Review

Wayfinding in People with Alzheimer's Disease: Perspective Taking and Architectural Cognition—A Vision Paper on Future Dementia Care Research Opportunities

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Abstract: Based on a targeted literature review, this vision paper emphasizes the importance of dementia-sensitive built space. The article specifically focuses on supporting spatial orientation and wayfinding for people living with dementia. First, we discuss types of wayfinding challenges, underlying processes, and consequences of spatial disorientation in the context of dementia of the Alzheimer's type. Second, we focus on current efforts aimed at planning and evaluating dementia-sensitive built space, i.e., environmental design principles, interventions, evaluation tools, strategies, and planning processes. Third, we use our findings as a starting point for developing an interdisciplinary research vision aimed at encouraging further debates and research about: (1) the perspective of a person with dementia, specifically in the context of wayfinding and spatial orientation, and (2) how this perspective supplements planning and design processes of dementia-sensitive built space. We conclude that more closely considering the perspective of people with dementia supports the development of demographically sustainable future cities and care institutions.

Keywords: dementia; Alzheimer's disease; wayfinding; spatial orientation; support; built space; environmental psychology; architectural cognition; perspective taking; demographic sustainability

1. Introduction

Current international statistics indicate a demographic transition towards aging societies [1,2]. A longer life also is associated with the risk of developing a dementia syndrome [3,4]; for people above the age of seventy, the likelihood of developing dementia doubles every five to ten years [5]. In thirty years, it is estimated that around 152 million people worldwide will be living with dementia [3], impacting social and economic structures [6]. Hence, the World Health Organization regards dementia as urgent public health priority, and calls for optimizing inclusive environments [6].

A parallel challenge of the twenty-first century is rapid urbanization [1,7]; space increasingly becomes a precious commodity that is negotiated between diverse users and agencies [8]. It is important that vulnerable groups remain part of such discussions. Demographic sustainability [9–12] means taking into account both demographic and spatial transitions (i.e., aging and urbanization); with the goal of sustaining optimal living standards for diverse people, while supporting multi-generational structures, and reducing costly redesigns and the demolition of built space. An aging- and dementia-supportive built space is sustainable, because older people and people with dementia can remain in their familiar environment, being confident, active, and socially included for as long as possible, while requiring less caregiver support when navigating their community. This article focuses on one part of dementia-sensitive built space: supporting wayfinding and spatial orientation.

1.1. Dementia and Wayfinding

The dementia syndrome is caused by a progressive decline of brain substance and is characterized by impairments of several higher cortical functions [13–15]. Such impairments can affect orientation and spatial abilities; perception, memory and recall; arithmetic functions; learning, speech and language; as well as the ability to judge and make decisions [16,17]. By definition, and in contrast to mild cognitive impairment, the dementia syndrome is only present when cognitive deterioration is so advanced that everyday functioning is impaired [18]. In contrast to delirium, consciousness is not clouded [19]. The dementia syndrome is etiologically unspecific [20], which means that there are several neurodegenerative or vascular causes, such as Alzheimer's disease or multiple strokes [20,21].

Dementia of the Alzheimer's type (DAT) is the most prevalent form of dementia (65%), followed by vascular dementia (30%), a combination of both (15%), or other forms [22]. Neurodegeneration affects memory and attention [13,23], thereby impacting learning and storing new information. Additionally, functions related to spatial and temporal orientation are already impaired at an early stage of the disease [24–26]. As both the acquisition of new information, as well as orientation, are fundamental everyday functions needed for successful wayfinding [27], people living with DAT face a high risk of disorientation and getting lost [28,29].

Unfamiliar public environments can be particularly challenging [30], and need to be adapted to the progressive vulnerability evident in dementia [31]. Depending on the stage of the disease, even the most basic needs, such as finding the restrooms in a familiar, small-scale environment, can be compromised [32]. The decline of navigational abilities is associated with increased external support by caregivers, and requires a dementia-sensitive built environment [26]. If the built environment was well-prepared and optimized for people living with dementia, they could rely on their residual orientation and wayfinding abilities for a longer time period and require less caregiver support—and, hence, also stay independent longer [32,33], e.g., in their community.

Prevention- and support-oriented efforts, such as the recently proposed international World Alzheimer Report 2020 [34] and various dementia strategies in Europe (e.g., [35,36]) emphasize the need to sustain the autonomy and social inclusion of people living with dementia, for as long as possible. While a large body of research already targets the topic of dementia sensitivity, it is only since recently that international efforts, additionally, call for supporting the planners of built space [34] and emphasize the importance of wayfinding for older people and people with dementia [37]. This vision paper describes the complex nature of the topic, identifies current challenges in efforts towards dementia-sensitive built space, and proposes avenues for future dementia care research.

1.2. Aims and Scope

As the article is a vision paper (thus, deviating from other research article formats), the authors use a targeted literature analysis and their interdisciplinary expertise (in environmental psychology and spatial cognition research, neuroscience and cognitive neurology, and dementia care research and nursing science) to develop an interdisciplinary research vision for future dementia care research. This article contributes a critical discussion of current efforts towards dementia-sensitive built spaces, in the context of supporting *wayfinding and spatial orientation*. We suggest to more closely take the *perspective of people with dementia* when designing and planning future built space.

We restrict the scope of our discussions to the context of the *built environment*, although the social environment is, naturally, part of it. Our discussions, if not marked otherwise, focus on dementia of the Alzheimer's type, because it is the most prevalent form of the dementia syndrome, and because wayfinding challenges are already evident in the early stages of the disease. We discuss both indoor and outdoor environments—independent of a particular setting (e.g., care institution or district) or a particular role of an environmental planner (e.g., architect, urban planner, or other stakeholders). Additionally, this vision paper does not create new guidelines, strategies, and evaluation tools. Rather, the authors

aim at supplementing an interdisciplinary research vision, by offering a discussion that uncovers challenges in existing efforts, in order to identify avenues for future research.

The structure of this vision paper is as follows: Section 2 describes wayfinding challenges in the context of dementia; Section 3 describes environmental design principles, interventions, evaluation tools, strategies, and planning processes aimed at creating dementia-sensitive built space; Section 4 describes opportunities for future research based on the challenges identified in the targeted literature review; and Section 5 concludes with a call for further debates in the research community.

2. Wayfinding Challenges in the Context of Dementia of the Alzheimer's Type

2.1. The Concepts of Wayfinding, Architectural Cognition, and Perspective Taking

Human navigation consists of two processes: wayfinding (a cognitive problem-solving process: deciding where to go) and locomotion (moving through space and avoiding obstacles) [38,39].

Wayfinding includes sensory perception and spatial cognition, such as orienting oneself in a space, planning a route, making route choices between a start and an end point, monitoring the progress while one moves towards the destination, and recognizing the destination once one has reached it [27]. While wayfinders purposefully move through space, they perceive and process information (to acquire a mental representation, or "cognitive map" of the environment and of how they are located within that environment); and they use that information for route choices at decision points, where more than one route option exists [27,40].

Wayfinding challenges typically arise from an interaction between the characteristics of the environment, the characteristics of the individual, and the particular wayfinding context [40–43]. As such, the complexity of a particular wayfinding task depends on an interplay of, e.g., how complete the person's mental representation of the space is and how well it corresponds with the real space; how suited the individual's chosen wayfinding strategies are for a particular wayfinding task in a particular environment; and how supportive or unsupportive a particular environment is [41,42].

Wayfinding can also be influenced by the social context, such as other people [44]. For instance, people with dementia may not venture out in evenings unless being supported by others [45], and caregivers may offer their help when people with DAT are disoriented [32,46]. While an unfamiliar space means learning and encoding new information, in a familiar space, one can typically rely on stored spatial knowledge, as well as information directly available in the environment [43,47].

Architectural/urban cognition, a concept developed at the intersection of spatial cognition and architectural/urban research [48–53], in this article refers to, both how people interact with built space (e.g., perceive, experience, use, and think about) and how environmental planners anticipate people's interactions during planning and design. In the context of planning wayfinding support, planners need to take the perspective of the future users of their planned space. To do so, they need to mentally immerse themselves into the informational, behavioral, and emotional situation of a person with different abilities and resources than they have [42,54,55]. This reasoning about others requires perspective taking: anticipating the responses of others by immersing oneself in their perception of the world—as if taking a walk in their "shoes" [56–60].

- In sum, successful wayfinding is linked a complex interplay of contributing factors, both spatial and non-spatial. Importantly, wayfinding is a highly complex cognitive problem-solving process, relying on several brain functions. Yet, in people living with DAT, neurodegeneration causes wayfinding processes to be disrupted, as the next section describes, and planning wayfinding support for this target group requires awareness and consideration of this complexity.

2.2. Wayfinding and Spatial Orientation in the Context of Dementia of the Alzheimer's Type

People living with DAT encounter orientation and wayfinding challenges that can be associated with impaired brain functions, such as visual motion processing [24,25,61], or other cognitive impairments. For instance, people with DAT may face challenges with path integration, i.e., the processing and updating of information about their position, speed, and movement direction while navigating a space [62–65]. Such deficits are linked to impairments in grid-cell-like representations [62,63], which are an important base for navigational functions. People with DAT consequently can have deficits in mentally representing space (i.e., cognitive mapping); both regarding person-centered orientation strategies (using one's body as reference) as well as allocentric strategies (using the positions of objects and their relations, independent of one's own spatial position) [66].

In addition, people with DAT may lose their route planning abilities. As such, it is harder for them to plan or monitor an overall wayfinding strategy to navigate towards a destination; and specifically, to solve complex or abstract wayfinding tasks [67]. People with DAT may face deficits in: (a) both global wayfinding strategies linked to the *overall* problem structure and general conceptualization of a wayfinding task, as well as (b) analytic strategies, such as solving *specific* requirements of the wayfinding task [68]. As a consequence of interacting impairments due to the neurodegeneration, it may be challenging for them to self-localize or to understand route instructions [69], or to identify suboptimal wayfinding decisions and correct them [67].

Moreover, discriminating relevant or irrelevant visual information can compromise their already limited attentional resources [70]. This might explain why people with dementia are easily overwhelmed by environmental stimulation [70]. For instance, depending on the stage of the disease, people with DAT, upon seeing an unrelated button, might press it without consideration of its consequence; if an elevator door opens nearby, they might enter it seemingly automatically; and if any type of written information is present, they may read all information, even if it is not relevant for completing their wayfinding task [67]. Recent eyetracking studies also indicated that participants with DAT gazed less time at salient wayfinding cues, but, over time, fixated more on repetitive irrelevant architectural elements than on supportive relevant cues—specifically at decision points [71]. This reliance on building features may point out that people do look for cues in the architecture, and that a more supportive environment could support specific spatial orientation needs during wayfinding [71]. However, few studies examine behavior and visual attention using naturalistic tasks in field settings.

At the same time, it should be noted that the pathology associated with the dementia syndrome does not always manifest in directly observable performance deficits. Some individuals may still yield unimpaired performance in cognitive tests or during wayfinding in early stages [25,26], as the brain might partially compensate for its damage by using brain networks more efficiently, or by using alternate brain networks or compensatory strategies [72,73]. This "cognitive reserve" could explain why individuals with similar brain pathology can differ in their cognitive and/or behavioral performance.

- In sum, people with DAT can face challenges with all stages of wayfinding as defined in Section 2.1; and in both unfamiliar as well as familiar environments (depending on the stage of the disease): with spatial reasoning needed for planning routes, with monitoring whether one is on the chosen route towards the destination, with recognizing the destination, and with directing attention to information relevant for solving a particular wayfinding task.

Figure 1 summarizes the outlined mechanisms and possible interactions between the environment, the person, the disease, and the context associated with wayfinding performance in people with DAT.
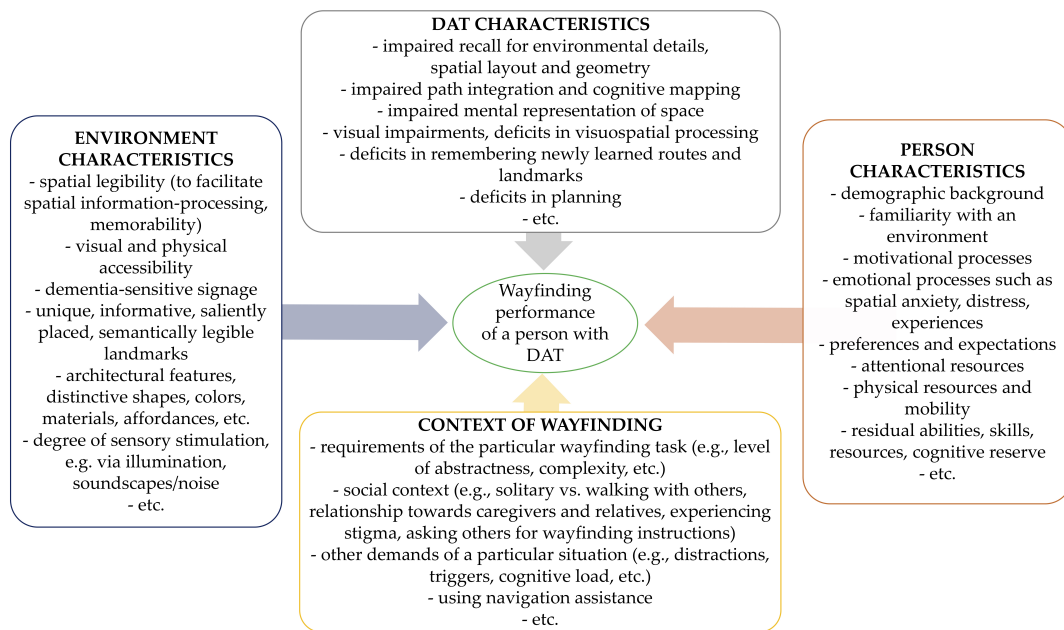
Figure 1. Non-exhaustive examples of factors contributing to wayfinding performance in people living with dementia of the Alzheimer's type (DAT).

2.3. Consequences of Wayfinding Challenges for People with Dementia

A *behavioral consequence* of getting lost for people living with DAT is potential harm [29]. Caregivers' reports indicate that 41% of people with a dementia syndrome got lost at least once in their familiar community; and a significant number of persons had an observable risk of getting lost [28]. In addition, caregivers' distress that their protégées might get lost might motivate them to keep people with dementia inside or surveilled. If caregivers felt more confident that their protégées were supported in wayfinding, e.g., via the built (and social) environment, one outcome might be that people with dementia could more independently and longer navigate their community or residential environment—and this might be positively associated with their health and social inclusion.

For the person with DAT, an *emotional consequence* of getting lost is anxiety or agitation [32,71,74]. Specifically at decision points, where one has to choose between several possible route options, people with DAT can perceive discomfort, insecurity, and mental overload—even if they know their destination [75]. This link between wayfinding challenges and distress specifically highlights the need for preventive and supportive adaptations to the built environment. Such adaptations could provide recognizable orientation cues to support a person's residual navigational abilities and thereby relieve spatial anxiety. Furthermore, due to the link with emotional processes such as agitation, the neuropsychiatric symptom of wandering [76] also has been discussed in the light of wayfinding [77]. In wandering, typically occurring in more severe stages of the disease, the person engages in locomotion, such as straying around, or leaving a place. In contrast to wayfinding processes, wandering does not always involve self-localization and spatial reasoning processes [32], and it can be hard to understand its causes [78]. Improving spatial orientation might potentially also contribute to less wandering; but to understand this, the perspective of people with dementia and their reasons for disorientation and/or wandering would have to be better understood.

A *social consequence* of losing navigational abilities is that, due to an increasing dependency on caregivers [32], and the related caregivers' burden, people living with DAT are often eventually admitted to professional care facilities. Gradually, the experience of built space changes: from large-scale environments that can be traversed independently towards smaller and more restricted environments and increasing dependency on support [79]. From the perspective of people with DAT, a transition from a familiar home

environment to a care facility can be linked to orientation challenges and spatial anxiety: the new environment is initially unfamiliar, learning new spatial information is impaired, and familiar relatives who could offer support are not always present anymore. This specifically emphasizes the need to design dementia-sensitive nursing homes to support spatial orientation [33,80,81]. However, given numerous guidelines, strategies, and efforts for dementia-sensitive indoor environments are already available to planners and practitioners, we deem it worthwhile to, additionally, examine whether large-scale, public environments, such as districts, may also benefit from dementia-sensitive planning criteria that exist for indoor wayfinding. Since the aim is to age well at home [82,83], the physical district, as well as the social community around the home ideally serve the people living there in their individual needs and abilities [35,84]. Such efforts would also contribute to demographic sustainability, as multi-generational age structures were supported [12].

- In sum, for people with DAT, spatial orientation and wayfinding challenges can have strong behavioral, emotional, and social consequences. Hence, the next section develops a perspective, how wayfinding in people with dementia might be supported via the built environment.

3. Planning and Evaluating Dementia-Sensitive Built Space

3.1. The Concept of Dementia Sensitivity

Earlier biomedical approaches to dementia focused largely on dysfunction and brain pathology. The social model of disability in the 1980s brought along a paradigm shift, turning away from a focus on dysfunction and towards the responsibility of society [85,86]. Additionally, the United Nations' Convention on the Rights of Persons with Disabilities (2008) emphasized that the design of an inclusive built environment must allow equal opportunities and, hence, unrestricted access to built space [87]. Furthermore, the development of Universal Design brought progress in establishing barrier-free accessibility, security, privacy, orientation, and safety principles, with the aim of achieving universal usability (e.g., of an environment) for the largest possible number of people [88].

The characteristics of a supportive built environment have also been discussed in terms of a person–environment fit [89], wherein the environmental docility hypothesis assumes that people with reduced competences are more dependent on a supportive environment [90]. People living with a dementia syndrome are more dependent due to their limited ability to adapt to or change their environment according to their personal needs or aspirations. This emphasizes the need to specifically develop dementia-sensitive environments that respond to their increasing dependency and to support residual abilities to foster autonomy, for as long as possible. An environment that does not fit the abilities, needs, and perspective of people with dementia can easily distract, fatigue, or overwhelm.

Furthermore, practicing a person-centered dementia care approach follows the idea that a person with a dementia syndrome can live well, even with the disease progressing [91]. Thus, while the pathology eventually causes a loss of spatial orientation, a person with DAT might still be able to cope with other everyday tasks and situations, if dementia-sensitive support structures are provided. Following such a salutogenic approach [92], planners of built space might focus on preventive and supportive factors, e.g., identifying resources and capacities that contribute to health and well-being, rather than on the impairment due to the disease. For instance, removing overstimulation to ease agitation is considered a pathogenic approach; and creating supportive design elements is a salutogenic approach [34]. A salutogenic design of built space tackles environmental design factors that enable a person to make sense of their situation, to be supported in their everyday tasks and needs, and to experience a sense of coherence, i.e., personal meaningfulness [34,93].

- In sum, for dementia-sensitive environments, the impairments (e.g., processing environmental information; potentially being distracted by environmental cues that are irrelevant to solving a wayfinding task; or having a low threshold for sensory stimulation) in terms of the design of built space might be translated to simply relying on simplified geometries, landmarks, and spatial functions. However, in its full potential,

built space would equally address a personal sense of coherence/meaningfulness, and an optimized ambience, while also offering dementia-sensitive engagement, and while supporting spatial orientation and wayfinding.

For the discussions in the next sections, we distinguish between *environmental design principles* (Section 3.2.) (often implemented *before* the construction or the redesign of built space), and *environmental interventions* (3.3.) or *evaluation tools and strategies* (3.4.) (often implemented *after* the construction of a space, e.g., translating design principles to a care context to test their effectiveness and feasibility).

3.2. Environmental Design Principles

A plethora of research in the past decades already investigated environmental design factors that might contribute to dementia-sensitive *indoor* built environments. For instance, in personal home environments or hospitals, night lights can support orientation [82,94]. In care facilities, areas that are not well-lit or look too similar, as well as signage with low contrast, may hinder wayfinding [95]. Especially people living with moderate or severe dementia progressively may benefit from on geometrically simple, small-scale floor plan layouts; whereas changes of direction can be linked to disorientation [33,95]. Visual accessibility to relevant places supports spatial orientation [96]. Yet, in late, severe stages of DAT, people might not be able to rely on compensatory wayfinding strategies anymore, even if supportive cues are present [71,97]. Hence, while supporting all stages is important, the built environment might best support people in early stages of the disease; thereby potentially supporting the use of residual abilities, and fostering sustained autonomy and social inclusion.

Yet, few studies exist on dementia-sensitive *outdoor* built environments, such as districts—with exceptions of, e.g., [84,98,99] who advocate inclusive neighborhoods, but do not specifically address spatial orientation or wayfinding. The few studies on outdoor wayfinding indicated, e.g., that people with mild to moderate dementia identified visual distinctiveness and memorability of outdoor landmarks (e.g., the size, shape, texture, color) but also the meaningfulness (e.g., a subjective personal significance or familiarity) as important [100]. Wayfinding cues, e.g., signage and the presence of other people, support them to navigate independently; whereas they avoid large-scale, crowded, and noisy environments [100]. Crossings, junctions, overstimulation, and unfamiliar spaces reportedly contribute to spatial disorientation [30]. People with dementia seek to stay engaged in outdoor spaces and connected to their community [84]. Thus, examining landmarks and other wayfinding cues, in terms of visual attention processes and behavior, is a potential avenue for further research; especially when considering the adaptation of outdoor spaces from the perspective of people with early stages of DAT.

At the same time, any single environmental design factor can also have negative effects, if not designed with the principle of dementia sensitivity and the perspective of the person in mind. For instance, stimulation involving more than one sense can easily overwhelm attentional resources, even if this factor is designed as wayfinding support. Yet, too many wayfinding cues can result in visual clutter and may be overwhelming, rather than supportive.

- In sum, the core component of dementia-sensitive indoor and outdoor environments is spatial legibility, the degree to which an environment facilitates spatial information-processing. In this context, simplicity and safety are key planning principles in current approaches. In the view of the authors, a dementia-sensitive built space must be tailored specifically to the needs and perspective of a person with dementia (e.g., via appropriate dementia-sensitive levels of stimulation and supportive orientation cues), whilst also offering factors that support positive, meaningful experiences (e.g., dementia-sensitive ambiences or sensory interaction that involves more than one sense). This requires evaluating planned and existing built environments from the perspective of people with dementia.

With regard to the characteristics of a dementia-sensitive built environment, the authors identify the following challenges:

1. A first challenge is acquiring informed consent, as the person may forget having agreed to participation, while already participating in the study. Researchers can use proxy consents by caregivers or relatives, or ongoing consent where the person is informed, and asked whether they like to continue, both at the beginning of the study, as well as continuously throughout the data collection [101].

2. A second challenge is to refine participatory dementia-sensitive methods. To more closely integrate the perspective of people with dementia in research and planning processes, researchers may need to develop alternative measures [102] and creative analytic formats [103]. On a content level, this includes developing methods that do not overwhelm but support people with DAT to, from their perspective, identify useful wayfinding cues. For instance, they could identify wayfinding cues involving more than one sense, rather than landmarks/geometries that appeal mainly to the visual sense. In each case, we deem it important that the research revolves more closely around their perspective, even if it may be challenging to develop sensitive methods.

3. A third challenge is that the plethora of studies about dementia-sensitive indoor (and to a lesser degree outdoor) environments makes it harder for non-researchers (i.e., planners of built space or dementia caregivers) to identify which studies are methodologically sound (e.g., simple geometries) and, hence, provide evidence for guidelines; and which ones show interesting directions, but contain study limitations and, hence, remain to be tested further (e.g., color recommendations). This also brings along the question how to translate research insights into practice (e.g., into an environmental design or intervention). Translation, in itself, is a complex endeavor [104,105] with many barriers (such as interpreting heterogeneous research outcomes) and practical issues (such as financial or organizational barriers).

4. In addition, different research disciplines, e.g., psychological research and architectural planning, typically rely on different methods, paradigms, and expertise (e.g., [106]). Here, developing a shared terminology between disciplines may facilitate a more nuanced perspective taking [107]. In our view, structuring participatory research approaches, and reaching a common terminology of concepts might be valuable for fostering interdisciplinary collaborations. Also, researchers and planners, in a combined effort, could collaborate to reach their shared aim of supporting wayfinding via a dementia-sensitive built environment.

3.3. Environmental Interventions

If the built environment is already constructed, environmental interventions can additionally contribute to optimizing dementia-sensitive spaces. Guidelines for people with severe dementia may target several aspects at once, e.g., ensuring a supportive, dementia-sensitive environment, but also sustained training for caregivers (focusing on their interaction with people with dementia and on self-care), as well as psychosocial interventions [108]. Psychosocial interventions target, e.g., the stimulation of physical activity [109,110]. Environmental interventions target, e.g., improving safety, or supporting various everyday tasks, such as toileting, dressing, or cooking [111].

The few environmental interventions specifically designed for supporting spatial orientation have largely focused on evaluating compensatory wayfinding cues, such as landmarks: studies evaluated installing residents' younger-aged portraits or names [112], images with familiar local content [95], or images along with personalized familiar objects placed close to the resident's room [113]. Researchers also emphasized the need for a good quality of these cues, such as using large-size and contrast, and proper illumination; as well as installing cues on an adjusted height and at relevant locations [81,95].

Recent studies also started debating how theory and evidence from neuropsychology and environmental psychology might inform principles and guidelines for dementia-

sensitive environments and landmarks [114]. For instance, landmark design should consider both the saliency (e.g., arising from unique colors and landmark placement at relevant locations), as well as their semantic differentiation (e.g., arising from verbally and visually differentiated landmarks). Additionally, dementia-sensitive levels of lighting, a meaningful personalization of space, and planning few decision points and small-scale units might minimize spatial disorientation [114].

- In sum, research about the perspective of people with dementia is beneficial to guide future environmental intervention approaches, e.g., by providing both the scientific knowledge as well as the evaluation methods for assessing dementia-sensitive environments.

With regard to environmental interventions, the authors identify the following challenges:

1. One challenge in the aforementioned context is that, based on the subjective individual perspective, needs, and abilities, researchers, planners, and caregivers often need to generalize insights to develop design principles or environmental interventions that accommodate the needs of a largest possible number of people. Yet, averaging individual backgrounds, e.g., cultural aspects, if applied without deeper reflection, may cause a design that is functional, but misses its full potential. In the view of the authors, this is where research could measure wayfinding challenges in field settings, and optimize spatial legibility and lived experience based on the perspective of people with DAT.

2. Another challenge is that, while numerous discussions of how environmental factors can support people with dementia exist, few focus specifically on evaluating spatial orientation and wayfinding from the perspective of people with DAT. In our view, it is worthwhile to identify, in a more nuanced way, how to integrate the perspective of people with dementia in design and planning processes. For instance, from the perspective of a person with dementia, space is not only related to physical and social environments, but in itself may become an existential experience, where a sense of continuity, self-identity, sense of place-attachment, familiarity, and autonomy remain relevant existential concepts that need to be preserved [79].

3.4. Environmental Evaluation Tools and Strategies

First, regarding environmental evaluation tools, we refer to the Environmental Audit Tool [98] as one example of such tools, to discuss potential challenges that are also inherent in other tools. Environmental evaluation tools often have a preventive character, focusing on actions to reduce negative factors:

A walkthrough and survey method, the Environmental Audit Tool addresses design factors such as: competence-oriented design and human scale; dementia-sensitive stimulation; unobtrusively placed safety features; familiarity with the space; spaces for both retreat/privacy as well as social inclusion; appropriate stimulation of meaningful activities; visual accessibility between locations; and opportunities for movement [34,98,115]. The concept of spatial orientation and wayfinding is evaluated by judging whether a certain design factor is present, or not. For instance, spatial orientation is evaluated by the presence or absence of tactile or acoustic stimuli that "offer a variety of experiences and support orientation," e.g., represented in floor materials, water, or soundscapes [98,115]. Spatial orientation, hence, is not regarded as an independent principle, but integrated within the larger principle of "positive stimulation." As spatial cognition and wayfinding play a minor role, it may remain unclear for practitioners (e.g., planners and caregivers) how they can best reduce wayfinding challenges.

Second, regarding strategies to reach dementia sensitivity, we refer to the recent World Alzheimer Report 2020 [34] and the German National Dementia Strategy 2020 [35], as two selected examples:

The international World Alzheimer Report 2020 [34], emphasizes out-of-home participation. This is important, as recent studies indeed indicate that people with dementia engage less than others in public places [116]. The report mentions so-called "easily seen

wayfinding cues" as essential design elements. In the report, suggestions for practitioners are driven by research (e.g., concepts for adapting signage, colors, lighting, or furniture to the needs of people living with dementia). Yet, spatial orientation and wayfinding are, again, placed within other design principles, such as supporting movement, optimizing stimulation, or ensuring visual and physical accessibility. Wayfinding is not recognized as independent principle.

Similarly, in the German National Dementia Strategy (2020) [35], spatial orientation also is not defined as independent principle, and solutions for a supportive environment in terms of wayfinding remain vague. For instance, the development of color principles is seen as possible method to support spatial orientation. Yet, color codes have in some studies been ineffective [69], despite being conceptually discussed as relevant [43]. While colors can become relevant when establishing contrast and marking edges [81], or can be used creating zones between areas, researchers are often hesitant to provide "golden rules": the use of colors is context and target-group dependent, and other design variables, such as geometries, visual and physical accessibility, are harder to change once a place is constructed. For planners, colors are also subordinate to other design factors, such as geometry [117]. The strategy also identifies an urgent need for district development, to foster mobility and social inclusion of people with dementia. For instance, it advises that people working in public transport systems need to be further trained. This could be extended towards developing, additionally, a spatially legible built environment.

- In sum, the key source for informing evaluation tools and strategies for dementia-sensitive environments is the perspective of people living with dementia. In particular, the use of contradicting information in dementia-sensitive strategies may indicate a need for identifying ways to continuously integrate research results into planning, and to translate research knowledge into support tools and interventions for planners. Such efforts could also distinguish results that are reliable, yet still falsifiable, from innovative pilot-studies that need follow-up studies. Thus, while, undoubtedly, such existing efforts are both timely and needed, they might benefit from further refinements based on research theory and experimental insights (also cf. [34,35,118]).

With regard to environmental evaluation tools and strategies for dementia-sensitive environments, the authors identify the following challenges:

1. A first challenge is that it currently remains unclear *how* the perspective of people with dementia could be further translated into early design and planning stages. We propose refining participatory methods and co-research, as Section 4 further describes.
2. Additionally, it is unclear whether existing principles would work similarly both for indoor (care institutions) and outdoor environments (districts, public buildings). Broad design principles are useful as they raise awareness and sensitivity. Yet, if research results are applied without further reflection on the changing stages and needs in dementia and across generations, these principles might not reach their full potential.
3. Additionally, in terms of advancing dementia-sensitive design and planning guidelines, one research avenue is to measure wayfinding challenges in a more nuanced way, and potentially over an extended period of time, to identify more responsive, dynamic solutions that respond to individual backgrounds and changing stages of the disease and aging.

3.5. Design and Planning Processes of Built Space

Design and planning processes of built space, by nature, require anticipating how the future users of a planned environment interact with the space. In the context of wayfinding, this means anticipating how different groups of users of the space, such as people with DAT, process and use spatial and non-spatial information to orient themselves and to decide where to go. During the design and planning process, planners iteratively immerse themselves into different spatial perspectives within a floor plan, using sketching, simulations, or physical- and virtual models [119].

While planners are trained by their education and experience to anticipate behaviors in terms of a perspective shift (i.e., anticipating what a user can see in a specific spatial configuration), they might yet face challenges with perspective taking (i.e., anticipating the informational situation of a user of the space, and how they would process, experience, and behave in the environment) [54,55]. Perspective shifting in this context is the anticipation of what the users of an environment can perceive from their viewpoint [54], e.g., that a room is open or closed based on its spatial configuration being wide or narrow. Perspective taking is a more holistic, metaphorical concept than perspective shifting: it means imagining how another person experiences the world from their perspective, and developing a positive concern for the person [56]. Both are needed to take the perspective of a future user of the space, and to develop optimized design outcomes.

Yet, it may be challenging for planners to take the perspective of a person who perceives and processes environmental information differently [53,107]; e.g., with limited attentional, emotional, or physical resources. Indeed, some professionals do report a lack of knowledge and methods to better integrate the perspective of people living with dementia into their design and planning processes [120]. Here, reflecting conceptually about another person's point of view and their difficulties based on impaired brain functions might require additional information. Furthermore, planners and designers are often focused on visual senses, whereas wayfinding design outcomes can potentially involve more than one sense, as long as it is not overwhelming people [81].

Additionally, there are other barriers for integrating the perspective of people living with dementia into planning and design processes: while planners have a high interest in developing dementia-sensitive concepts for built space, the interactions between built design and behavioral outcomes cannot be entirely objectified [117]. Planners long for knowledge about how several environmental design factors are linked to specific behavioral or experiential outcomes. Research, to ensure experimental control, may yet focus on isolated details, such as colors or furniture. Yet, these are not the main focus in planning processes [117] that need to consider design factors more holistically.

Multiple requirements (e.g., resources and budgets; regulations and norms; capacity planning, etc.) and stakeholders (e.g., owners; developers; planners; facility managers; specialized consultants; structural engineers; technicians, etc.) influence the decision-making processes during planning. This results in competing interests. For instance, when re-designing a district, the perspective of people with dementia may be subordinate to other planning requirements or stakeholder interests, such as: federal and state laws; guidelines and statutes at various political and legal levels; mobility- and transport structures; climatic, ecological, and technical considerations; administrative, governmental, or budget-related concerns; topographical and historical aims; and the municipality's land use and zoning plans that provide a framework for the city's further development.

Moreover, the driving forces behind the design of public buildings (e.g., public libraries or shopping malls), private buildings (e.g., care facilities), and urban environments (e.g., districts) rely on different design considerations, processes, and interests. For instance, when planning a dementia care facility, the perspective and needs of people with dementia are usually the driving force for the design. For public buildings, however, planners may strive for a futuristic design and unconventional floor plan layout—even if there is a risk that building users may find this disorienting [42,53]. Furthermore, many retail environments contain a sheer abundance of visually distinct shapes, materials, illumination, commercial displays, soundscapes (and so on): here, developers might even aim at triggering disorientation in time and space. Additionally, the redesign of a district needs to serve various functions and diverse user types at once, and often depends on manifold regulations. Efforts to renew an urban environment may improve a district on several aspects—but the changes can also bring along a loss of familiarity (e.g., removing or changing landmarks; or disrupting place-attachment; both of which may be particularly challenging for older persons and people with dementia).

As such, planning built space is a highly complex process, where anticipating the behavior and experiences of diverse groups of users of the space can easily fall by the wayside [55,121–123]. Close cooperation and coordination between the involved stakeholders [12], as well as a sustained collaboration with researchers who can provide scientific knowledge, could support, e.g.: managing the competing interests and expectations; exchanging and communicating information between disciplines; and deriving decisions, compromises, or trade-off solutions that benefit the users.

- In sum, the complexity of the design and planning process may be a reason why perspective taking of a person with limited resources is challenging. While the needs of people with vulnerabilities might be represented in specific guidelines/norms, various design requirements and stakeholder interactions can influence the final planning decisions and design outcomes.

With regard to perspective taking in planning dementia-sensitive environments, the authors identify the following challenges:

1. One challenge is that the design and planning process is highly complex, with multiple requirements and stakeholders influencing decision-making. These requirements can draw attention away from designing from the perspective of a person with dementia. We envision iterative interventions for planners that inform early stages of planning that emphasize the perspective of people with dementia. In addition, wayfinding processes in people with dementia rely on highly complex interactions between the person, context, and the environment. It is worthwhile to examine how these complexities can be generalized and translated into interventions for planners, without oversimplifying the perspective of people with dementia.
2. A second challenge is that it can be hard for environmental planners to anticipate the perspective of a person with limited attentional, motivational, or physical resources. Additionally, research studies combining cognitive and behavioral measures in naturalistic tasks in the field are rare, and often contain low sample sizes. We envision that research using naturalistic tasks and in field settings can refine this perspective; while also translating this perspective into an appropriate format that can supplement existing design and planning processes. Furthermore, inclusive or participatory methods could be regarded as general requirement in future studies.
3. A third challenge depends on whether all involved stakeholders in a planning and design process are equally interested in supporting people with dementia; specifically, if built space needs to serve diverse groups of users and various competing interests (such as in the retail context). Raising awareness on the importance of dementia-sensitive built space is one step. Yet, it may be needed to mandate principles for dementia sensitivity as a general requirement for urban planning, with the goal of establishing demographically sustainable future cities.

4. Opportunities for Future Dementia Care Research

4.1. Interdisciplinary Research Vision

The way people with dementia perceive and reason about space, and how they use spatial or non-spatial information for wayfinding and orientation, could be integrated as directly as possible into design processes, by providing scientific evidence to planners. Yet, approximating the perspective of people with dementia can deviate from the lived experience and subjective perspective of an affected person (first-hand experience). For instance, relying only on caregivers' and relatives' perspectives (informed external experience) means "reconstructing" and, hence, approximating the perspective of people with dementia (cf. [124–130]). In future research, using dementia-sensitive methods, the involvement of people with dementia can provide first-hand perspectives that might be translated into further design considerations.

Based on the identified challenges in the prior sections, this last section combines the concepts of wayfinding (research) and architectural cognition (planning), to outline opportunities for interdisciplinary research. Specifically, research about the perspective of

people with dementia regarding wayfinding is combined with, additionally, examining how integrating this perspective into planning processes could best be supported, and how both of these efforts could also impact care processes. We suggest aligning two processes focused at perspective taking:

1. *Research:* understanding the complexities and perspective of people with dementia during wayfinding, and advancing inclusive, interdisciplinary research methods, in order to indicate which residual abilities exist, and to identify how the person might be supported via the built environment (wayfinding processes and spatial cognition).
2. *Planning:* integrating and translating research knowledge about the experiences and perspective of people with DAT into planning processes, to ultimately reach optimized dementia-sensitive outcomes that also impact care processes (planning processes and architectural/urban cognition).

We acknowledge that these efforts are all complex (i.e., examining wayfinding processes in people with DAT, examining architectural cognition processes as well as methods for fostering perspective taking, and finally translating research insights into care processes). Nevertheless, Figure 2 represents a simplified visualization of our research vision. The form (not the content) of this visualization is loosely inspired by Cohn's theme-centered interaction [131]: instead of any stakeholder (represented by the corners in the triangle) dominating the collaborative process, potential group dynamics are being moderated, while also being aware of certain constraints that are potentially disrupting reaching the shared aim.
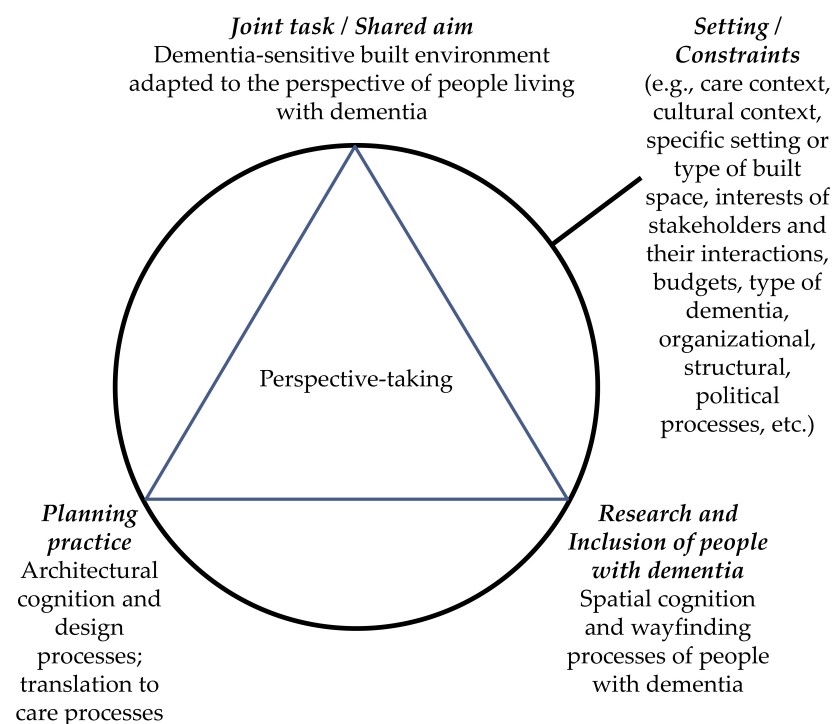

Figure 2. Simplified visualization of the interdisciplinary research vision: linking the perspective of people with dementia during wayfinding (i.e., research together with people with dementia) to architectural/urban cognition (i.e., research on planning and design practice), while working towards the shared aim (i.e., adapting efforts towards a dementia-sensitive built environment), but under the constraints of the setting (i.e., complexities that interrupt the dynamics between the stakeholders), and by fostering perspective taking (i.e., to link these challenging, joint efforts).

This translates to our research vision as follows: the two key drivers (here: research and planning) collaborate closely towards their shared aim (i.e., a dementia-sensitive environment), while being aware that manifold complex constraints can disrupt reaching

their shared aim, and while the dynamics between research and planning are moderated (here: via perspective taking: measuring and integrating the perspective of people with dementia).

4.2. Methods for Perspective Taking in Research

4.2.1. Inclusion of People with Dementia

As discussed, we aim at encouraging researchers to include people with dementia. Participatory methods often rely on qualitative approaches, such as focus groups and interviews, or collaborative engagement of people with dementia in committees or as co-authors (cf. [124]). Also, co-research is specifically useful when classical research methods, such as behavioral experiments, are too demanding for participants. Co-research involves regarding both the researcher and the person with dementia (who traditionally is in the role of a participant) as equal collaborators, while ensuring the quality of research [81,132].

For instance, using the photovoice method [102], people with dementia, in the role of co-researchers, are encouraged to take photos and to verbally reflect on topics they identify from their perspective, e.g., challenges in their community. People with dementia regard this method as meaningful, as it might challenge stereotypical views of dementia in society [133]. Photo elicitation, where the researchers provide photos that reflect certain issues, can also prompt responses, and facilitate reflecting on abstract or difficult topics.

Recent participatory approaches also started combining several methods, such as photo narratives, associative card and image sorting, and inclusive workshops for people with mild cognitive impairment [134]. Recent studies implemented promising co-creation methods [132]. Yet, given the pathology, people with dementia may be fatigued faster; less able to focus on complex questions; forget information; become emotionally burdened by questions centering around the disease; or become distracted during the study. Therefore, such approaches require careful informed consent [101], and facilitation [133].

4.2.2. Translating Laboratory Results back to Real-World Settings

In laboratory research, virtual reality simulations offer high experimental control and the possibility of comparing relationships between different environmental characteristics and behavioral outcomes [135–139]. While traditional studies meant lying motionless in a scanner and having limited interaction with the simulated environment [140], recent discussions involve more realistic paradigms and naturalistic tasks for virtual reality simulations [135,141]. For instance, virtual reality studies, combined with functional magnetic resonance imaging, are informative for examining neural determinants of disorientation [62]. Specifically, the combination of eyetracking and virtual reality can support examining differences in visual attention for different spatial or landmark features [71]. Future research can further refine the development of realistic paradigms.

For field research, future studies could define naturalistic, real-world wayfinding tasks and rely on mixed methods. The reason is that a wayfinding task in a field setting may be less abstract. Hence, wayfinding might be more natural for people with dementia (cf. [67,68]), and their residual abilities may come to light. Such studies might be tedious to prepare. Yet, rather than planners informing the design of built space, or caregivers approximating the perspective of people with dementia, future research could refine how to more closely integrate people with dementia. For instance, a recent study involving older adults unfamiliar with a retirement development showed promising directions for the combination of spatial cognition theories and the inclusion of potential future users of the space: older people identified wayfinding strategies, disorienting features, and suggested redesigns [37]. Combining both quantitative and qualitative data can, in a more nuanced way, capture human–environment interactions. Yet, in the context of dementia, such efforts still need further development of appropriate methods and inclusive formats.

4.2.3. Mixed Methods: Linking Spatial and Physiological Data

Researchers could also examine how physiological measures are linked to specific characteristics of an environment that people with dementia report as relevant. For instance, accelerometric and GPS data in combination with biofeedback (cf. [142–144]) support understanding correlations between built space and behavioral outcomes (an aspect planners are often interested in). However, anything that is attached directly to the body, such as wristbands, mobile electroencephalography measures, or eyetracking glasses, can be a potential trigger for fiddling with the device. It can influence how comfortable a person with dementia feels, independent of whether the person can verbalize discomfort or not. This can also result in equipment damage or measurement difficulties. Field studies may, hence, need oversampling to acquire an appropriate sample size for quantitative analyses. Additionally, in some countries, eyetracking or video recording in public places may not be allowed due to data protection laws. The aforementioned aspects might explain why few studies yet use physiological measures during naturalistic wayfinding tasks in public places.

Yet, examining visual attention could support detangling the importance and saliency of specific environmental characteristics from other factors (e.g., specific architectural features, landmarks, or signage that are relevant from the perspective of a person with dementia). Capturing visual attention and behavior over an extended period of time, hence, might: (1) be beneficial to understanding the progression of the disease and help identifying potential distractors for navigational performance (cf. [71]); and (2) indicate which wayfinding cues are salient from the perspective of people with dementia (rather than aspects researchers or planners define as relevant). Future research can identify appropriate measures to study wayfinding in the field, using naturalistic tasks.

- In sum, future research could refine dementia-sensitive, inclusive research methods, so that affected people can voice their preferences for support structures in the built environment. Using mixed-method approaches, qualitative measures, such as photovoice, co-creation, or other participatory methods, can be combined with quantitative measures, such as systematic behavioral observations, and using naturalistic tasks in the field. Translating laboratory results back to real-world settings, but also identifying realistic paradigms and naturalistic tasks for laboratory research (e.g., using virtual reality), remain important avenues for future studies.

4.3. Methods for Perspective Taking in Design and Planning Practice

4.3.1. Analyzing Architectural Cognition and Design Processes

Examining architectural/urban cognition in the context of dementia involves understanding the decision-making processes during the design and planning stages (e.g., what happens in the iterative stages between a competition brief and the construction of built space). So far, we have argued that planners and developers of built space need to be well-informed about perspective of people with dementia, especially in regard to the complexities in wayfinding and spatial orientation processes (cf. Section 2).

Future interdisciplinary research could, hence, examine how planners reason about and plan for people with dementia, and whether this is aligned (or not) with what people with dementia express. Analyzing how planners think about people with dementia provides a base for how and when perspective taking methods could best be integrated. Examining how planners engage in perspective shift and perspective taking in the context of planning dementia-sensitive environments can help identifying where planners themselves see a potential for further support structures. This might provide a better understanding of which support tools and methods planners already use. Process evaluations can help identify which aspects planners themselves might perceive as challenging when reasoning about people with dementia.

4.3.2. Supplementing the Perspective of People with Dementia into Planning and Design

Future research could also examine where research-based information about the perspective of a person living with dementia could best be integrated, in which format, in which design task, stage, or process, and for which stakeholder. It may be that different situations, design stages, types of tasks, types of personalities, stakeholder processes, interactions between researchers and planners (and so on) need specific formats to further support perspective taking in planning. This includes exploring different perspective-taking tools or methods planners use in their planning practice. Yet, as any tool or intervention could only act as advice, it is important to, over an extended time, work towards a paradigm shift in perspective taking, where the planner switches from design and stakeholder requirements and restrictions, to emphasizing with the person they plan the space for. However, as this is a highly complex and ambitious long-term process, this vision paper marks only a few aspects of the full range of complex planning interactions.

Recent approaches encourage perspective shift during architectural education, e.g., by simulating cataract while students experience space [81], or by using virtual reality to immerse architecture students into different spatial scenes that potential users of space might perceive [145]. Future research could examine how to include perspective-taking methods as standard practice in educational curricula and the professionals' design studio. Research could also target making research outcomes more visible to planners using creative formats [107]. Studies could specifically examine, together with people living with dementia and environmental planners, how large-scale districts and future care homes can be adapted, so that people with dementia living can venture out, feeling confident that they are supported by a dementia-sensitive built environment, for as long as possible. Yet, to facilitate the planners' acceptance of such collaborations in the long term, the support format also depends on the needs of the planners.

4.3.3. Translating Research Insights back to Care Processes

Finally, it would seem rather intuitive that a supportive built environment also can positively impact care processes. For instance, smaller nursing homes may be linked to less rushed care and staff exhaustion, simply because staff spends less time on walking distances between locations [46]. Furthermore, negative experiences for people with dementia may be linked to challenging behaviors and, hence, may make caregivers' work more challenging [46]. As such, nursing home staff may regard wayfinding challenges and stimulation overload as factors of an unsupportive built environment.

For instance, it can be frustrating for staff to recurrently resolve conflicts between residents who walk into each other's rooms, or to continuously provide wayfinding instructions [46]. Caregivers are aware of the link between spatial layout and behavior [46], but may not always know which research or guidelines to rely on, or how to make a change. Future research, hence, might target ways of encouraging caregivers to be aware of spatial orientation and wayfinding challenges; i.e.: by refining wayfinding-related assessment questions in existing environmental evaluation tools for practitioners; by identifying person-centered wayfinding support strategies; or by examining caregivers' attitudes, values, and mindsets regarding the perspective of people with dementia.

- In sum, future research could more closely collaborate with planners, to understand architectural cognition, to identify opportunities for integrating the perspective of people with dementia into planning and design practice, as well as develop interventions that target raising awareness on the importance of wayfinding, to translate research evidence and knowledge to care processes.

4.4. Limitations

A first limitation is the deliberate choice of relying on a targeted literature review and the authors' combined interdisciplinary research expertise, instead of providing new research data or a systematic literature review. The article deliberately is a vision paper:

hence, our aim was an in-depth discussion to identify the complexities and current research challenges, and to outline avenues for future dementia care research.

A second limitation is that, naturally, dementia-sensitive built space also requires a dementia-sensitive social environment (e.g., community and caregiver training and support, supporting dyads to encourage independent wayfinding of the person with dementia for as long as possible, etc.). For instance, a discussion on caring strategies and the role of healthcare staff in different healthcare disciplines is an important consideration; yet, the focus of this vision paper was on built space. Furthermore, technology may play a role in discussions about the person–environment fit and in the light of fostering demographic sustainability [12,146]. For instance, a person's technological abilities are considered a prerequisite for access to and participation in public places, such as to public transport and services [147]. Indeed, future cities might contain adaptive, responsive information systems embedded in the built environment (e.g., talking signs or dementia-sensitive, individually-adapted mobile wayfinding assistance). Recent approaches already involve technology-enhanced environmental interventions to both facilitate wayfinding and create a meaningful sensory experience for people with dementia [148]. For this article, discussing the complexities of the above considerations (i.e., social environment, caring strategies, or technology) would have considerably exceeded the focus, scope, and length of the current article.

A third limitation is the article's deliberate focus on discussing wayfinding in the context of the built environment. This choice does not mean that other environmental design aspects, such as ensuring safety and security, physical and visual accessibility, familiarity, privacy and social sharing, atmosphere and ambience (to name but a few), are less important. Any environmental design, ultimately, will address several requirements and constraints all at once, and for as many people as possible. Thus, while this article strongly advocates to "zoom in" on the perspective of people living with dementia, especially public built environments still have to afford the needs of diverse other people. Finally, a dementia-sensitive, inclusive built environment that adds to a sense of coherence, well-being, and behavioral support is likely also beneficial for not only Dementia of the Alzheimer's type, but also other forms of dementia, and other people. This article advocates a refined development and integration of wayfinding from the perspective of people with dementia in existing guidelines, strategies, and environmental evaluation tools—both in research and planning practice.

5. Conclusions

In the light of internationally ageing societies and increasing urban density [1,7], preparing and optimizing the built environment to support older people and people with dementia is a necessary step towards demographically sustainable future cities and care institutions [10,12]. Motivated by recent calls for adapting the built environment [6,34–36], we used a targeted literature review to describe wayfinding in people with dementia, and highlighted the complexities inherent to the topic of dementia-sensitive built space. Identifying challenges that could be tackled in future research, we strongly advocated for a more nuanced understanding of the perspective of people living with dementia, both in research and planning practice, and especially with regard to spatial orientation and wayfinding, which so far are not established as independent principles in evaluation tools.

In our view, a dementia-sensitive built environment needs to foster sustained autonomy, health, and social inclusion of people with dementia for as long as possible. Yet, what "supportive" means depends on the perspective of the affected persons and their changing needs. Hence, this is what future research could do: (1) to further develop inclusive methods, focusing on perspective taking; (2) to examine how environmental planners reason about people with dementia and offer support when and if needed; (3) to keep critically reflecting on environmental design principles, interventions, evaluation tools, strategies, and planning processes—especially with regard to wayfinding; and (4)

to engage in translational research that can impact future dementia-sensitive spaces and care processes.

To do so requires perspective taking, which, when taken to practice, becomes a highly complex and delicate effort. As such, the research vision we highlighted means deeper layers and complex interdependencies that we could only briefly touch on in this article. Yet, in the light of rapidly aging societies and urbanization worldwide, and with human longevity being linked to the likelihood of developing chronic diseases, such as a dementia syndrome [1,2,5,34], it is essential to consider demographic sustainability, i.e., supporting multi-generational structures and diversity, while fostering the social inclusion and autonomy of aging people and people with various abilities.

Upon closing, the key message of this vision paper is that we encourage the research community and practitioners to rethink dementia-sensitive efforts, as to prepare and optimize built space for demographic sustainability, by more closely integrating the perspective of people with dementia.

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