, or how, the residents were able to find those destinations, was rated by the head of nurses and/or a gerontopsychiatric trained nurse as shown here:

0 Point resident does not find the way.
1 Point resident needs some reminder or direction to reach the destination.
2 Points resident reaches the destination independently.

The stage of dementia (mild, moderate, or severe) that the resident was in was identified by using a scale from clinical practice,[15] which was developed on the basis of the Global Deterioration Scale.[16]

To systematically analyze the orientational abilities of people with dementia, measurable variables are required—in this study, the finding of places relevant to the residents. Those who felt compelled to wander and walk around all the places of the home were not included in this study.

The data collections were carried out in 30 German nursing homes, and 450 residents (mild dementia n = 91, moderate dementia n = 183, severe dementia n = 176) were rated. From these data, the average orientational indices were calculated separately for each of the 5 routes, and also as a sum of routes 1 to 3 as the overall orientational index of the home (here routes 4 and 5 remained out of consideration because those destinations were not existent in all the analyzed homes).

Through an empiric-qualitative exploration, architectural features of the floor-plan structure were graphically analyzed and quantified. The layout of the circulation system was the most distinctive variation, and 3 major typologies were identified: straight circulation systems (n = 14), layouts that featured one shift in direction (eg, L-shaped circulation systems, n = 9), and continuous paths around an inside courtyard (n = 7). Within these 3 typologies, differences in the shape of the walls of the corridors were identified: 40% featured smooth walls, 60% featured several wall recesses and alcoves. Within the straight circulation systems, the possibility to overview the whole living unit was analyzed, which was given in 42% of these homes. The other distinctive features of the nursing homes included the number of live-in kitchens within the residential living unit, the availability of an additional toilet outside the bathrooms of the resident's rooms, and the way the access to the outdoor space was designed.

According to their architectural features, the nursing homes were divided into groups and subsequently ranked on the basis of the orientational

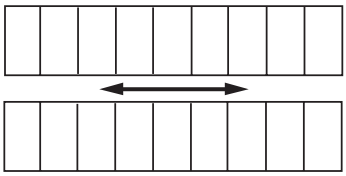

Figure 1. Straight circulation system (str).

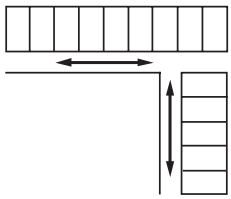

Figure 2. L-shaped circulation system with a change in direction (cd).

indices they had scored. Based on this exploration of the data, hypotheses on architectural features that promote wayfinding and orientation were postulated. These hypotheses were tested for statistical significance using the Mann-Whitney *U* test (significance level $P < .05$; Figure 1).

Results

Residents with mild dementia found their way about in all nursing homes very well. Their average overall orientational index (addition of the score on routes 1, 2, and 3) was $\bar{x} = 5.85$ ($s = 0.23$) for a maximum of 6 points. Because of their good orientation, residents with mild dementia were not considered further. The indices for people with moderate dementia ($\bar{x} = 4.63$; $s = 1.14$), and severe dementia ($\bar{x} = 2.18$; $s = 1.25$) declined, as expected.

The number of residents and the size of the living area constitute the most significant factor on a resident's orientation. It is apparent from Figure 6 that the orientational indices decline as the number of residents per living area increases.

The most considerable result of data evaluation concerning the architectural features of the floor plans is that the size and shape of the corridors within the living area affected the resident's orientation significantly. In straight circulation systems, residents were able to find their way better than in any layout that featured a shift in direction. Numerous shifts in direction even further interfered with the resident's wayfinding. Within the straight circulation

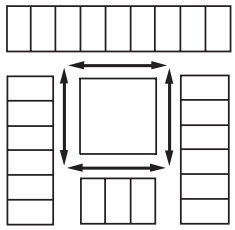

Figure 3. Continuous path around an inside courtyard (cp).

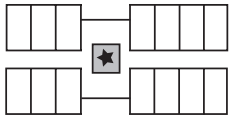

Figure 4. "Intermediate Element" dividing a corridor.

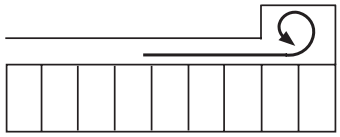

Figure 5. Corridor ending.

systems, orientation was further enhanced if the whole corridor could be overseen from any point of the living unit. From the data exploration, eliminating any unnecessary alcoves and wall recesses within the corridor walls also seemed to be a supportive design. In the statistical evaluation this fact turned out to be nonsignificant.

In all living areas within the homes included in this study, there was always one place where meals were eaten and sometimes also cooked. These live-in kitchens featured a dining table, a fitted kitchen, and often a sitting area. This place has a great importance for residents as a spatial anchor point: wayfinding on this route (# 1) in all homes scored the highest compared to the other 4 routes. Locating the live-in kitchen was also determined by the layout of the circulation system. In straight structures, locating it was found to be easier than in any other typology. Another significant factor that determined high orientational indices was the provision of only one live-in kitchen—both the tracking down of this place as well as overall orientation increased.

The act of locating the resident's individual bedroom is strongly linked to the stage of the dementia that they are in. With advancing dementia, orientation on this route (# 2) declines. The most significant

Table 2. Statistical Evaluation of the Essential Hypotheses

			Sample Size (n) and Means of the Orientational Indices ($\bar{x}$)					
	Significance		Moderate Dementia			Severe Dementia		
Hypothesis	Moderate Dementia	Severe Dementia	Design	n, $\bar{x}$	Δ-Value	Design	n, $\bar{x}$	Δ-Value
Straight circulation routes (str) provide better orientation than typologies featuring one change in direction, eg, L-shapes (cd)			str	n = 11		str	n = 12	
			cd	n = 16		cd	n = 13	
Σ Route 1–3	$P = .040$[a]	$P = .001$[c]	str	$\bar{x} = 5.15$	0.88	str	$\bar{x} = 2.93$	1.45
			cd	$\bar{x} = 4.27$		cd	$\bar{x} = 1.48$	
A continuous path (cp) causes lower orientation than all other considered typologies (oth)			cp	n = 7		cp	n = 7	
			oth	n = 20		oth	n = 18	
Σ Route 1–3	$P = .048$[a]	$P = .002$[b]	cp	$\bar{x} = 3.78$	1.15	cp	$\bar{x} = 1.15$	1.43
			oth	$\bar{x} = 4.93$		oth	$\bar{x} = 2.58$	
Typologies featuring *one* change in direction (cd) provide better orientation than typologies featuring a continuous path (cp)			cd	n = 9		cd	n = 6	
			cp	n = 7		cp	n = 7	
Σ Route 1–3	$P = .122$	$P = .058$	cd	$\bar{x} = 4.65$	0.87	cd	$\bar{x} = 1.88$	0.73
			cp	$\bar{x} = 3.78$		cp	$\bar{x} = 1.15$	
Straight circulation routes (str) provide better orientation than all other typologies considered (oth)			str	n = 8		str	n = 9	
			oth	n = 19		oth	n = 16	
Σ Routes 1–3	$P = .050$[a]	$P = .001$[c]	str	$\bar{x} = 5.22$	0.84	str	$\bar{x} = 3.12$	1.47
			oth	$\bar{x} = 4.38$		oth	$\bar{x} = 1.65$	
Overview on the whole circulation system (ov) provides better orientation than all other typologies considered (oth)			ov	n = 5		ov	n = 6	
			oth	n = 22		oth	n = 19	
Σ Routes 1–3	$P = .049$[a]	$P = .006$[b]	ov	$\bar{x} = 5.32$	0.86	ov	$\bar{x} = 3.20$	1.34
			oth	$\bar{x} = 4.46$		oth	$\bar{x} = 1.86$	
Corridors with smooth walls (smw) provide better orientation than corridors with alcoves and wall recesses (alc)			alc	n = 16		alc	n = 14	
			smw	n = 11		smw	n = 11	
Σ Route 1–3	$P = .156$	$P = .292$	alc	$\bar{x} = 4.45$	0.43	alc	$\bar{x} = 2.02$	0.35
			smw	$\bar{x} = 4.88$		smw	$\bar{x} = 2.37$	
Living areas with only one live-in kitchen (one) provide better locating of this place than units with several (sev)			one	n = 16		one	n = 15	
			sev	n = 11		sev	n = 10	
Σ Routes 1–3	$P = .010$[b]	$P = .001$[c]	one	$\bar{x} = 5.01$	0.93	one	$\bar{x} = 2.89$	1.77
			sev	$\bar{x} = 4.08$		sev	$\bar{x} = 1.12$	
Formation of the live-in kitchen to a spatial anchor point (ap) provides better locating of this place than other designs (oth)			ap	n = 4		ap	n = 3	
			oth	n = 9		oth	n = 9	
Route 1	$P = .045$[a]	$P = .026$[a]	ap	$\bar{x} = 1.76$	0.45	ap	$\bar{x} = 1.13$	0.65
			oth	$\bar{x} = 1.31$		oth	$\bar{x} = 0.48$	
A shared toilet within the living area (tl), additional to the residents en suite bathrooms, increases the locating of a toilet (none)			tl	n = 8		tl	n = 7	
			none	n = 19		none	n = 18	
Route 3	none > tl, ns	none > tl, ns	tl	$\bar{x} = 1.23$	0.28	tl	$\bar{x} = 0.45$	0.13
			none	$\bar{x} = 1.51$		none	$\bar{x} = 0.58$	
Access to the outdoors from the live-in kitchen (lik) provides better locating than access from any point on the circulation system (cs)			lik	n = 13		lik	N = 11	
			cs	n = 8		cs	N = 8	
Route 4	$P = .245$	$P = .160$	lik	$\bar{x} = 1.06$	0.18	lik	$\bar{x} = 0.79$	0.26
			cs	$\bar{x} = 0.88$		cs	$\bar{x} = 0.53$	
An outside sitting area (sa) close to the exit from the living area provides better locating of the outdoor space than none (none)			sa	n = 9		sa	N = 8	
			none	n = 3		none	N = 3	
Route 4	$P = .322$	$P = .041$[a]	sa	$\bar{x} = 1.04$	0.25	sa	$\bar{x} = 0.88$	0.57
			none	$\bar{x} = 0.79$		none	$\bar{x} = 0.31$	

[a] Significant.
[b] Very significant.
[c] Extremely significant.

supportive factor in this case is the straight layout of the circulation system.

This also relates to the finding of the toilets in the en suite bathrooms that belong to the resident's bedroom. The provision of an additional toilet within the living area, which was not assigned to an individual bedroom, did not affect the orientational indices of wayfinding to a toilet on this route (# 3). Here it

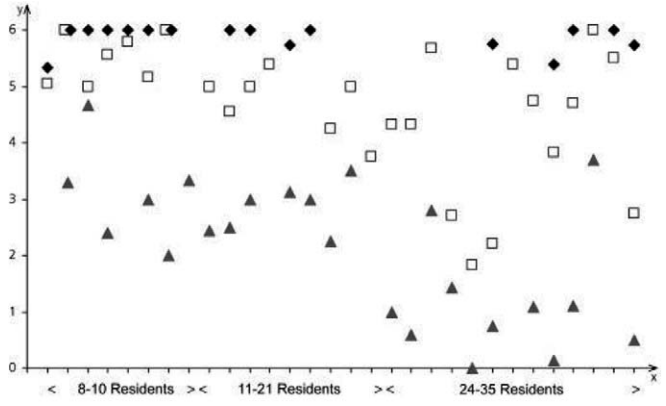

Figure 6. Dispersion of the Mean Average Orientation Index on Routes 1 to 3[a].

[a]X-axis: nursing facilities arrayed by increasing number of residents; *y*-axis: arithmetic mean of the summated orientational indices on routes 1, 2, and 3; ◆: orientation indices of residents with mild dementia; □: orientation indices of residents with moderate dementia; ▲: orientation indices of residents with severe dementia.

was assumed that further nonarchitectural but organizational issues (toilet training, door identification marks) were a determining factor.

Locating the garden or balcony similarly decreased with an increasing number of residents per living area. Here too, organizational factors are assumed to play an important role. Architectural features also determine the locating of the outdoor space. If it is accessed from the live-in kitchen, the outdoor space seems to be better located by the residents, compared to an access from any other point on the circulation system. However, this effect is only visible in the data exploration, and is nonsignificant in the statistical evaluation. If a terrace or a balcony with a sitting area that accommodates a larger number of residents is allocated close to the exit from the living area, the locating of the outdoor space increases significantly.

Discussion

A decline of spatial orientation and wayfinding performance is very common among people with dementia. It can also be one of the early symptoms: getting lost in unfamiliar locations is already mentioned at Stage 3 of the Global Deterioration Scale,[16] which implies a mild cognitive impairment. At stage 4 of mild dementia, disorientation can also occur in familiar locations. When people with dementia move to a nursing home, they are often unable to locate places within the unfamiliar setting of the home. This results in a loss of autonomy, and also affects the efficiency of the institutions and the quality of care provided.

Research confirms that residents' orientation depends on the physical environment.[4] Architectural design guides suggest various strategies to enhance orientation, including improvements for wayfinding by using signage and by choosing a supportive building organization. However, on the latter issue, only a few empirical studies are available.[12-14] Concerning the building organization, simple structures were found supportive,[14] while in smaller units also more complex structures provided good orientation.[12] The type of facility is also associated with orientation among residents and the importance of "meaningful decision points" was established.[13] In the existing studies, the typology of the circulation system and its effect on the resident's orientation was not further investigated. The empirical findings of the study presented here, however, emphasize the importance of this design feature. The reason for this significance can be found in the change of orientation strategies employed by people with advancing dementia.

The overall decline of spatial orientation and wayfinding performance in people with progressing dementia is caused by their impaired cognitive spatial skills, including mental spatial representation.[17] These internal representations of the environment in one's mind are called cognitive maps, which are a prerequisite to orientate oneself and to the successful locating of places. A cognitive map contains environmental information on places that lie beyond the perceptual range of vision.[18] The mental visual representations of those objects, places, and routes are produced by an area of the brain called the mind's eye (Precuneus).[19] Because there is an overall decline of cognitive abilities in dementia, it is expected that the prerequisite to orientation, which is cognitive mapping, is also limited. However, this might not be the case in the early stages of dementia, since in this study those residents' level of orientation is very high in all homes. With further 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 the deteriorating orientation. This is supported by MRT-Studies on people with dementia at the Dresden University of Technology, which showed reductions in the metabolism of the brain, including in the area of the mind's eye (Dr Vjera Holthoff, oral communication, March 2007). This implies that with advancing dementia, residents may encounter

great difficulties in retrieving a mental visual image of a place which they cannot see, rendering them unable to generate, maintain, and use a cognitive map. Concerning the layout of the circulation system, the importance of a direct visual access to all places relevant to the residents becomes evident.

The absence of a cognitive map can be partially compensated by using other kinds of orientation strategies. Residents then may orientate themselves allocentrically, from one decision point to the next. In straight circulation systems, this orientation strategy can be efficiently and successfully used 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. Also, tracking down a place takes longer and during that process the aim of the trip undertaken may soon be forgotten.

A small number of spatial anchor points (eg, having only one live-in kitchen) as a supportive design feature may also be ascribed to cognitive mapping: a less detailed cognitive map that is easier to generate, maintain, and use would be the result. Further, differentiations between similar elements are no longer necessary, which becomes increasingly difficult with advancing dementia.

Recommendations for Architectural Design

Not all the results from the statistical data evaluation can directly be transformed into recommendations and guidelines for architectural design. Even though maintaining orientation is important to everyone, including older people and people with dementia,[20,21] other factors that determine a resident's well-being have to be taken into account. The design criteria shown in Table 1 remain valid. To integrate the results of this study, a design criteria catalogue of dementia-friendly architecture, which can be used in the architectural practice, was developed.[22] Concerning the layout of the floor plans, the following recommendations should be considered in future designs.

A smaller number of residents per living area facilitate orientation and wayfinding. The current development toward smaller units within the homes may be judged positively from this viewpoint, too. Further, it is essential that people with moderate-to-severe stages of dementia need well-defined, geometrically simple structures to orient themselves and to succeed in wayfinding. Guiding elements, such as a straight wall running though the whole living area, can be supportive features.

It should be noted that changes in the direction within the circulation system of a living area cannot always be avoided, particularly, in terms of shape and size. They might already be in existing buildings, or they may become necessary owing to the local situation on a new plot.

Memorable reference points which can support a resident's allocentric orientation strategy are thus needed. These can be architectural elements (such as the live-in kitchen) or fixtures, fittings, and furniture (such as objects with a biographic reference). It is very important that these reference points are carefully placed at the spot where the direction changes, and that they are interpreted, remembered, and used by the residents in the designated way.

If living units with a large number of residents are designed according to the findings of this study, very long corridors leading to an institutional appearance would be the outcome. Here reference points can serve as an "intermediate element" to divide long corridors without interfering with the resident's orientation.

Clearly visible endings of corridors provide a good orientation. However, careful consideration is needed in the architectural design of these points: cul-de-sacs have to be avoided, and provision of enough safe space for activities and exercise around is advisable.

Spatial situations and places should not be repeated. The live-in kitchen, in particular, should be designed in such a way that it becomes a unique and memorable feature of the living area. Its function as a spatial anchor point can be intensified by the allocation of other functions, such as the exit to the garden or balcony, or the duty room. In larger living areas, more than one live-in kitchen has to be provided, because of the increased space requirements and acoustic reasons. In this case, these places should be allocated next to each other.

The location of the resident's rooms and toilets is mainly determined by the layout of the circulation system. In addition, helpful elements such as door markings and signage, among others, can be included in the furnishing.

The access to the outdoor area or balcony should be located in a central area within the living area. A sun-protected sitting area with enough tables and chairs for all the residents should be placed in the balcony or on the terrace. In this way, caregivers can

still supervise the residents while working inside. This also responds to the need of some residents to stay close to the group of caregivers or fellow residents.

Beyond the careful layout of the circulation system, it is very important that all places within the home need to be designed in such a way that they are architecturally legible—meaning that their function is evident through their size, proportion, materiality, and furnishing. In this way, distinct and easily memorable places are created to help enhance the resident's orientation. All the discussed architectural elements designed to enhance a resident's orientation can also be used conversely—in this way, places that should not be found by the residents are hidden from their paths.

Conclusions

To maintain their autonomy in a nursing home, people with advancing dementia are increasingly dependent on a compensating environment, enabling them to locate places within their home. Through this empirical study design, the features of nursing homes' floor plans that provide good orientation for dementia residents were identified. The importance of the layout of the circulation system, which was not well understood so far, was established and ascribed to the changes in the orientation strategies used with advancing dementia.

The findings related to the typology conflict with recommendations from the architectural practice. This emphasizes the importance of empirical studies on the architectural design of long-term care facilities. They also provide the basis for evaluating, assuring, and further enhancing the quality of care within the institutions. The methods applied in this study could also be used for the investigation of other issues of therapeutic design as well as for further development of an evidence-based architecture.

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