
The impact of architectural environment on behaviors of people with dementia- exploratory research on adult day-care centers

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Structured Abstract

Purpose – Adult day-care facilities, as one type of the care facilities for older adults and people with dementia (PWD), have attracted attention from researchers and practitioners since the 1990s. These care facilities provide community-based programs to meet the needs of older adults during the work day and relieve informal caregivers from the stress of full time care. However, studies that emphasize on architectural environment, and its impacts on the behavior of the care recipients, i.e. the people who use the day-care services, are still lacking. The aim of this study is to offer an insight into the behavior of PWD in adult day-care facilities from an architecturally disciplined perspective, as well as to interpret the relationships between behaviors and architectural properties in order to improve the future facility design.

Design/methodology/approach – To reach this goal, the study was developed through a strategy that includes two focuses: 1. Focus on the spatial distribution of unstructured behavior of PWD; 2. Focus on the architectural properties including the function complexity, the typology, and the interior furniture. Six day-care centers in Dresden, Germany, were chosen for the case studies. In each center, care recipients over 65 years and diagnosed with dementia by their general practitioners, were observed with Behavior Mapping method.

Originality/value – As exploratory research, the findings of this study provide empirical evidence as a basis for further discussion. It is among the few current studies examining the relationships between architectural environment and the unstructured behaviors of people with dementia. It provides evidence for the activity-friendly facility design, the development of architectural intervention, and the policy to promote indoor environment in day-care facilities of PWD and the older adults.

Practical implications – Although the floor plans of the day-care facilities in this study are different, and their space usages vary from one to another, the analyses proved that they share generic properties of architectural environments governing the behaviors of the care recipients. Based on the findings of the study, several design recommendations are

offered for various design stages from floor-plan design phase to interior design phase, which is highly beneficial for architects as well as care administrators.

Keywords – Adult day-care facilities, dementia-friendly architecture design, unstructured behavior of people with dementia, environment-behavior study, spatial property.

Paper type – Academic Research Paper

1 Introduction

Dementia represents a major public health challenge as a consequence of the rapid increase in the aging population worldwide. The design of care facilities for people with dementia (PWD) has become an area of increasing clinical, architectural, and research interest (Day et al., 2000). Evidence has emerged that adequate control of environments may promote the positive activity of PWD, and hence, improve their well-being. A day-care facility, as one of the several types of long-term care facilities serving the older/fragile population, has demonstrated beneficial effects on dementia care and functionality for PWD.

This study aims to investigate the relationships between the activities of PWD and the architectural properties in day-care facilities. Design recommendations will be given based on the findings of the study.

2 Research background and its novelty

While many regions celebrate longer life expectancy as one of humanity's major achievements, we recognize that the world is experiencing an unprecedented demographic transformation. Over 47 million people worldwide were living with dementia by the year 2015, and the cases are set to triple by 2050 (WHO, 2015). Dementia affects memory, orientation, language, comprehension, and judgment. As the disease progresses, PWD are in increased need for assistance with daily tasks.

Adult day-care facilities, or adult day-care centers, as one type of the care facilities for older adults and PWD, have attracted attention from researchers and practitioners since the 1990s (Jarrott et al., 1998; Furness et al., 2000; Moore, 2006). These day-care facilities provide community-based programs to meet the needs of older adults during the work day and relieve informal caregivers from the stress of full-time care. Prior research suggested that the majority care recipients and their families find day-care service useful, and overall levels of satisfaction are high (Zarit et al., 1998; Furness et al., 2000). Unlike nursing homes or other long-term care facilities, which offer accommodations, day-care facilities are relatively small in scale and easier to establish, thus playing an increasingly supportive role for the entire care system of the older adults.

2.1 Adult day-care in Germany

In Germany, day-care facilities have been paid for as an insurance benefit since the introduction of the compulsory long-term care insurance (Pflegeversicherung) in 1995. The population of adult day-care beneficiaries, in Germany alone, has risen to 45,000 by the year 2013- which almost triples the number in 2005 (Statistisches Bundesamt, 2013). The average age of their population is about 80 (Statistisches Bundesamt 2013). About 60% suffer from the condition of dementia, geriatric disease, and other cognitive symptoms (Weyerer et al, 2004), thus, an array of services should aim explicitly to the PWD.

In respect to room function arrangement, the situation varies from facility to facility. German day-care facilities, as suggested, often consist of the following function components: an entrance area with cloakroom, living area, dining area (with kitchen equipment), 1-2 sleeping rooms, personal care space, storage, and workplace for caregivers (KDA, 2010). The current services of German day-care facilities share similarities as well: care recipients typically begin their days in the dining room with breakfast, spend the daytime with programs in the living room or activity room, and finish their days after coffee in the dining room in the afternoon. This makes the living area and dining area of a day-care facility its core space.

2.2 Unstructured behavior during the day-care service

During the service days, activity programs are usually organized in great detail by care providers: sometimes even minute-by-minute. Guidance for care providers also suggest that they invite care recipients to participate in all activities. However, the unwillingness of participation from care recipients should be accepted and respected (Tate and Brennan, 2013). It is always important to have the care recipients decide what they want to do in the facility and have the freedom to choose whether or not to participate in these activities.

It is therefore particularly significant to distinguish between activities that are organized by the care providers (**structured behaviors**) and those that are initiated by the care recipients themselves (**unstructured behavior**) (Lemke and Moos, 1989), as the forms of activity have quite different personal and environmental determinants.

Unlike the structured activities that occur in the company of caregivers, activities, which the care recipients behave on their own terms, are more influenced by the building environments. Furthermore, freedom to use the space will improve care recipients' well-

being, as they may feel greater self-esteem. However, unstructured behavior requires more surveillance from care providers and embodies higher chances of PWD getting injured, especially if the environment is not dementia-friendly.

Due to a lack of studies that emphasize how architectural environment in day-care centers facilitates the unstructured behavior of PWD, exploratory research on this topic is in demand and will greatly benefit care practitioners, architects, and decision makers, allowing them to better understand the spatial needs of PWD, and hence, offer them friendlier environments.

3 Research aims and hypotheses

3.1 Aims

The aim of this study is to offer insight into the unstructured behavior of PWD in adult day-care centers from an architecturally disciplined perspective, as well as to interpret the relationship between behaviors and spatial configuration of the space. The final goal is to propose design recommendations for day-care facilities for PWD in order to support dementia care in a safer and friendlier environment. With this purpose, a key research question is proposed to guide the project:

How does unstructured behavior of people with dementia occur in relation to the architectural environment of their adult day-care facilities?

In order to answer this question, the study was developed through a strategy that combines observations of behaviors in order to understand the spatial distribution of PWD's unstructured behavior and analysis of the day care facilities' floor plans, with a focus on the spatial configuration of buildings, including function complexity, typology, and interior furniture.

3.2 Hypotheses

Before the statement of hypotheses, several concepts are presented to address their meanings in this paper.

1. Spatial distribution of behavior: The percentage of observed behaviors in each functional component, which is computed case by case, with a 100% in total for each case.

2. Functional complexity: The number of function components in each facility. The function components are clustered based on the German suggestion of day-care facility

design (KDA, 2012), which chiefly consist of living area, dining area, zone of transition, sleeping room, personal care space, storage, and workplace for caregivers. In real cases, the function complexity of a day-care facility varies with the building situation and the service program.

3. Typology: The configuration structure of space, i.e. the way in which rooms and spaces are organized in the facility. Typology of building determines the space structure and the centrally located space. For instance, the ward wings of hospitals are commonly designed with linear corridors in the center, which play the role of organizing all the other spaces, whereas kindergartens often consist of halls or play rooms in the middle and are attached by other rooms.

There are two typologies in this study: Type 1, living-room-centered, and Type 2, corridor-centered.

4. Floor plan and furniture location: Qualitative data, presented with the floor plan drawings.

Three hypotheses are proposed based on the aforementioned strategy. These hypotheses answer the question of whether or not any relationship exists between unstructured behavior and a building's functional complexity and typology. The analyses of hypotheses also explain and illustrate how floor plans and furniture can facilitate or hinder the unstructured behavior of PWD in day-care facilities.

Hypothesis 1- Function complexity: Regardless of the functional complexity of the facility, unstructured behaviors are always concentrated in spaces with the dominating functions, i.e. living area and dining area of day-care facilities.

Hypothesis 2- Typology: Depending on the typology, unstructured behaviors of care recipients in day-care facility are more accumulated in the centrally located space.

Hypothesis 3- Floor plan and furniture location: The location of unstructured stationary behavior (e.g. sitting and socializing) is more dependent on the location of furniture, whereas the tracks of unstructured movement (e.g. wandering and standing) are more dependent on the space structure of the facility.

4 Methodologies and data collection

Six day-care facilities in Dresden, Germany, were chosen for the case studies. In each center, spatial data was collected by analyzing floor plans of the buildings.

In these six centers, care recipients of these six centers over 65 years old and diagnosed with dementia by their general practitioners were observed with Behavior Mapping sheets. Behavioral mapping is a type of systematic observation research method that tracks behavior over space and time. It uses an actual plan of an area (Working sheet) on which people's location and activities are indicated. This method can describe where and how target behaviors occur in relation to the space, rather than what was planned for that space (Ittelson et al., 1970), hence revealing the real usage of the space. Behavior mapping is broadly used with populations for which interviews or questionnaires are less appropriate, like patients in healthcare facilities (Sommer and Sommer, 1991).

During this project, the observations were made 12 times in each facility at 5 min intervals from 9:00 to 16:00 on the care recipients in all accessible areas to note down the behavior type of the care recipients who had changed their locations from the last scan. Total duration at each facility lasted 84 hours.

When the daily number of observed care recipients was over 10, the observation would be settled for a partial record, i.e. only 10 of the total were to be selected. The care recipients who attended the care service less frequently should be included in the observation rather than the more frequently joining ones. However, this situation (the number of daily observed care recipients larger than 10) never happened during the observations.

Two realms of behaviors were taken into consideration: **stationary behaviors**, including sitting, leisure, and socializing, and **movements**, referring to wandering and standing. Definitions of the five behaviors are presented in Table 1.

Table 1 Time table of the six day-care centers

Sitting	Sitting in a particular place doing little or nothing*.
Leisure	Recreational activities, such as playing with toys, knitting, reading.
Socializing	Talking to each other or gaining information by using verbal communication.
Wandering	A walking activity without a clear particular purpose or destination.
Standing	Stops during wanderings or standing at a particular place without obvious purposes.
*If care recipients were socializing while standing or sitting, the behavior would be coded as socializing.	

5 Case introduction and analyses results

5.1 Case studies

Visits to these six day-care centers prior to formal observations made it apparent that they all operated under the same set of standards and similar schedules (Figure 1) and offered services to 10-15 care recipients per day. The facility buildings had all been remodeled to adapt to the programs with the aim of offering services to PWD. To ensure confidentiality, we name them Centre T, A, V, C, G and D. The information of the size of the buildings and the floor plans are illustrated in Table 2.

Figure 1 Time table of the six day-care centers

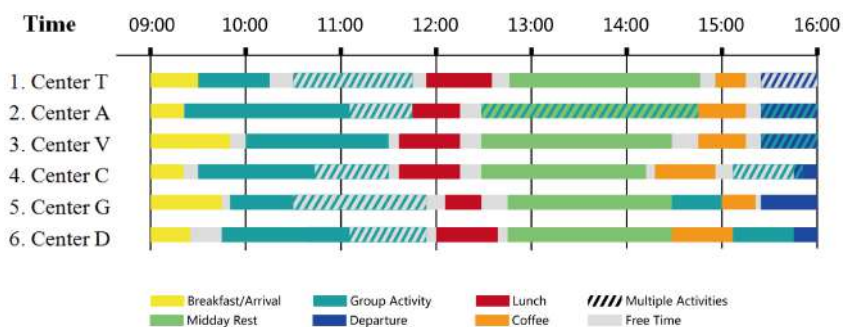
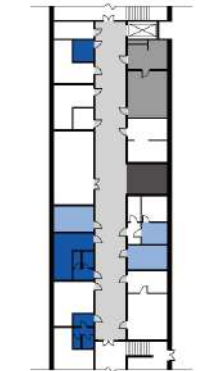

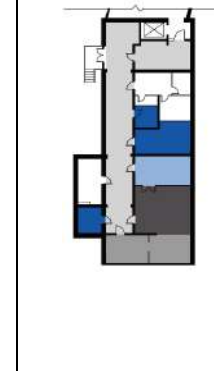


Table 2 Size and floor plan of the six day-care centers

Type 1 ¹	1. Center T	2. Center A	3. Center V
Size (in m ²)			
In total	187.9	222.01	332.3
In use	164.6	111.7	250
Per person	15.43	9.36	17.45
Floor plan			

Type 2 ¹	4. Center C	5. Center G	6. Center D
Size (in m ²)			
In total	470.4	307.8	281.3
Accessible area*	349.1	284.3	261.7
Per person*	31.74	18.05	19.03
Floor plan			
<p>* 1. Type 1: Living-room-centered; Type 2: Corridor-centered. 2. The accessible area for the care recipients. 3. German regulation on the size of day-care facilities serving 10 to 15 daily participants is from 16 to 24 square meters per person (KDA, 2010).</p>			

5.2 Quantitative analysis

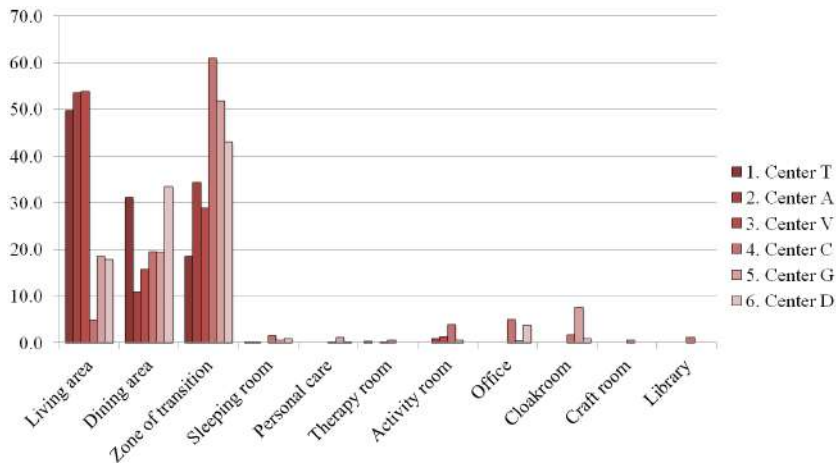
After collecting observational data and analyzing the spatial properties of the six facilities, the distributions of behavior of each case were calculated and then compared using statistical methods.

In terms of **Hypothesis 1**, the data analysis shows that the numbers of the centers' functional components vary from one to another, even though five of the function components exist in all of the study's cases: living area, dining area, zone of transition, sleeping room(s), and personal care space. These five spaces are highlighted with different colors in Table 2. The reason behind variety of functional component number is often spatial restraint. However, regardless how many functional components the day-care facility contains, the distributions of unstructured behaviors have performed a strong tendency towards three of them: the living area, the dining area, and the zone of transition. More than 90% of the total unstructured behaviors in the six day-care centers happened within these three areas (Table 3, Figure 2). Statistical analysis suggests that this result is significant ($p=0.000$, one-way ANOVA, $\alpha=0.05$). This finding confirms the first hypothesis of the study stating that the living area and dining area should be the most frequently used space for unstructured behaviors.

Table 3 Spatial distribution (%) of unstructured behavior in each facility in terms of room function

	1. Center T	2. Center A	3. Center V	4. Center C	5. Center G	6. Center D
Function complexity¹	6	6	7	11	8	7
Function components	Behavior distributions (%)					
Living area	49.8	53.7	54.0	4.8	18.5	17.9
Dining area	31.3	10.9	15.7	19.6	19.4	33.5
Zone of transition	18.5	34.3	28.9	61.1	51.9	43.1
Sleeping room	0.2	0.2	0.0	1.6	0.6	0.9
Personal care ²	0.0	0.0	0.0	0.1	1.1	0.1
Therapy room	0.2	--	0.1	0.6	--	--
Activity room	--*	0.9	1.3	3.9	0.6	--
Office	--	--	--	5.0	0.4	3.7
Cloakroom	--	--	--	1.6	7.5	0.9
Craft room	--	--	--	0.5	--	--
Library	--	--	--	1.2	--	--
1. The number of independent function components in each facility. 2. Personal care includes toilets and bathrooms. *. "--" indicates the function component does not exist in that corresponding facility.						

Figure 2 Histogram of spatial distribution (%) of unstructured behavior in each facility in terms of room function



To further analyze this result, a comparison among the mean distributions for the three leading function components was conducted. This is seen in Table 4. However, the result shows that the difference among them is not significant ($p=0.191$, one-way ANOVA, $\alpha=0.05$).

Table 4 Spatial distribution (%) of unstructured behavior in each facility in terms of room function

	Living area	Dining area	Zone of transition	<i>p</i>
Mean (%)	33.1	21.7	39.6	0.191
SD	21.8	8.9	15.6	

As several prior studies suggest that spatial visibility and spatial accessibility influence human movements in spaces (Hillier and Hanson, 1984; Penn et al. 1997; Hap and Luo, 2012), it may explain the reason why the zone of transition in day-care facilities would show such a high distribution of unstructured behavior. While day-care facilities are usually small in scale and less complex in space, the zone of transition still was highly accessible and visible from all the spaces due to its natural spatial property.

The findings expand on the first hypothesis of this study to a conclusion that in day-care facilities, regardless of the facilities' function complexity, unstructured behaviors are always concentrated in spaces of the living area, the dining area, and the zone of transition.

The purpose of **Hypothesis 2** is to verify the possible influence of building typology on the distribution of behaviors in day-care facilities. Due to the findings from the first hypothesis, the comparison between Type 1 and Type 2 facilities focuses their most used space for unstructured behaviors.

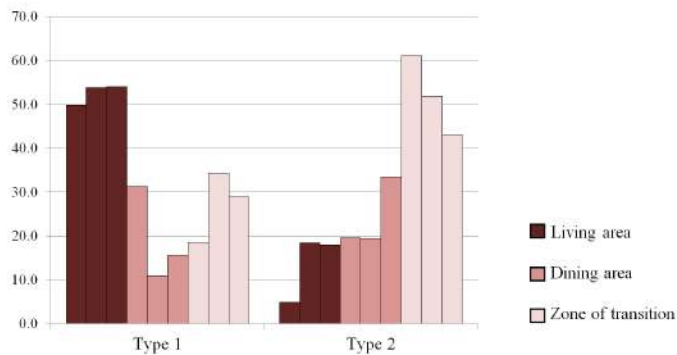
Table 5 illustrates a clear difference between the situations for the two typologies. It is seen that, in Type 1 cases, the living area is leading among the three spaces in terms of the distribution of unstructured behavior, whereas, in Type 2 cases, this leading role is played by the zone of transition. An ANOVA test (one-way ANOVA with Post-Hoc test, $\alpha=0.05$) was done to statistically support this finding, with which a significant result was proved: $p=0,005$ for Type 1 and $p=0,003$ for Type 2 (Table 5, Figure 3).

To note that for these two typologies, the living area and the zone of transition, respectively, are their centrally located space, the findings from the aforementioned analyses confirmed the second hypothesis of the study, indicating that even though the centrally located space could vary in functions due to the typology of building, this space is the one in which the most unstructured behaviors of care recipients occur in day-care facilities.

Table 5 Comparison of means of spatial distribution (%) of behavior in living area, dining area and zone of transition in respect to typology (one-way ANOVA, $\alpha=0.05$, with Post-Hoc test)

		Living area	Dining area	Zone of transition	<i>p</i>
Type 1*	Mean (%)	50.5	19.3	27.2	0.005
	SD	2.3	10.7	8.0	
Type 2*	Mean (%)	12.3	25.3	53.0	0.003
	SD	6.7	3.2	9.1	
Post-Hoc test: In type 1, $p=0.005$ for Living area & Dining area; $p=0.018$ for Living area & Zone of transition. In type 2, $p=0.006$ for Zone of transition & Dining area; $p=0.021$ for Zone of transition & Living area. * Type 1: Living-room-centered; Type 2: Corridor-centered					

Figure 3 Histogram of spatial distribution (%) of unstructured behavior in living area, dining area and zone of transition in respect to building typology



For **Hypothesis 3**, the collected data reveal that the stationary behaviors of care recipients (sitting, leisure, and socializing) often happened next to the furniture or at the moment when furniture is in use, while the occurrence of the wandering and standing are less likely in relation to furniture. This result is confirmed with both numerical analysis (Table 6) and descriptive analyses presented in the next section of this chapter. This finding can be applied both in the phase of floor plan design and during the process of furniture locating.

Table 6 Spatial distribution (%) of unstructured behavior in relation to the furniture location

	Stationary Behavior (%)			Movement (%)	
	Sitting	Leisure	Socializing	Wandering	Standing
With furniture ¹	99.9	67.7	67.4	0	0.3
Without furniture ²	0.1	32.3	32.6	100	99.7
P-value ³	0.037	0.013	0.061	0.006	0.004
1. Referring to the situation in which unstructured behavior were happening by the furniture or while care recipients are using the furniture. 2. Referring to the situation in which unstructured behavior were happening without direct involvement with furniture. 3. Independent T-test in SPSS, $\alpha = 0.05$.					

5.3 Descriptive analysis

After the accumulation of observational data and the illustration of behavior tracks based on the data, the patterns of unstructured behaviors of the care recipients in the six facilities are presented and then compared.

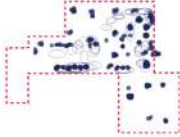
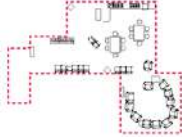
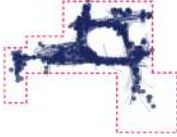
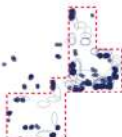

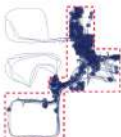


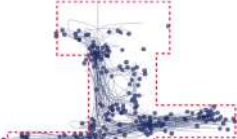
Tracks of all the observed behaviors are set forth in table 7. In order to understand the relationship between the behaviors and the architectural environments, descriptive analyses about the tracks of unstructured behavior in relation to the floor plan and furniture location was conducted. By presenting the results of the observation, it is clearly suggested that the unstructured behaviors tend to occur in the areas of living, dining, and the zones of transition in terms of room function, and in the centrally located areas in terms of typology. These results confirm our quantitative analyses regarding Hypothesis 1 and Hypothesis 2.

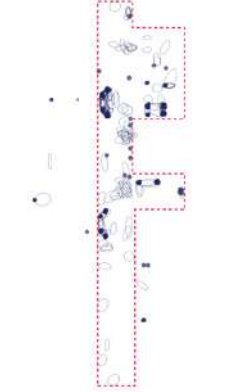
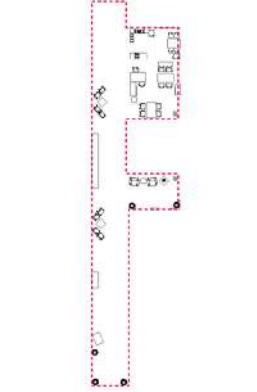
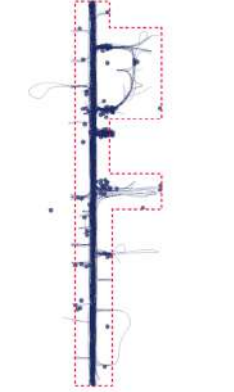
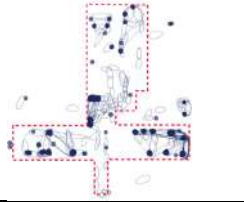
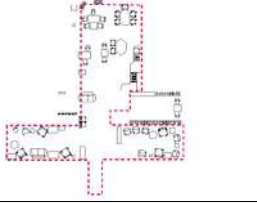
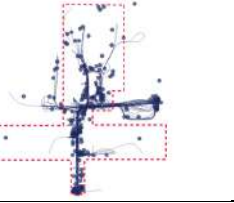
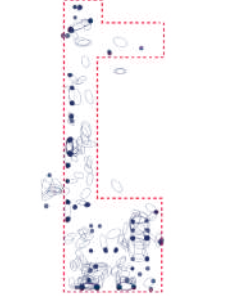
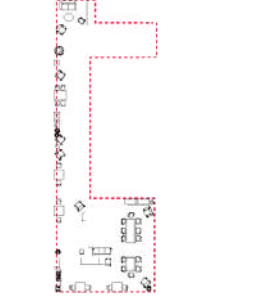
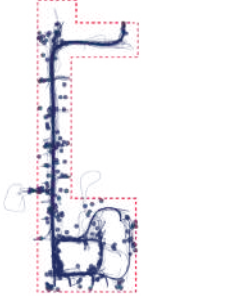
Table 7 Behavior patterns in the six day-care centers

1. Center T	2. Center A	3. Center V
		
4. Center C	5. Center G	6. Center D
		
<p>1. Unstructured behaviors include wandering (blue lines), standing, sitting, leisure (blue dots), and socializing (blue circles). Separate layers of behavior patterns can be found in Table 8. 2. Red dash line outlines the edge of the living area, dining area and zone of transition in each case.</p>		

After the study of behavior patterns in the range of the entire floor plans, a narrowed-down analysis is provided to emphasize Hypothesis 3. The focus in this analyzing phase is reduced to the living area, the dining area, and the zone of transition, which are the location for > 90% of total unstructured behaviors (see Table 2). Behavior tracks are layered into two layers- one for stationary behavior and one for movement (Table 7). The illustrations present the contrast of these two realms of behavior: the majority of stationary behaviors, i.e. socializing, leisure, and sitting, happen by furniture or while the care recipients are using the furniture, whereas, almost the entirety of movements occur without relation to furniture.

Table 8 Behavior patterns of stationary behaviors and movement, with furniture location in the area of living, dining and transition

Tracks of stationary behaviors	The area of living, dining and zone of transition	Tracks of movements
1. Center T		
		
2. Center A		
		
3. Center V		
		

Tracks of stationary behaviors	The area of living, dining and zone of transition	Tracks of movements
4. Center C		
		
5. Center G		
		
6. Center D		
		

6 Recommendations

Although the floor plans of the day-care centers in this study are different, the analyses proved that they share generic properties governing the behaviors of the care recipients (Table 9). To develop a lively, enjoyable, and dementia-friendly environment in adult day-care facilities, recommendations are offered based on an attitude that

unstructured behavior should be allowed, but through a beneficial environment that can maximize the safety and well-being of PWD as well as lessen the potential disturbance to other care recipients and group activities (Algase et al., 2003; Campbell, 2014).

Table 9 Summaries of research findings

Spatial properties	Findings
1. Function	Unstructured behaviors occur chiefly in living area, dining area, and the zone of transition.
2. Typology	Centrally located spaces have a dominating influence on the occurrence of behaviors.
3. Floor plan & Furniture	Locations of stationary behaviors are often by/at the location of furniture, whereas the tracks of movement are more related to space configurations.

Living areas, dining areas, and zones of transition, as the most frequently used spaces for unstructured behaviors of PWD in day-care facilities, should be absolutely safe, barrier free and flush. Detailed design recommendations are given in terms of various design phases.

Floor-plan Design Phase:

1. The typology of building influences the distribution of behaviors in the facility. Clustering the living area together with the zone of transition will facilitate more unstructured behavior within these spaces, which could make the spaces inappropriate for quite/stationary behaviors.

2. Dining is an activity best cued by creating familiar settings for eating (Moore et al. 2006). A dining space, which is not directly attached to the living area and zone of transition, may help the care recipients distinguish the function of this area and enhance the independence of the dining activity.

3. A buffer area for quiet place that physically attached but functionally distinct from the three most used areas is suggested in order to lessen stationary activity distributions by the movements of the others.

4. Facilitating at least one staff location with visual access to the most used space of unstructured behaviors help staff maintain visual surveillance of the spaces and thereby enhancing the safety of care recipients.

Interior Design Phase:

Furniture helps to define space identity functionally and spatially. Providing proper settings and furniture in the living area, dining area, and zone of transition is likely to encourage more engagement of related behaviors in these areas, as opposed to a situation in which they are provided in other locations.

7 Conclusions and study limitation

This study is among the few to examine the relationships between architectural environments and the unstructured behaviors of PWD. It provides evidence for the activity-friendly facility design, the development of architectural intervention, and the policy to promote indoor environment in day-care facilities of PWD and the older adult.

As exploratory research, the findings of this study provide empirical evidence as a basis for further discussion.

For designers, consideration for a dementia-friendly environment in a day-care facility should start as early as the programming stage and cover not only the programs themselves but also the architectural environments and areas that venue the programs. Integrating the concept of spatial usage from the perspective of PWD into the facility design and planning process results a smoother interior design process and enhanced function arrangement of the facility.

For care administrators, care providers, and activity programmers, the findings of this study provide a foundation with which to effectively modify or multi-use the facility space during the service. For example, it may be more feasible for day-care centers with long corridors to implement group games in this space rather than to use it for midday rest. These considerations not only help care recipients achieve maximum benefits but also reduce potential conflicts among care recipients brought on by the mixed use of quiet spaces with active spaces (e.g. wandering guests may influence the ones in their midday nap).

Although this study was relatively small and limited in geographical scope, the findings add to the growing evidence for day-care facility design based on empirical data gleaned from systematic observation and spatial analysis. The study also revealed unstructured behavioral differences in terms of physical environmental needs. These results help confirm the conclusions of previous studies and suggest possible routes for immediate application in facility planning, design, and programming by relevant

stakeholders. In particular, applying this new information on spatial use load to emphasize the character of existing spaces and, thus, enhance perception of these spaces by care recipients may be a cost-effective way to strengthen the day-care service already in place at existing facilities.

It is necessary to note that this study only considered six facilities in Dresden, Germany, which may limit the scope of the results. In future, study with a larger number of samples may offer more reliable results. Moreover, these day-care centers were public care facilities that provided service during the study, making it impossible to remodel the space or to change the interior design and, thus, test our hypotheses in a situation with confounder factors, such as change to demographical features or service delivery.

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