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Designing care environments for persons with Alzheimer's Dementia: visuoperceptual considerations'

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"A dwelling is much more than shelter. Ideally, it should provide safety, refuge, and accessibility, as well as a sense of belonging, purpose, and well-being."
(W. Satariano, Blueprint for Aging, 1995)

Content

This article starts by providing background information about the projected need for specialist dementia care environments in the UK. It summarizes the effects of poorly designed environments and acknowledges that despite a range of residential models to date, no single one has been shown or agreed to be the best. It considers current efforts in the UK which could potentially positively influence future care environments.

Thereafter, it provides an overview of insights coming from several fields:

1) the experience of architects, planners and designers of residential and nursing homes,
2) those involved with identifying the knowledge base for, and developing the professionalization of dementia care, and
3) progress in the understanding of the visuoperceptual difficulties associated with normal aging
4) progress in understanding specific visual difficulties associated with Alzheimer's disease (AD). These are not well understood yet in other dementias.

This latter point is expanded upon to emphasize the implications and potential benefits of understanding AD as a 'visuo-cognitive disorder'.

Visuoperceptual difficulties (mistakes) translate into certain types of 'visual phenomena' in AD; illusions, misperceptions, agnosias, misidentification, (and hallucinations- though more rarely than previously thought). Visuoperceptual difficulties combine with other cognitive difficulties (orientation, time perception and reality-testing) to affect a person's 'perceived proximate social environment'. Subsequent attempts to find 'a rational explanation for' what is unknowingly being misperceived, can significantly influence behaviour in dementia.

A summary is given of a variety of design guidelines and specific design interventions have been generated in response to general knowledge that older persons have 'poor vision'.

Combining the above insights however, increases the specificity of our understanding of the difficulties experienced in a way which challenges us to re-think and even re-define behaviour changes in dementia. It offers scope for increased innovation in the design of dementia care environments to help anticipate, overcome and compensate for known visuoperceptual difficulties. It also increases our understanding of individual 'adaptive behaviour' to such difficulties.

Utilizing an integrated approach to design, based one this new understanding of how persons with dementia experience their environment, would enable us to improve/enhance the 'perceived environment' for particular visual ranges ('micro /1m'; 'meso/ 1-10m'; 'macro/10+m'; and 'outdoors').

Understanding what is in a person's visual field at these distances can help optimize the physical environment, and also to guide care-giving practice in such environments (understanding the limitations of some seating configurations, optimizing posture to enhance visual field, use of vision aids, how staff approach and place themselves in a given resident's visual field, and ensuring that meaningful and symbolic objects are highly visible in all visual ranges of environmental settings).

Such an integrated approach has conceptual and educational implications. What is the best way to move from thinking of the physical care environment as a place to 'contain a range of [so-called] challenging behaviours'- to- a place to help assist, reduce, and possibly even prevent some of the difficulties people with AD have in interpreting their physical environment, so that it is perceived and experienced in a non-frightening way, like our ideal of the metaphor of 'home'.

As quotes below illustrate, designing special care environments for people with dementia requires the application of several sources of knowledge. It is possible to design the environment to help compensate for visuoperceptual difficulties….will the needs of people with dementia be seen on a par with those of sportsmen though?

"…those of us responsible for choosing colors probably choose them based on what we see rather than on what elderly residents see. Our perception of the environment does not [usually] include the possibility that older people see it differently than we do." (Christopher Graeff, Architect, Prof. of Architecture, 1995)

Compare the statement above with the following:

The Optometrists Association Australia recommends that cricketers who suffer from colour blindness ask their club to use side-screens behind the bowler to change [improve] the contrast so they can see the ball better against the playing field and surrounds, particularly when running on the grass for seeing the ball against trees and bushes. (Optometry Today, Nov 30, 2007 p24)

Projected increases in dementia will require more care environments

The 2007, Dementia UK report[1] provides estimates that about 424,000 people with late-onset dementia (diagnosed after the age of 65) live in private households in the community and about 244,000 live in care homes. Furthermore, the proportion of those living in care homes rises steadily with age, such that about 61% of those with dementia 'aged 90 and over' reside in care homes. Sixty-two percent are estimated to have AD the most common type of dementing illness.

This report estimates that the increase in people with dementia will rise sharply with a 38% increase in the next 15 years, and a 154% increase in the next 45 years. This may be an under-estimate since other findings suggest that only a third of the people with dementia in the UK receive a formal diagnosis, and that many reside in care home settings for 'frail elderly people'; this frequently results in their dementia symptoms remaining, un-named and un-investigated [2].

This need for additional dementia care environments and new potential to improve design for dementia care environments, runs in parallel with efforts to reduce the current cost of residential dementia care.

Torrington [3] states that it is possible to design care environments to more nuanced understandings of abilities, difficulties and needs of people with dementia. He maintains that tailoring environments does not necessarily translate into more costly buildings, but rather requires very clear design efforts and specific, accurate use of materials and resources, and also new use of technologies. This is said in amidst the efforts of many to make dementia care environments more home-like and personal. Poor design is also costly.

Effects of poorly designed care environments

Poorly designed physical environments have been found to affect residents, family and staff in the areas of quality of life, safety and staff stress. Joseph[4] reviewed 250 peer reviewed journal articles from different fields related to dementia care. The following types of design characteristics of residential care settings were found to contribute to disorientation: 1) monotony of architectural composition and lack of reference points, 2) long corridors with many doors, 3) lack of windows or lack of access to windows, 4) ad hoc signage.

Sloane et al [5] found that the factors which led to higher levels of agitation among residents in special dementia care units, corresponded to environmental features including: large size of care home, low scores on a rating of 'home-likeness', poor cleanliness of corridors, inadequate maintenance of public areas and bathrooms, the absence of non-glare/ non-slip floors, odors of urine in public areas and bathrooms, and the absence of a kitchen for activities and family use.

The new field of design for dementia care environments

Each society has assumptions about what 'good dementia care' entails; social attitudes and cultural, economic and legislative histories vary, as do ensuing models, ideals and realities [6], [7],[8]. An increasing exchange of design ideas is occurring internationally.

Although the body of literature about designing optimal dementia care environments is growing rapidly in the UK, as in other countries, it is still a young field. Conspicuously absent from the literature are references to 'post-occupancy evaluations' of completed and occupied care homes (initiated by planners and architects in discussion with care staff, residents and family visitors) about how and why certain aspects may not be 'working as expected'.

Researchers are investigating the elements of design that contribute therapeutically for residents in dementia care settings. These include such factors as: the physical layout; access to outdoor spaces; supportive features and finishes to enhance socialization, mobility and overall well-being; and ways to reduce disorientation, barriers, falls, infections and noise [4, 9]. They are also exploring ways to improve upon design standards and guidelines for new and renovated care settings.

The process of planning and designing new dementia care environments

In an ideal world 'form follows function'. New, purpose-built designs, (and also to some degree modifications made to existing care settings), arise from a process of identifying and balancing a variety of needs, resources, assumptions, objectives, 'use-of-space requirements', minimum standards[10], and models of care-service provision. These considerations have been well- described by Cantley and Wilson[11] and others.

No single best type of care environment has been identified

The more familiar models include larger traditional hospital-like institution models, rehabilitation-style models, 'hotel appearance and service models', 'resort models', 'life-style' living[12], small scale 'home-like' living [13], [14], [15], small scale living pods in a larger building, combination care centres (sometimes called one-stop shops, meeting all levels of care needs on one site[16]), and other variations on smaller scale living [17], [18], [19], [20], [21],[22].

Larger scale 'more institutional-looking' settings for dementia care have largely fallen out of ideological favour in the UK; memories of former psychogeriatric ward settings linger. Information about Dutch, large and small-scale care settings was presented recently in the UK[16], including small-scale living groups within multi-storey buildings, complete with phased levels of domotic monitoring technology for different levels of dementia and safety risk assessment.

One detailed example was given, of a large, 30 year old 'combination care centre' in Amsterdam, designed to be like a village and located in a residential area near shops. It was explained in terms of the specialist design features of the building,

psychosocial activities, bespoke case management[23], and how the on-site multi-disciplinary teams were constituted (specialist Nursing Home Medicine physicians, nurses, care-givers, and paramedical staff; psychologists, physiotherapists, social workers, occupational therapists, speech and language therapists, social activity co-ordinators, pastoral care workers). The site includes offices and work-areas for each profession, a crèche for the children of staff, a large pond and gardens, a farm-animal petting zoo, small recreation/activity areas, a large auditorium with stage- for daytime activities and evening entertainment, a billiard area, restaurant/bar, small store, internet café, library, and a large Day Care area which has an office-like area and a workshop with real tools.

Evaluation feedback after this presentation showed that virtually all attendees were reconsidering their views on the merits of large scale settings for dementia care, if supported by trained staff, and an adequately organized and resourced care system. Whilst the merits of co-ordinated care services and having all multi-disciplinary team members on-site were clear- an attempt to determine any accurate comparative benefits of 'economies of scale' that such large settings could potentially provide (compared to the cost of equivalent service provision in small scale settings), was not possible. This was due to differences in: state funding for care; costs of land and salaries, and, the range of services routinely provided.

Obviously, the types, quality, amount, availability, and accessibility of, specialized assessment procedures and care staff (and how they are organized), are significant factors in making any care setting work.

Is there new hope?

A number of factors and ongoing efforts stand to contribute positively to dementia care, and dementia care environments in the near future.

New 'assistive (domotic) technologies' for 'smart houses' and care homes are likely to play a larger role in the physical safety and monitoring aspects of future residential environments[24,25,26,27,28,29]. This technology already includes sensors- to detect falls, approach to and use of doors, water and heat, toilets, entry into and exit from beds. It is being extended in scope and detail to facilitate remote health monitoring and video-monitoring. Also, electronic tagging[30,31,32] of people with dementia has just been endorsed by the UK Alzheimer's society, though not without criticism[33].

Other current endeavours that have the potential to affect UK dementia care standards, models and environments include:

1) demands for a 'new ethics for good dementia care', based on acknowledging that affirming the dignity of persons with dementia can differ from doing so for frail elderly, [34,35,36],
2) care-giving models for dementia care are increasingly emphasizing the need to meet sensory, emotional and pastoral/spiritual care needs,[37.38,39,40,41] beyond physical and social ones; meeting these needs requires the creation of suitable spaces,
3) continued endeavours to standardize assessment[42], and measure and improve 'quality of life' measures in dementia care [43],

4) increased recognition for the need to develop good palliative care services for end-stage dementia care, linked to existing care settings [44],[45],[46],
5) government directives to Mental Health Services in the UK (the umbrella structure for the diagnosis of dementia and some aspects of care provision) to make 'respecting a person's dignity' a new priority in care services [47],
6) the Nuffield Council for Bioethics (workgroup on dementias) is considering a range of issues related to ethical issues in dementia care including how decision are made for people and the care they receive[48], and,
7) current government initiatives to prioritise and improve dementia awareness and care by producing the first ever 'National Dementia Strategy'[49].

What sources of information influence the design of dementia care environments?

The literature on dementia care home design contains a range of advice: from choosing locations, example blueprints of buildings, care and management models to activity considerations and décor [50],[51],[52],[53],[54],[55],[56]. Such advice is interspersed with reminders about 'reality' including the cost of land in urban areas, scarcity of large sites which increasingly necessitates multi-storey buildings, being proximate to populations for recruiting staff, the necessity dementia education for staff, and the implications of long-term 'block-booking occupancy contracts' for minimal fees.

Adaptations to help compensate for sensory and mobility changes in normal aging are being more widely publicized; consequently they are being increasingly considered by care facility commissioners, architects, planners and designers[57],[58],[59],[60],[61],[62].

Design guidance is also being derived from conceptualizations about specific difficulties arising in particular dementing illnesses. In recent decades researchers have begun to focus on understanding the 'experience of having dementia': the nature of emotional needs, changing awareness, and progressive difficulties[57,63,64].
As a result they are increasingly seeking to address the physical parameters of the buildings, and spaces, which may help with orientation and the user-friendliness of buildings.

The opinions of people with dementia are increasingly being sought about their ideals for living environments [65],[66],[67]. Responses are in keeping with what normal adults would wish for their own home settings. Some critics see this as misplaced tokenism, arguing that a person with dementia- who has not experienced the illness before- and likely has limited knowledge of others with the illness professionally, is not likely to be able to provide much useful guidance about design issues. (E.g. Assumptions about their ability to maintain independence and exercise choice and privacy are likely to be rose-coloured. If asked what colour they would like the bedroom painted, a person might choose 'blue', remembering that this has always been their favourite colour- but unaware that as they age, and with having AD, the blue/purple/green part of the colour perception will be affected most, and those colours will be perceived to be more like dull grey.)

Publications also exist on a range of other specific topics including: acknowledging culture[68] designing to minimize so called 'disruptive behaviour'[69], [70], 'agitated behaviour'[71], designing sensory gardens for dementia[72], flooring considerations to minimize falls and their impact [73], [74], [75], and the therapeutic use of outdoor spaces[76]. Tools are being developed for measuring the characteristics of physical and social dementia care environments [77], [78], as are guidelines for adapting ward environments [79] and day care settings. With so many separate endeavours to promote aspects of good design, have any guiding principles been generated?

Ongoing efforts to redefine and improve design principles for dementia care environments

Figure 1 shows three sets of 'design guidelines', and a set of 'quality of life parameters' that good design has been shown to affect.

The original design principles set out by Calkins in 1988, were from the first book written for architects designing purpose-built care settings for people with AD [80]. Marshall[81] and Flemming et al[79] have made their own conceptual changes to them, both including a preference for 'small-sized living units'. Joseph's list [4] provides quality of life indicators, not design principles. It is the only listing to mention hygiene considerations specifically. These headings, were generated from reviewing literature about design issues for a range of care settings for people with dementia, not just residential care homes. They are a useful way of categorizing research findings to show the link with the purpose and variety of particular design elements and innovations.

Not surprisingly, literal, visible features of 'home-likeness' are the current hallmark of what many want for dementia care environments, but how do they need to be designed to look like home, given that persons with dementia can also become 'visually lost' even in their own homes? (Also, since so many residents, especially male ones, seek to 'leave' to 'go to work', should some work-like environments not also be planned for?) What is known about visual changes in AD that could explain such extreme visuoperceptual 'lostness'?

Figure 1
Design principles and quality of life parameters for dementia care environments

Calkins (1988) design principles	**Flemming et al (2003) design principles**
1 compensate for disability, 2 maximise independence, 3 enhance self-esteem, confidence, 4 demonstrate care for staff 5 facilitate orientation- be understandable 6 reinforce personal identity 7 welcoming for relatives, local community, 8 allow control of stimuli	1 be safe and secure 2 be small 3 be simple and have good visual access 4 have reduced levels of unwanted stimulation 5 have enhanced levels of helpful stimulation 6 provide for wandering 7 be familiar 8 provide opportunities for privacy and community 9 provide links to the community 10 be domestic
Marshall (1998) design principles	**Joseph (2006)** **designing the environment to improve quality of life parameters** aiming to:
1 small size 2 familiar, homelike, domestic in style 3 scope for normal activities (kitchen, washing lines, garden sheds) 4 unobtrusive features for safety concerns 5 different rooms for different functions 6 era-appropriate furniture and fittings 7 safe outside space 8 individual rooms enabling personal belongings 9 good signage and sensory cues 10 use of objects for orientation in preference to colour 11 enhancement of visual access to areas 12 the control of stimuli, particularly noise	1 improve sleep 2 support orientation and wayfinding 3 reduce aggression and disruptive behaviour 4 increase social interaction while providing privacy and control 5 provide links to the familiar 6 promote physical activity 7 promote resident safety 8 reduce factors contributing to falls 9 reduce infection 10 reduce wandering and unsafe exiting

Why is there an urgent need for even more specialist design strategies relating to vision changes in AD?

AD is increasingly understood and being defined as a 'visuo-cognitive illness'[82]. Rapidly growing new insights in neuroscience about normal perception (understanding how elements such as motion, depth, colour, contrast, objects and faces are constituted to form visual representations) are providing tools for understanding 'mistakes in perceptions' due to visual pathology in AD and other dementias. This is providing an understanding about the ways in which people, objects, and the environment can be 'misperceived', which in turn is contributing to design ideas about how to minimize such visual mistakes in specialist dementia care facilities. What evidence underpins this?

Neurobiological research has shown that in AD, the characteristic 'plaque and tangle' (and other) damage can eventually affect the whole visual system, particularly the visual cortices where visual images are 'assembled'. For most people, the order of visuoperceptual changes in AD appears to follow the progression of plaque and tangle damage described in the Braak neuropathological staging model[83],[84]. Visual changes in other dementing illnesses, particularly from stroke/vascular dementia- are more difficult to study due to the numerous possibilities in sizes, location, density, intermittency, and degree of recovery possible from stroke-type damage. Parkinson's disease (PD) and Lewy Body dementia(LBD) are also receiving more attention, but details about visual difficulties in these illnesses are not as well understood yet as for AD[85],[86],[87],[88].

This information is helping researchers to develop a more comprehensive 'dementia-specific/ stage-specific' understanding of how particular types and spread-patterns of brain damage affect particular abilities, and, which abilities are retained. In practical terms, such detailed knowledge means that structural and programmatic design will be able to focus increasingly on how to adapt the 'macro', 'meso' and 'micro'visual range environments, so as to positively engage and support people with varying types and degrees of disabilities, especially visuoperceptual ones.

Environmental design adaptations can influence dementia behaviour and care-giving practice since visual difficulties and resultant misperceptions can elicit fearful behaviour[89]. Increased understanding of the visuoperceptual difficulties in specific dementing illnesses is already affecting design and care concepts in several ways:

1) old attempts to manipulate behaviour using visual interventions are being replaced by ones that do not cause startle-effects or anxiety. E.g. In the past, such things as stop signs, mirrors, grids patterns, dark carpets with spiral patterns were recommended to be placed at exit points to stop residents from leaving. Such interventions were considered successful if they reduced the number of approaches to or contacts with the door, without determining what the emotional effects of such visual stimuli were on residents (panic, increased anxiety, disorientation, or, where else the 'searching and escape' behaviour was occurring). Recent efforts to conceal entrances by use of engaging artwork, interactive memorabilia displays, matching the surrounding wall colour, murals[90] and their placement at a strategic exiting location, and low-lighting as opposed to high-lighting, are newer alternatives which are not so potentially upsetting to residents since they are not noticed readily.

2) Vague terms about dementia behaviour (such as 'wandering', 'unsocial vocalizations' and 'agitation') are being replaced by more specific terms, so that they are not used in the cryptic way of referring to generalist 'symptoms of dementia'. These terms cover many specific types of behaviour, occurring for different reasons, at various stages of illness- which can be easily overlooked if they are used generically. (Such vagueness has knock-on effects for the design of dementia care environments, which some still describe too simplistically as: 'they wander, so a building should have a 'wandering circuit', preferably around an inner quadrangle space, well away from the lounge where the cognitively intact frail elderly sit'.)

Two distinct views of behaviour in AD

Jones et al [91], [92], and others[57,] hold that there are two distinct ways to conceive of the behaviour of persons with dementia: either as 'abnormal in a normal world' or, as 'relatively normal in an abnormally perceived world'. (This could also be expressed as the difference between referring to: 1) coping and compensation mechanisms to perceived and undesired changes- resultant from pathology and different from mechanisms used in earlier adult life, or, 2) as 'failing coping and compensation mechanisms' to poorly perceived and undesired changes.)

These two views of 'dementia behaviour', have differing implications for care-giving, and also for the design of care environments[93], [94], especially in the UK (where unlike other countries, dementia ultimately falls under the remit of 'adult mental health services', as opposed to geriatric or neurology services).

Consider the differences in the 'thought trains' potentially associated with these two views.

If a 'visual misperception' is thought to be a hallucination, it may linked to the following thought train: > psychosis? > mentally ill ?> unpredictable? > unreasonable? > crazy? > may be dangerous? > need to be on guard > may need to distance oneself to stay safe at times > may need to use medication.
The resultant communication strategy might be to tell the person that what they are seeing is not real and try to provide them with objective evidence to the contrary.
[Pharmacological implications: likely older style antipsychotics since Respiridone and Olanzapine have been recommended against in recent years. Old style antipsychotics have anti-cholinergic effects which can make symptoms of AD worse (AD being a cholinergic deficit illness). Persons with PD and LBD have been reported to be especially sensitive to them; some even make visual difficulties worse and induce hallucinations. Visual-aid interventions would be unlikely to be considered.]

If a 'visual event or mistake is thought to be an illusion/ misperception/agnosia (misidentification), or naming difficulty, it is more likely to be linked to the following thought train: > a visual mistake > easy to identify with since we all make mistakes > a fragile person who needs careful observation and listening to > may need visual aids and help to enhance key cues in the environment, and help to interpret the person and manage in their environment.
The resultant communication and care strategies might be: listening to the person's accounts carefully to try to understand what is being 'perceived, deduced and felt'; frequent empathic monitoring and assistance to compensate for difficulties; and, ensuring the close proximity of others to reduce isolation, disorientation, anxiety and fear. Other interventions might include provision of extra lighting, shadow elimination, enhanced figure/background contrast for important items, and routine assessment of the extent of a person's visual field.
[Pharmacological implications**:** those which boost cholinergic functioning [95],[96],[97].]

The vast majority of people requiring specialist dementia care in care homes have a combination or mixture of two sets of visuo-perceptual difficulties- those

accompanying normal aging, and those occurring in dementing illnesses, particularly AD.

Key findings about normal age related visual changes, and those occurring in AD are summarized next. They show the challenges involved in designing environments and providing care- both to create the look and feel the atmosphere of home.

Vision and normal age-related visual changes: how do older people see their world?

Accurate visual perception is dependent on the condition the entire visual system- including image assembly areas of the brain as well as the other sensory systems and memory storage sites connecting these areas. It is dependent on overall health, attentional ability, the significance of a given visual experience, alertness, mood, state of consciousness and, on the motivation and expectations of 'what should be seen'. Perceiving is the product of 'seeing-in-good-focus' and of synchronizing every aspect of cognitive abilities.

Understanding normal age-related visual changes is an essential baseline to be familiar with before considering the additional visual changes that can occur in AD. (In early onset AD, visual difficulties associated with AD occur in the absence of characteristic aging changes). Figure 2 summarizes the implications of age-related visual changes as they relate to daily life (see Jones et al 2006 for details[91,92]). Lighting, figure/background contrast, colour perception, night vision, glare and peripheral vision are the main elements considered.

Fig. 2 -Visual changes associated with normal aging:

adapted from Jones et al (2006) see original for background references

Feature changed	Common responses/ adaptations	Reason
Colour Vision . bright warm colours seen best (red, orange yellow), . blue/purple vision reduced . dark and pastel colours are difficult to distinguish between,	. difficulty matching colours, - . frequent preference for brighter colours, . heavier application of make-up, . setting TVs to brightest hues . easy to confuse coloured pills.	. lens discolours . effect: like wearing sunglasses indoors - blue/purple light filtered out making these colours appear grey-dull
Reduced Acuity - nearby images become blurred . viewing small things close up without corrective lenses may result in eye strain.	. near vision blurs . difficulty seeing position of dials on appliances and small print . reading glasses required, then bi-focals for distance vision, then possibly vari-focals, . ↑ size (or print size), light, and the figure/background contrast of objects	. cornea thickens making light scatter inside the eye- reducing focusing power of the lens . lens hardens with age; . close focusing and later distance focusing become difficult
Blurring from floaters (clumps of cellular debris) . irritation from unclear vision	. wondering if one is 'seeing things" or has a serious eye problem	. vitreous humour gel thins . 'floaters' do not settle and stay at bottom of the eye as well
Momentary intrusions . intrusions may be like light flashes or distortions of images	. wondering if one is 'seeing things" or has a serious eye problem'	. posterior vitreous detachment . 'vitreous' thins and begins to pull slowly away from the retina
Ambient Light levels . to ambulate, do tasks and read . ncreased light required	. use of stronger wattage light bulbs . install light above kitchen sink so better see if dishes are clean - un care homes, the seats most occupied are the ones near the best lighting conditions and near doorways.	. only 30% of the light reaches the retina at age 60 , compared to age 20 due to pupil diameter reduction and lens transparency changes
↑ **Effect of glare** from strong light sources, reflections, backlighting . difficulties from things like light reflecting in mirror, morning sun shining face-on in window . may be uncomfortable to be in strong outdoor light	. avoid driving when sun is low in the sky when sun comes out after rain . avoid sitting in areas which are visually uncomfortable . increased use of sunglasses and sunhats to aid being outside in bright light	. pigmented surface layer behind the retina becomes irregular, less able to absorb excess light and control light scatter in the eye. . retinal thinning at peripheral edges changes cellular orientation and angle of light hitting the photo-receptors
Night vision or response time adaptation to large light level changes: from darkness into light, and vice versa Darkness looks darker.	- strong light from point source can temporarily blind; limit driving at night - install/use lights in dark cupboards drawers and even handbags. . difficulty moving from dark to light rooms or vice versa (increased adaptation time)	. pupil size decreases with age; . less light reaches retina . lens changes increase light scatter, reducing contrast (light/dark) of an image
Peripheral vision and high, low parts of visual field . reduced by up to 35 degrees on each side by age 80 to 85	. startle reflex if approached quickly from behind or the side difficulty: . engaging with those seated adjacent . when driving-not seeing cars approaching . seeing some traffic signs/ lights . detecting when elevator doors start closing . noticing signposting, cues, seeing paintings hung too high, contents on upper or lower shelves . learn to move head further sideways	. foveal vision decreased. . sensitivity of visual field decreased twice as rapidly at 30 degrees eccentric, than at centre field
Contrast sensitivity (ability to detect boundaries between objects) - decreased ability to detect back-grounds, boundaries, edges, of objects against patterned surfaces	. choose strong colour contrasts e.g. vary colour of plate and placemat . more resolvable figure-background combinations e.g. marking edges of steps . make larger sized, high contrast labels for spices, medicines, important text, e.g. black text on white paper, strong hue against a pale, contrasting one)	. combination of above factors
↓ eye (saccadic) movement for tracking still and moving objects	. slowing affects reading and other tasks . use of larger, clearer print and ↑ light . need to observe attentively, aware of possibility of missing seeing things	. ↓ visual reaction time (short-term memory changes in normal aging may also affect ability to organize incoming visual stimuli
Depth perception decreased	. more care in placing feet, reaching for objects accurately	. combination of the above factors

Routine vision testing for older persons?

In a survey of dementia care home managers and staff in 25 settings, it was found that they rarely had up-to-date information about residents' vision, had not been taught specific details about normal age-related visual changes, nor how to do simple tests to assess for visual ability or the extent of a person's visual field [98].

Hyvarinen [99],[100], points out omissions even in 'routine' sight testing of the elderly and those with cognitive deficits. Acuity testing is the starting point of all assessment- further assessment should be done (or adapted) for the distance which is clearest. Contrast sensitivity testing needs to establish how 'low' contrast details can be seen for the test distance. She maintains that agnosias are far more common than diagnosed, including facial recognition, expressions, sizes and direction of movement. The tester needs to determine whether- when testing 'perception of expression' deficits- a loss of contrast sensitivity is contributing. Vision testing by a knowledgeable tester is essential since the elderly do not report visual disturbances readily: "Vascular accidents in the retina or visual pathways cause patchy, sectorial or half field defects in the visual field. These may not be diagnosed for months or years if visual functions are not decreased so much that it would disturb the daily activities".

Visuoperceptual changes in AD: how do persons with AD see their world?

Sources for our current understanding of visuoperceptual difficulties in dementia include: neuropathological staging models of AD (and, increasingly other dementing illnesses such as PD[101]); neuropsychological visual experiments; brain scan studies; and observational studies of the types of repeated mistakes and behaviour changes of persons with dementia[102]. Piecing together such information is leading to a better understanding of a number of difficulties that can be experienced in AD.

Visual damage in AD has been reported at a number of locations along the visual pathway including the retina, optic nerve, lateral geniculate nucleus, primary and secondary visual cortices [103], [104], [105]. Most of this damage appears to result from the presence of plaques and tangles [106],[107],[108], cell damage and death have been reported but are as yet unexplained [109]. The 'tectal pathway' area, now known to be important for less understood 'blind sight phenomena', automatic visual functioning and eye movement control [110],[111],[112], is also affected in AD. It has recently been shown to be the location for unconscious processing of orientation and colour[113], providing more evidence for why people with AD can experience losses in these particular abilities. This damage translates into visual changes; those reported include colour perception, spatial orientation, motion perception, object and facial recognition [114] [115][116] [117] [118] [119] [120].

Researchers are currently working on visual tests to assess AD in early stages[121, 122]. These tests are different from ones optometrists routinely use, and include tests to measure impaired contrast sensitivity, visual attention, face recognition, and simulated driving. Information about the existing/current visual dis/abilities of older people, and those with dementia in care homes, is almost ubiquitously inadequate.

Figure 3 summarizes the key changes to visual perception in AD, and their implications for daily life (see [91,92] for additional information).

Figure 3 Visuoperceptual difficulties reported in AD
(for reference details see Jones et al 2006, and 2006a)

Deficits in primary (lower order) ocular function	**Intermediate ocular function**	**Complex visual functions in AD:**
. visual acuity not usually impaired yet in early stage AD . contrast sensitivity . colour vision affected in blue/violet range . global reductions in visual field (especially in inferior field) . depth perception decreased (especially if acuity is poor) . motion perception reduced . reduced critical flicker fusion (ability to see light flashes as separated)	. ↓ perceptual organization . ↓ ability to group objects . ↓ texture discrimination . ↓ figure/background separation . ↓ identification of fragmented pictures . ↓ ability to integrate visual elements into global images . inability to process multiple elements to interpret an image . difficulty identifying, describing and segregating individual objects **Eye Movement problems** . ↓ saccadic (eye movement) latency velocity . ↓ initiation and accuracy . ↓ target fixation	. visuo-spatial trouble . impaired eye movements affect reading (as distinct from comprehension) . object and face recognition difficulties

Piecemeal listing (like above) cannot convey the overall effects of visual deficits.
Information about **what lesions to specific levels of the visual system do**- provides other clues.

. retinal lesions can result in all damage to all aspects of information processed
. optic nerve damage can result in loss of visual function if symmetrical
. optic chiasma damage results in loss of the visual field on the opposite side
. lateral geniculate (LG) lesions may cause 'form recognition' to be poor but the analysis of 'long lines' to be unaltered
. optic radiation of LG: small lesions correspond to patchy loss of visual field

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Observation of the **systematic errors** of persons with AD provides further clues.
Since people with AD have **noun-finding difficulties** they can make mistakes in describing what they are seeing, further increasing misunderstandings about their perceived world.

Familiar examples include difficulties interpreting:
. reflections and glare (including their own reflections in mirrors)
. figures from backgrounds- especially in poor light (thus perceiving that TV images are in the room)
. shiny surfaces appearing wet; patterned surfaces causing illusions; dark surfaces and shadows appearing to be holes;
. loss of depth of field when surfaces are dark or unclear

. inability to observe or follow quickly moving people and objects.

Overall effects:
. difficulty identifying who and what is in their environment; and is remaining present
. difficulty being able to check one's environment to navigate, problem solve, locate others, feel safe
. decreased ability to focus and hold haze on more than one object at a time leads to decreased participation with others and the environment
. need for frequent guidance and reassurance- both from persons and cues that are conspicuous/ present

These changes can result in certain types of 'visual phenomena' (illusions, misperceptions, agnosias and misnaming errors. Figure 4 summarises visual phenomena that can happen to all people, however, in persons with AD, they can be problematic because of reduced ability to 'test reality' and their permanence, due to existing or increasing damage to the visual system. Furthermore, visual mistakes seem to occur in a particular order/stage of AD, in keeping with the pattern of spread of 'plaques and tangle formation' described by the Braak staging model[83,84]. Figure 5 shows the overlap of these visual phenomena with the stages of AD. Figure 6 shows some examples of specific mistakes made by residents with a 'probable' diagnosis of AD.

Figure 4 Visual phenomena that can occur with AD and dementia

Illusions:
are not a degraded image, but a 'distortion of reality' through the physical properties and characteristics of the image (reflections, shiny or bright surfaces, figure/ background contrast, etc.), or the difficulties inherent in the visual interpretive system that synthesizes visual signals to resolve the image accurately.
e.g. a resident mistook the reflection of a doorstop (which appeared doubled and curved in a stainless steel cylindrical bin) for a 'mouse in the bin'

Misperceptions:
are 'best guess' at inaccurate, degraded or, distorted visual information due to 'state of consciousness, systemic, visual system damage, or visual and/or cognitive interpretive difficulties. They are influenced by motivation, previous experience and expectation.
e.g. a dark water stain on the carpet was mistaken for a rat; walking down a long, dark corridor made a lady think she was at a train station

Misperceptions of illusions:
What is already incorrectly seen, may be further distorted by visual system compromise or damage.
e.g. a gentleman approaching an elevator with three mirrors in it, mistook his own reflection (multiplied thrice) for a crowd of aloof men who would not move to allow him to fit in

Misnaming errors:
Inability to retrieve nouns correctly can complicate our comprehension of what a person with dementia is describing they are seeing currently. (This problem can be worsened when a person is describing things in past tense, and, is not able to remember accurately sometimes emphasizing the most salient, emotionally-linked details.) e.g. a lady pointed to four green cushions on the couch as sunlight was landing on the frilled edges and saying "look at the cabbages there"

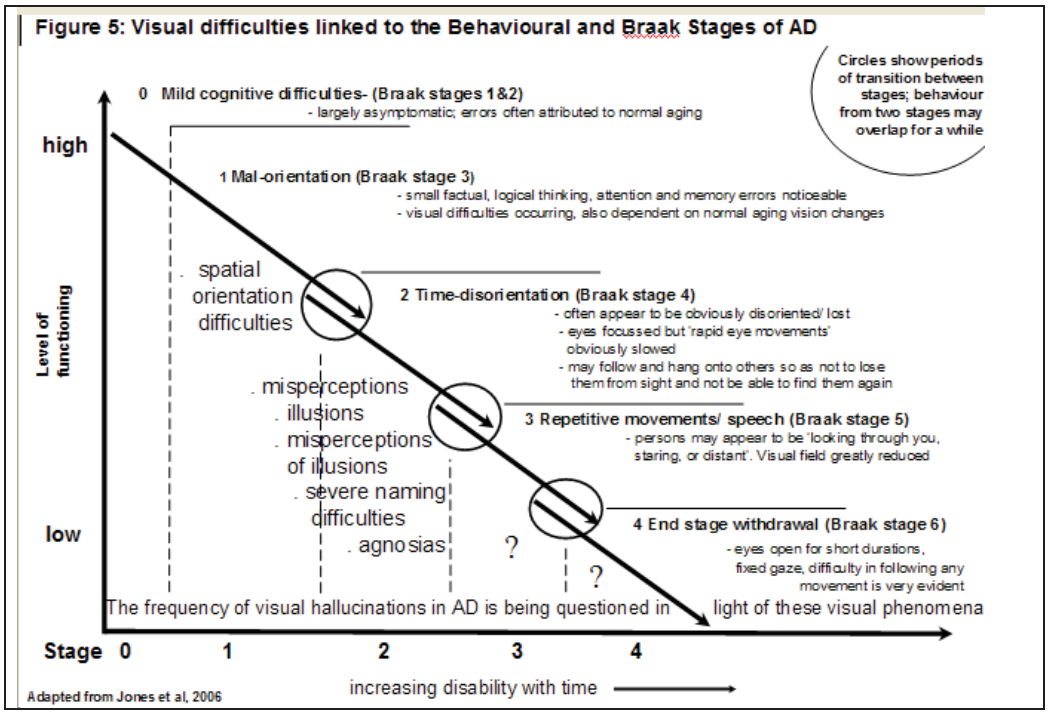
Agnosias: inability to identify leading to misidentification errors
These are severe deficits in recognizing objects, faces, and sometimes persons, even spouses and children. Agnosia results from not perceiving or being able to construct details accurately enough to know/recognize the correct identity of what is being seen or interacted with.
e.g. a gentleman was observed trying to use the black remote control for the TV to shave himself with

Hallucinations:
Non-problematic visual constructions:
An internally generated, or retrieved visual image can be experienced with eyes closed or open (super-imposed in part or full on the outside world), but the person is aware that it is not retinally seen and present in the outside world. The images can be stopped at will.

True Hallucinations
Internally, (currently produced, and/or stored visual image) experienced with eyes open, experienced as occupying the full visual field, or superimposed in part on the outside world; but one is NOT aware that is not present in the outside world. The image can/cannot be stopped at will. There are many different types of hallucinations, which are increasingly being linked to particular types (palettes) of brain damage. Assessment for visual hallucinations requires information about content of what was seen, the duration, recurrences, current sight ability and medication
e.g. a resident with an occipital stroke (the area of her visual cortex) said she saw firemen skating on an ice-rink in her bedroom.

The above-listed changes are sometimes mistakenly dismissed as 'delusions', 'hallucinations' and 'psychotic symptoms'. (Additional complications can arise from medications that can cause visual side effects, and from the misuse of antipsychotics for 'non psychotic' problems). Jones et al (2006) found 'possible true visual hallucinations' in persons with AD to be much rarer than previous reports in the literature; only 3%, compared to the mean of the range reported- about 40%.

(Figure 5 graph visual phenomena in AD- by stage, about here)



(Figure 6 photos about here)

Figure 6 Examples of visual difficulties in AD

Residents with dementia sitting in this lounge area were seen by staff pointing to and commenting on the nice 'fish pond'; they did not walk across the patterned carpet but around the edges of it.

A gentleman, former bricklayer, was distressed for days, asking when the 'hole in the wall' would be repaired. His daughter discovered he mistook the dark TV for a hole from where he was sitting .

A gentleman with AD, thinks he is in his own home. He mistook the quickly ascending, white uniform of staff for a ghost before becoming distressed
.

Mirrors and reflective surfaces can cause visual illusions (mistakes) such as thinking that someone is approaching , the lift is full, or it is a corridor,

Visuoperceptual mistakes, thinking errors in AD

"What we perceive of our world is much more a composition of our brain than an exact image [reconstruction] of the surrounding physical structure."[99,100]

Whatever a person perceives (also unknowingly incorrectly), necessitates an attempt to understand it- explain at a rational level. Figure 7 shows how visual perceptions are linked to thoughts, and the sense in which visual perception and cognition are inseparable[123]. The importance of 'expectation' (anticipation) to visual perception is increasingly being understood[124], and confirming that it is possible 'to see what we expect to see', more than 'seeing what is really there'.

(Figure 7 about here)

Figure 7 Visual perceptions are linked to faulty thinking and behavioural responses in AD

Past experiences and motivation create visual expectations.

When something is poorly/ incorrectly seen:
. it needs to be enhances (from visual/contextual memory) and assimilated
. interpreted or guessed at (an attempt to understand causation with whatever logical thinking ability one has) and linked one's for former experiences and current fears
. acted upon
. remembered (as accurately as possible)
. explained to others (with waning language ability)

Cognitive frailties in AD create extra places in the above chain for difficulties to occur.

Visuoperceptual difficulties in AD affect self-awareness and social-awareness for example:

. if you can't see the gravy stains on your clothes, you are not self-conscious about them, or aware that others may be judging or reacting to your grooming or your attire

. if you can't see people's faces clearly, don't remember that you have become old, and don't know how old you are, you will likely guess and mistake their exact identity

. if you can't see people clearly, and don't know if they are objects or persons, you might be thought to be stupid or rudely ignoring them

. if you do see something tangible in your immediate visual field, however incomplete your information, you will likely comment on it enthusiastically and spontaneously and try to engage with it

Seeing persons with dementia as behaving 'relatively normally in an abnormally perceived world' enables the refinement of vague terms about behaviour (such as those already mentioned), and also the replacement of vocabulary which has come to be used to describe dementia behaviour although it originally applied to other illnesses.

For example, traditionally, a delusion is defined as: a false belief based on incorrect 'inference' about external reality that is held despite proof to the contrary. There are two difficulties in applying this definition to persons with AD: 1) it may be an 'incorrect perception'- not an incorrect inference, and, 2) that with damage to logical thinking ability, attempts at offering 'logical, factual proof' to correct a person's incorrect understanding may not be fully comprehended, let alone remembered.

Jones et al[91,92] see 'so-called delusions' in AD as 'mistaken explanations' (best-guess theories) for a poorly perceived world which may be becoming less predictable and frightening. 'Mistaken explanations' are an early response to poorly remembered thoughts about fragmented, distorted, or incorrectly combined pieces of information, and to early visuo-cognitive changes. These are inseparable from a person's attempt to understand and control what is happening, though with increasingly limited abilities.

Consequences: visuo-cognitive difficulties affect behaviour in AD

What we perceive as being present to us (whether correct or not) can influence our emotions and behavioural responses, as does our expectation of 'what should be present'. Memory and attention deficits affect expectation, but also difficulties with higher level cognitive functions such as 'logical thinking ability, 'problem-solving ability' and the 'ability to test reality'. Deficits in these abilities further contribute to mistaken perceptions, ideas and memories about what is happening in the environment of the person with dementia. Jones et al[92], give over forty examples of such mistakes and show how they change over the course of AD. The examples range from a gentleman, aware that he was not seeing things well, starting to carry two flashlights around with him to illuminate whatever he was looking at to see it better; through to a lady mistaking a slice of ham for a pink kitchen cloth, and, another lady, a farmer's daughter- mistaking a white feathered hat for a chicken and plucking the feathers from it to stuff them in a bag.

Consequences of not understanding visuoperceptual changed in AD: mislabeling visual phenomena in AD as hallucinations

The findings of Jones et al[92,] indicate that the visuoperceptual difficulties in AD are poorly understood, as are differences between hallucinations and other visual phenomena in dementing illnesses. Hence, they are often not differentiated between or diagnosed correctly. They reported on two studies looking retrospectively at GP letters of referral to an Old Age Psychiatry Service for people who were identified as having visual hallucinations. When these cases were studied and re-categorized as separate visual phenomena (under illusions, misperceptions, agnosias, misnaming and possible visual hallucinations), there was found to be more than 50% over-reporting of hallucinations for the AD and PD /LBD groups, (though not for the groups with 'toxic/infections' and 'rare dementing illnesses/brain tumours').

The implications of this are that persons experiencing such visual phenomena (other than hallucinations), 1) may miss out on opthalmological treatment and low-vision aids, 2) be inappropriately treated with antipsychotic medication [125], 3) may miss out on: a detailed exploration of their incorrectly perceived, ever-changing world; accurate empathy; frequent reassurance and helpful communication; and appropriately adapted interpersonal interventions, and 4) are unlikely to have features of the physical environment adapted and enhanced to further assist them.

The consequences of potentially mislabelling any visual event as hallucinatory (hence potentially psychotic) and subsequent administration of anticholinergic antipsychotic medication- which further reduces already impaired cholinergic functioning in AD and PD- range from unhelpful to seriously harmful.

Design for visuoperceptual difficulties in normal aging and AD

Considering the difficulties that normal elderly can have (and visual pathologies will not even be mentioned in this review), it is likely that most elderly people in care settings could also benefit from design that takes visuoperceptual difficulties into account. People with AD are increasingly cared for in the community as long as possible- admission into specialist dementia care settings often occurs in Behavioural Stages 2 or 3 [126], [127], when significant, permanent, visual and time perception difficulties exist.

However, there are some important differences between these two groups of people, which requires greater rigour in optimizing visual aspects of design for dementia care environments. A vision aid advisor explained it thus: "People without dementia who have poor sight can remember the advice given, how to use particular vision and mobility aids, and, importantly, they remember what parts of their environment have caused them difficulties previously. Working with people with dementia was a whole new challenge for me, because anything that is a visual obstacle or puzzle can often remain so each time it is encountered, unless the solution is novel, very bright or even funny…such solutions seem to be remembered best."

The literature about the design of dementia care environments contains a range of practical suggestions that can be helpful both for the visual difficulties associated with aging eyes and with AD. These are summarized in Figure 8.

Figure 8 Vision Enhancement tips from the literature

Lighting: the single most important aid to vision
It is estimated that older people need about 30% more light for equivalent vision to younger adults; this can rise to 500% more light required for reading, doing crafts and tasks.
. even ambient indoor illumination between adjacent living areas to reduce glare and shadows (desk, table and floor lamps cause pooling of light and shadows)
. light levels of 30 to 70 foot-candles are recommended ; (1 foot candle = 10 lux) (UK requirement for bedrooms in care homes is 140 lux)
. extra focussed light on orientation cues, signposting, artwork
. use of night lights in toilets, help most when toilet door can be seen from bed
. dark areas are avoided by residents and can invoke fear behaviour when persons and objects in dark areas are not readily interpretable)

Use of colour
. use brightest colours for most important visual information
e.g. location of toilets, handrails, signs on bedroom door
- to use bright colours effectively requires reducing competing visual information (glare, busy patterns [geometrical, flecked, vibrating], and reflections)
. warm colours (yellow, red, orange) are seen best
. cold colours (blue/purple/green) are not seen well
. dark colours are best avoided (especially on flooring) because they can cause depth illusions
. pastels (low saturation) colours not seen well or distinguishable from each other

Use of colour contrast to enhance legibility and figure/background distinction

e.g .choose dark toilet seats and hand bars in an otherwise light coloured washroom
. high contrast floor baseboards or strips help define floor edge and give depth cues
. on signs (white or yellow on a very dark colour)
. can aid perception of food on plates
. location of drinking cups and beakers
. activities and games done on table and floor surfaces
. light switches in bedrooms high contrast colour to the switch cover and wall

Orientation cueing,
. many elderly have difficult reading; realistic, familiar symbols and objects are good substitutes
. signs/artwork located within visual field (lower than normal, lower edge just above handrail height)
. best when potential visual over-stimulation from surroundings is minimized (unpatterned surfaces)
. providing 'clear lines of sight' to destinations (open doors to lounge areas, uncluttered corridors)
. sign posting, use of colour, distinctive objects used to provide information about the purpose of each living area
. signs mounted perpendicular to the wall are noticed more than

Camouflaging
e.g. paint doors of 'no go areas' the same colour as adjacent walls (exit doorways, staff toilets, utility
. areas, storage cupboards) to minimize residents noticing them. [large murals also been tried]
e.g. have 'light switch covers' in corridors the same colour as the background to have residents switch them (on or off) our of habit, as they walk past

Artwork, sculpture, memorabilia (what we see effects us emotionally)
. artwork that depicts positive emotional affect, happy familiarity, surprise, novelty or is linked to the 'theme' of a part of a building
. interpretable (avoid abstract and art without clear definition)
. non-glare finish
. realistic, high contrast (black and white, or good colour range with bright colours)

Mirrors

. avoid their use if possible for persons beyond stage 2; if they are needed to reflect light into an area, locate them high to avoid residents having direct eye contact with them

Priorities: lighting, signposting, colour and other interventions to assist vision

Incorporating some design suggestions can be challenging if the shape of the property is limiting (such as reducing lengths and increasing widths of corridors, making lounge and communal areas focal points from corridor areas, and providing accessible safe, outdoor gardens areas). Others however, such as the provision of good lighting and visual cues that are highly visible, familiar, and salient[128] could be considered essentials, not luxuries dependent on property shape parameters.

Improving overall ambient lighting is pointed to as the single most important intervention variable[129, 130, 131, 132, 133]. Aside from enhancing acuity, depth perception, perception of figure-background contrast, there are other benefits to improving lighting. Stabilization of daily rhythms and sleep patterns have also been reported. A Swedish study which examined the effects of improving lighting in older persons' homes even reported improvements in appetite, physical condition, self-confidence, general health, and decreased loneliness, temper and degree of anxiety[134]. Other studies have found similar positive results [135]. The review by Joseph[131] on the health benefits of improving lighting confirms these findings. Good lighting is also a factor cited for reducing falls[136].

Aside from helping to locate toilet doors, specific use of bright, saturated colours (warm) has been found to be helpful for signalling the location of specific objects. Perhaps the most dramatic effect of the use of colour cueing with people with AD, is the one reported by Dunne et al[137]. They found that replacing white dishes and cups with red ones, led to an 84% increase in liquid intake and a 25% increase in food consumption without any other intervention. (This is in keeping with the previously mentioned findings that bright, saturated, warm colours are seen best by persons with AD. Glass cups take on the colour of the background surface, and are more difficult to see.)

The next stage of environment design: for macro, meso and micro range environments to optimize sensory and social engagement, emotional security, and contented behaviour

There are some design innovations used in care homes, reported by staff members to 'work', but the rationale for their use has not yet been linked to information about specific visuoperceptual deficits.

They include such interventions as: half-circle markings on stairs (as opposed to lines, which readily create strong depth illusions); barn-doors (split horizontally mid-way with hinges) on residents' bedrooms- the top half only can be open allowing some privacy and as well as brief social interactions (greetings, smiles, waves); open

shelving and floor lighting adjacent to the bedroom entrance (so that memorabilia can be displayed, parcels dropped off, and any so the floor surface, or any changes in it, are maximally illuminated).

More detailed levels of design for dementia care environments will be able to take into account factors such as: visuo-cognitive errors influence emotions and behaviour, the order in which these difficulties occur and, staffing ratios for different levels of need, what stages the residents are in, and what types of stimulation, activities and care interventions are planned for each stage.

Such designs inherently 'utilize abilities' and 'support difficulties' by considering different ranges of vision and possible difficulties in each range- both in deciphering the physical environment and engaging with it. It involves asking detailed questions about the visible contents in each range, and about the 'process of caring'[138]. Figure 9 describes 'outdoor', 'macro', 'meso' and 'micro' visual ranges the relevant features and objects to be assessed in each range, and, for each stage of AD.
Of key importance is considering what visual information is essential and what is less essential. Dignity issues, safety issues and balancing visual over and under stimulation are all considerations.

Figure 9
Parameters of four ranges of vision in physical environments

Level	Visual Range	In different settings	Use of this space and requirements
Outdoors	**Macro, meso and micro range vision applies** - need to consider glare in bright sunshine, shadows, and potential illusion effects of reflective surfaces	What is perceived at this range by a resident when: . entering this space . moving around . locating seating, people, help, objects . exiting this space	. focal points of interest . cues to signpost way back to entrance . highly visible, level, non-slip, uniform colour and texture walking surface . height changes and path well marked path with bright colour for handrails . sunglasses, sunhat, or parasol if bright . seating to enjoy views . social, face-on seating
Macro **larger communal spaces** .requires distance focussing ability	**10+ m** - within a foyer, large lounge or communal room, the length of a corridor, - the extended physical environment of residence	What is perceived at this range by a resident when: . entering . moving around to locate help, seating, people, activities and objects . exiting typical rooms	same as above ---------- . with questions specified to the mobility levels of residents: - self ambulatory - those using walking aids - people in wheelchairs -people who are bed-bound

Meso **smaller social spaces** .requires mid-ground vision focussing ability	**1- 10m** - within an average to medium to large sized room - virtually all lived-in areas of a care home	What is perceived at this range by a resident when: . entering . moving around . exiting typical rooms - own bedroom - lounge - dining area - kitchen area - bathroom/toilet - views from windows	same as above ---------- . highly visible symbols of familiarity to connote the purpose of a particular room . bedroom doors/corridors wide enough to push beds through to lounges and by windows, for persons in later-stage AD care
Micro **personal space** .requires near vision focussing ability	**1 m** - within reach about 1 arms-length	What is perceived at this range by a resident when: - in bed - seated in lounge - seated at table - using toilet - using bath - from chair in lounge - seated at dining table - seated at an activity table - posture is poor and assistance is needed with eating	optimize: . staff/visitor opportunities to engage with persons who can see only at this range . face on, proximate seating for maximizing visibility during visits/ help to eat . engaging in enjoyable solitary activities / exploration of familiar objects at a table . ability to access help

Design for different levels of care intervention and diverse ranges of perception

If 'affirming a person's dignity' is to be an design objective over-arching all others- it will require and understanding of the specific ways dignity can be unaffirmed. For example, a care objective might be: 'preserving continence as long as possible by enabling residents to locate and use the toilets independently as long as possible'. There are several ways to facilitate this including: locating the toilets strategically; making toilet doors very conspicuous; ensuring that the toilet is of a suitable height and high contrast to the background walls (e.g. not a white toilet bowl and seat against a white tile background), and also that the support bars visible, long enough to extend into the person's peripheral visual field, and easy to use.

Other care objectives might be 'the preservation of mobility, encouragement to explore, and optimal engagement with and enjoyment of the environment'. These objective require the manipulation of information in the macro and meso levels of the physical environment. Strategies could include: 1) the location of highly visible handrails (high contrast to a simplified background), 2)installed at a good height (some homes have even installed two sets of handrails to accommodate the range of height differences in residents), 3) with maximal visual continuity to the next handhold when they are interrupted by doorways and spaces; 4)replacing carpeting

with non-slip flooring; 4)locating engaging small lounge areas for rests along long corridors; 5)and strategically locating highly memorable or novel landmarks that residents enjoy seeing or interacting with. Helping residents to move across a room safely includes minimizing all potential 'visual obstacles' which require 'mental effort to decipher' such as patterns, shadows, glare, interruptions and colour changes.

Example of Macro environment enhancement

Increasingly, the concept of 'larger scale interactive memorabilia' is being used to create the feeling of 'familiar places to visit' when residents move beyond the home-like living areas. During the construction of a recently opened dementia unit, a bright red Austin Mini car (made safe) - was located in a link corridor-lounge area between two outdoor quadrangle spaces. The bright couches nearby the Mini are for those who enjoy looking at it and observing those in it, but don't wish to sit in it. The boot of the Mini contains a large picnic hamper, which is sometimes filled for 'picnic lunches' for residents, to provide the feeling of an outing even when a literal one is not possible.

Adjacent this area is a built-in sandbox, complete with beachside murals, a large model lighthouse, brightly coloured sand toys, buckets and scoops. The idea was to encourage more young children to visit by designing an opportunity for an enjoyable activity. This provided residents with a chance to enjoy the children playing, as well as possibly stimulating memories of 'sand and sea'. There are numerous, internally lit, wall-to-floor 'memorabilia-themed' display cabinets built right into the wall, so that they are not perceived as obstacles- occluding the view/cues in the corridor beyond and, so that handrails are not discontinuous around them.

The two quadrangles [outdoors, but within the building footprint] have distinct features in them to make them highly distinguishable; one contains a rowboat and beach objects, the other has more traditional gardens and water feature. Large balconies overlooking the quadrangle spaces have been located on the first floor, so that everyone has daily access to fresh air directly from the living area of the dementia unit.

Examples of Meso range environment enhancement

The main focal point of the lounge area is a fireplace with a couch and single chairs surrounding it. The fireplace surround facade is painted in high contrast to the wall behind it. To maximize visual resolution, only a few symbolic ornaments have been placed on the large mantelpiece; a clock, a trophy, a decanter, two photo frames, and two brass candlesticks. The electric mock-fire has a bright orange glow, but the heat has been disconnected for safety reasons (residents mistaking it for a real coal fire and throwing tissues on it, and, lacking accurate heat perception- sitting so close to it that they would burn their shins). This area contains open shelving with various types of ornaments and memorabilia, as well as a collection of books with mostly pictures. A large, flat-screen TV has been mounted at a low height on another wall, and has been turned into a DVD aquarium. It is located near to the stereo system, so that music can be enjoyed whilst brightly coloured fish are easy to observe. The dining area has as a

focal point the dining tables alongside a wall of low windows facing a pleasant view. The focal point for the kitchen area is the sink unit and draining rack with brightly coloured tea towels hanging nearby.

Examples of Micro range environment enhancement

At the 'micro-range' level, the key consideration is to help residents identify whether anyone or anything meaningful is proximate. Being able to see 'something' familiar or stimulating within arms-reach can make the difference between feeling safe, or isolated, forgotten or abandoned. Naturally, this level of intervention is highly bespoke. For example, one resident seems happy and contented when a collection of small bright towels are on the table; she can spend an hour folding them contentedly whilst interspersing this with scrubbing and folding movements. Yet another lady happily occupies herself when she finds a bright yellow duster and two small, highly embossed brass plates, which staff keep on a tray for her and place on the kitchen table each afternoon. She often sings while she polishes (though without Brasso, as she sometimes complains). A gentleman, a former clerk, is equally contentedly engaged when he can locate a red file box, with alphabet cards and many file cards with pasted magazine photos on them. He cannot arrange things alphabetically anymore, but seems unaware of this as he goes through familiar movements, and his own ordering system, which may be as simple as separating male/ female images, animals/ humans, nature/ objects, or happy/sad images.

To aid 'micro range' perception, staff have switched to brighter uniforms so they can be seen better. Bright red cube-stools are used to help staff sit lower than residents, so make it is easier to remain in residents' visual fields without being on bended knee, or with poor back-bent posture. These cube-stools are also used by staff when conversing with residents who are short and/or have poor posture. As well, they enable staff to sit directly front of residents who need significant help to eat and drink (rather than beside them, out of range of peripheral vision). Some staff have started wearing bright lipstick, to help residents see facial expressions better and enhance lip-reading in this micro-range.

It is not yet clear what the long term implications of such design will be on 'dementia behaviour'. It is likely that some behaviour currently described as 'neuro-psychiatric symptoms of dementia' may diminish or disappear in such carefully constructed, managed and safely perceived environments.

Education about the purpose and use of specially designed care environments

Any specially adapted dementia care environment requires an explanation (i.e. dementia education) of the adaptations for staff members, family consumers, and local planning inspectors, fire safety enforcement officers [139],[140],,[141142]. Environments with adaptations for visuo-perceptual [and other sensory] deficits will 'look different' from conventional ones. For example, they will be more open plan, use objects and bright colour specifically for high-lighting important cues and information, have minimal or no patterns in flooring and textiles. If deliberately designed 'features' are

not explained and understood, they risk looking like 'poor cousin equivalents' to the existing hotel-look and service care models that are the norm in many residential care home settings.

Family members have admitted that in the absence of such knowledge, plush, well-matched décor is an attractive selling feature and major consideration for them. They cannot necessarily know what may be best for their family member. Many do not know the nature of the progressive difficulties experienced in dementia, or about possible interventions. (Linked concerns are that many people are never told their diagnosis, and, if they are already living in a residential setting and subsequently develop symptoms of dementia- are often never formally diagnosed[143]).

Even making apparently simple environmental interventions requires education as the following examples show.
"After careful planning, we decided to change the seating arrangements in the lounges- to group them for different options: some in pairs facing each other, some in small semi-circular grouping for social conversation, and others to make best use of the windows with good outdoor views. However, each night for a week after the changes, the cleaning staff put them back against the walls of the room as usual. We had forgotten to include them when explaining to everyone, the changes being planned, and the reason for them."

"After we removed the mirrors in the toilet and the patterned carpeting in the bedroom Mrs. S never complained again of having intruders or of insect infestations again. The family was opposed to any changes thinking it would worsen her disorientation, but that was resolved when we explained about her visual difficulties and mistakes." (Home Manager, Bournemouth)

Conclusions

The design of care facilities for people with dementia has gone through a considerable evolution, ranging from large care institutions to residential hotel-type settings and services, and small-scale homelike living groups. No single best care setting or design has yet been found, despite the great diversity of efforts.

It is crucial that architects, designers, and those evaluating existing care settings continue to work with those who are knowledgeable about the care implications of particular design features.

Specific knowledge about 'visuoperceptual difficulties' in AD, and understanding the implications of it being a visuo-cognitive illness provides new opportunities for designers of care environments to anticipate these whilst striving to create an environment that 'feels like home', although it might not look like home objectively.

There is great scope for refining existing design guidelines, which are still very general. Current ones make no distinction between specific visual requirements for different types and stages of dementia, or perceptual ranges. For example, one existing design principle 'use of objects for orientation in preference to colour', could

be conceptually extended to describe the best uses of specific classes of objects, and the best uses of colour/s.

Since existing design solutions already involve careful of a wide range of factors (lighting, use of colour, sign-posting, optimizing figure/background contrasts, the use of engaging objects and memorabilia for orientation and pleasure, and the strategic location of important rooms), more nuanced levels of design will need to determine which ones should be essential priorities. Balancing these factors already aims to enhance key features of the physical environment (increasing the likelihood that particular features will be perceived more quickly, accurately- or even symbolically), and minimize competing and less important others. Future levels of such enhancement and adaptation strategies can be planned for micro, meso, macro and outdoor ranges of visual perception, and, for differing levels/stages of care needs.

Some specific challenges for the future will include: 1) how best to disseminate information about visuoperceptual difficulties in AD and other dementias, for everyone involved in design and the delivery of care, 2) how to improve assessment of and interventions for, the variety of visual changes residents in dementia care environments can have, 3) how to avoid sacrificing existing and evolving specialist dementia design and care knowledge [in response to pressures to produce care facilities and employ staff quickly to meet increasing needs for dementia care homes in the most economical way possible], and 4) how to anticipate in what ways the next generation will conceive of ‘home’, ‘work’, and ‘leisure pursuits’ and adapt care home designs accordingly.

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