DESIGNING ENVIRONMENTS FOR PEOPLE WITH DEMENTIA

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A Systematic Literature Review

BY

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ABOUT THE AUTHORS

Alison Bowes is Professor in Sociology and Dean of the Faculty of Social Sciences in the University of Stirling, UK. Her research focuses on supporting older people to live the lives they want as they age, in a good environment and with care, if needed, provided in a person-centred, individually preferred way. She has a particular interest in supporting people living with dementia, including families and communities.

Alison Dawson has been a Research Fellow in the Faculty of Social Sciences, University of Stirling, UK, for more than a decade. As an Applied Sociologist, she draws on a unique blend of business-oriented academic qualifications and public and private sector regulatory work experience to identify, analyse and understand challenges to social policy and practice and offer workable solutions and recommendations for action. Her research has examined and evaluated a range of policies and practices aimed at supporting and/or improving the well-being of vulnerable older people in different contexts.

ACKNOWLEDGEMENTS

BACKGROUND

There is now widespread recognition that the environment in which people live can be designed to support them to live better with dementia, and that poor environmental design can also be detrimental to living well. The research literature in this field is now very extensive, having grown rapidly in recent years. This paper updates an earlier review conducted by Fleming, Crookes, and Sum (2009) first published as part of the Dementia Services Development Centre (DSDC) at the University of Stirling's Design Audit Tool in 2009. Its aim is to provide the foundations for further development of practical design work in relation to environments which can enable people to live better with dementia. We have previously noted (Bowes, Dawson, Greasley-Adams, & McCabe, 2016) that much available advice on design has mixed provenance: whilst some design measures that are widely promoted have a strong evidence base, others have little. Rigorous review of evidence is therefore well-merited, and the present systematic review aims to contribute this.

Recent reviews which have addressed this area have some limitations. Our search and selection process (see below) identified four of these, which explored various aspects of designing environments for people with dementia. The present review is the most comprehensive, as it includes all types of research design and provides quality assessments of them. It also uses more comprehensive search terms.

Marquardt, Bueter, and Motzek (2014) review literature looking at the impact of the design of the built environment for people with dementia. They note that the evidence base is quite disparate. They both review and assess qualitative or quantitative research literature that measured the impact of the physical environment on people with dementia living in long-term care facilities, and in which people with dementia participated. They did not include other care settings (unlike the present review). Their review provided a hierarchy of evidence, whereby the highest level was met by experimental and/or controlled designs, with more qualitative work classified at a lower level, again in contrast to the present review which does not privilege any particular research design. They focus on a range of impacts or outcomes, falling into the categories of behaviour, cognition, function, well-being, social abilities, orientation and care outcomes. They summarise their findings according to four main categories – basic design decisions, environmental attributes, ambience and environmental information. They excluded studies which did not include precise design information. Following initial review, they included 169 studies. The review was able to demonstrate a range of positive impacts of environments for people with dementia across all the outcomes, except for cognition. They do highlight some limitations and evidence gaps: in particular, they privilege certain types of research design (the more controlled). They identify the control of daylight (for which there has not been consistency of support across studies) as a research gap and point out that some areas, such as sensory environments, are under-researched. Our study has also noted this.

Giving priority to certain research designs has historically limited the insights that may be drawn from literature. A Cochrane review (Price, Hermans, & Grimley Evans, 2001) of subjective barriers to prevent wandering for people with

dementia found no randomised controlled trials ('RCTs') or controlled trials that examined this issue and concluded that other experimental studies that were identified were unsatisfactory for a number of reasons. We would suggest that in a rapidly developing field, a range of study designs and even quite small studies may provide instructive insights as long as the limitations of the studies are acknowledged. One example could be Zeisel's (2000) review of environmental design effects on Alzheimer's disease (AD) symptoms in long-term care residents which 'recounts an investigative journey' and 'describes and links the work of a small group of investigators and practitioners'. This was not therefore a systematically undertaken review, but its conclusion that environmental design can improve both quality-of-life and health outcomes has been supported by other studies included in this review.

A previous review by Marquardt et al. (2011) is helpful for highlighting the need for a comprehensive and holistic overview of design. This sought to provide an overview of the available literature on architectural wayfinding design for people with dementia in caring environments. The authors concluded that floor plans could support spatial orientation and wayfinding, and that other interventions such as signage, lighting and colour cueing cannot fully compensate for 'unhelpful architectural design'. Similarly, Woodbridge et al. (2016) argue that the design of the physical environment is a particularly complex issue, and therefore difficult to research using more structured research designs. This review does not include quality assessment of literature and also limits itself to one set of outcomes however, namely support (or otherwise) for carrying out basic and instrumental activities of daily living (ADLs).

In the light of the gap in literature and the need for a comprehensive review taking a holistic perspective, relevant to a range of environments, which is open to alternative research

designs and tentative findings whilst retaining rigour and clear quality assessment, the aims of the present review were as follows:

- To systematically identify, examine and evaluate the literature on designing environments for people with dementia.

- To identify lessons for good practice that are grounded in research evidence.

- To inform future work on designing environments for people with dementia, including that of the University of Stirling.

METHODS

The review begins with a preparation phase which involves developing and testing search terms to achieve a balance between sensitivity (finding every relevant study but with the potential for huge numbers of irrelevant studies) versus specificity (higher ratio of relevant to non-relevant but with the potential to miss some). The process was informed by the design experience of DSDC which helped identify relevant terms. The quality assessment criteria were designed to ensure assessment of the full range of research methods used in the literature, and the research team developed initial criteria to guide the extraction of relevant information from the sources included. Light touch ethical review was carried out by the University of Stirling School of Applied Social Science Ethics Committee.

Identification of Relevant Literature

Table 1 lists the search terms used. These were aimed at covering the full range of terms for dementias and different types

Table 1. Search Terms Used.

Condition	Setting		Design Aspect	
Terms	**Term Group**	**Terms**	**Term Group**	**Terms**
Dementia* Alzheimer* Cognitiv* impair*	Building types	Home* Hous* Domestic Building* Hospital* Special Care Unit (SCU)* Day cent* Medical cent*	Whole building	Locat* Architect* Layout* Position* Structur*
	Key features of buildings	Entrance* Exit* Door* Wall* Ceiling* Floor* Step* or stair* Lift* or Elevator* Window* Corridor*	General support-related	Accessib* Usab* Suitab* Safe* Assistive Technolog*

Table 1. (*Continued*)

Condition	Setting		Design Aspect	
Terms	Term Group	Terms	Term Group	Terms
	Specific rooms/areas	Room*	Senses-related	Sound*
		Hall*		Noise*
		Dining		Visual
		Lounge* or living room*		Visib*
		Bedroom*		Colour* or color*
		Bathroom*		Contrast*
		Toilet*		Tone*
		Shower*		Light*
		En suite*		Reflect*
		Outdoor		Glare
		Balcon*		Pattern*
		Patio*		Brightness
		Garden*		Textur*
		Path*		Smell*
		Examination room*		

General	Environment* Refurbish*	Specific fixtures	Seat* Furni* Facilit* Fitting* Control*
		Addressing dementia-related deficits	Sign* Wayfinding Orient* Landmark* Appearance Recogni* Individuali* Familiar*
		Other	Cultur* Activit*

Notes: Where possible single inclusive condition term used, i.e. (dementia* OR Alzheimer* OR (cognitive* impair*)). Not all databases allow for multiple bracketing of terms. Asterisk denotes 'wildcard' character, e.g. 'Architect*' returns items using terms including architect, architects, architectural, etc.

Table 2. Databases Searched.

CINAHL

Medline

ProQuest (ASSIA + Social Services Abstracts + Sociological Abstracts databases)

PsychINFO

Web of Science − core collection

DAAI (Design and Applied Arts Index)

RIBA British Architectural Library Catalogue Online

of residential environments including types of buildings where people live and/or receive care, features of the buildings and aspects of particular rooms or areas, including any refurbishments and any generally focused discussions of design. Design aspects included the whole building, potential areas of support, matters relating to senses and sensory impairments, specific fixtures and fitting, dementia-related impairments and general areas of culture and activities. Table 2 lists the databases searched and Figure 1, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram, indicates the items identified and the process of arriving at the items eventually included. A PRISMA checklist for this review is available on request from the authors.

The majority of searches were carried out in December 2014−January 2015, with searches of Design and Applied Arts Index (DAAI) and Royal Institute of British Architects (RIBA) British Architectural Library Catalogue Online carried out in May 2015.[1] The earliest publication date was set

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[1]Where later dates appear in the reference list, these refer to print publication, subsequent to online previews.

Figure 1. PRISMA Diagram.
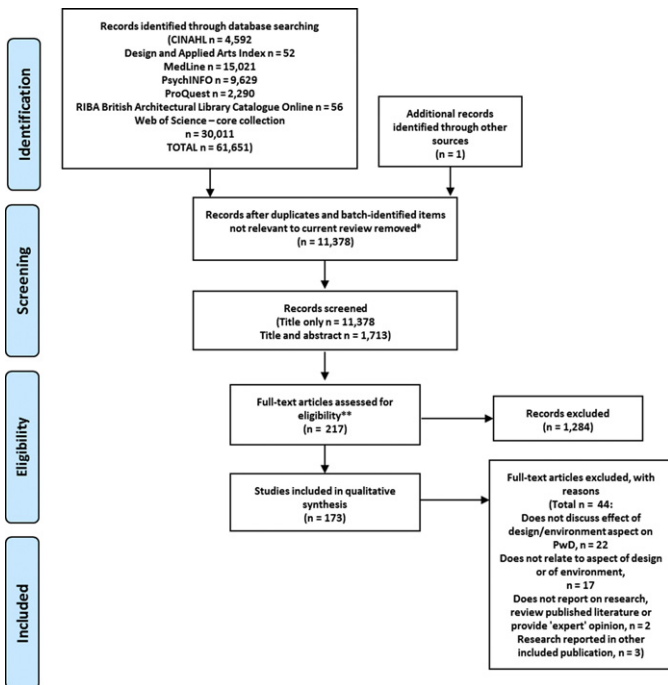
Source: Diagram format after: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(6): e1000097. doi:10.1371/journal. pmed1000097. For more information, visit www.prisma-statement.org.

Notes: *E.g. items with reference to proteins in title, which were not likely to be relevant. **429 items remained after screening by title and abstract. Reports of single studies or research programmes were prioritised for full text consideration above reviews and other publication types.

to 1990 where possible, the publication language to English and the search category to 'Abstract', or, where no abstract search was available, to 'Topic'. These limits allowed a balance between breadth of coverage and retrieval of a

manageable and reasonably up-to-date range of materials. Additional searches were not conducted for similar reasons.

Some limitations should be highlighted. Inevitably, a systematic review has to operate within time parameters, and the complex process of analysis means it cannot catch up with the most recent publications. However, each one provides a punctuation point in the research record, and this review is particularly large and diverse, providing a state-of-the-art overview. Moreover, we have not been able to systematically address the cultural diversity represented in the international literature we have considered. The main reason for this is that this has not been a consideration in the literature: it is a gap that could now usefully be addressed, as design for dementia rolls out across more diverse contexts.

Screening Processes

Results of individual searches for each database were uploaded separately to online RefWorks bibliographic data management software. Searches were combined and within-database duplicates removed. The number of unique results for each database is shown in the PRISMA diagram (Figure 1). The large volume of results for MedLine, PsychINFO and Web of Science databases caused difficulties with the reference management software. Numbers for these databases were reduced by identification of results not expected to be relevant to the review by searches for selected terms in the item title and batch deletion of items retrieved. These terms included 'mice', 'mouse', 'amyloid', 'molecular', 'apolipoprotein', 'Donepezil', 'rats', 'plasma', 'biomarker', 'magnetic resonance', 'radiotherapy', 'cancer', and 'agonist'. The reason why so many items clearly not relevant to the subject of the review were identified by the searches is that

searches looked at either the abstract or topic, and the word 'Design' is a required heading in the abstracts of many scientific journals. Remaining results from all databases were then combined and across-database duplicates removed to leave a total of 11,378 unique references to undergo screening.

Two stages of screening were carried out. The first considered the remaining search results by title, removing any items clearly not relevant to the subject matter of the review. This left 1,713 items for consideration. These were screened by title and abstract. To be considered for inclusion, an item had to appear to meet three inclusion criteria based on the information available in the abstract: (1) the item either reports on research, reviews literature or provides 'expert' opinion; (2) the item relates to some aspect of design or environment; and (3) the item relates to how the design or environment affects or supports people with dementia. A total of 429 items appeared to meet these inclusion criteria.

Prioritisation of items for retrieval of full texts for review and evaluation was necessary due to time and resource constraints. As part of the screening process, readers were asked to identify whether or not the item appeared to describe a single research study or research programme. A total of 336 items apparently met this criterion. Primary studies were then prioritised in order to maximise the included research evidence and minimise the risks of overstating evidence through inclusion of both reviews and the studies included in those reviews.

Full texts were retrieved for items published in both primarily academic and primarily professional publications. Due to lack of available information regarding the peer-review and/or editorial processes that these items may have been subject to, full texts were not retrieved where the item was revealed to be a book or book chapter; a master's or doctoral dissertation; a conference presentation; or the abstract of a presentation reported in a peer-reviewed journal. As the PRISMA diagram

shows, a total of 217 full-text articles were retrieved, of which 173 were reviewed and evaluated and 44 were excluded at this point. Of the excluded items, 22 described studies which did not include people with dementia and did not directly address how design aspect or environment affects or supports people with dementia. A further 17 items did not relate to an aspect of building design or environment, including three which described multi-sensory or music interventions, two which described the development of assistive technology prototypes, one which described a monitoring system and one which described the development of a website for home modifications for older people with dementia. Two items were not considered to report or review research or provide expert opinion: a book review and a technical specification for a technology, respectively. The remaining three described research that had been described in other included items and so were excluded as effectively duplicates of included studies.

Review of full-text Items and Assessment of Quality

The process of review and evaluation used a version of the Stirling Literature Review Proforma specially adapted for this study in consultation with design experts to extract data on issues and outcomes relevant to supporting practical design work. The proforma has been used successfully and is described in detail in a number of studies (Bowes, Dawson, & Greasley-Adams, 2013; Bowes et al., 2016; Bowes, Dawson, Jepson, & McCabe, 2013; Dawson, Bowes, Kelly, Velzke, & Ward, 2015). Each item was read and evaluated online by a member of the team. Data were extracted and recorded in the study proforma. The data extracted included full summary of the key findings of the work, data about the nature of the study, the key conclusions and recommendations. Each review required

the reader to answer specific questions about the implications of the work for designing environments for people with dementia. Reviewers extracted data on general bibliographic details; 'PICO' data (Population, Intervention, Comparator, Outcomes of interest) (see Appendix, Table S2), general categories of outcomes addressed in the items reviewed; types of dementia referred to in included publications; the types of buildings to which the included item's conclusions and recommendations relate; which aspects of design or environment the item's findings relate to; the sections of the current DSDC Design Audit tools to which the included item relates; and whether the conclusions and recommendations of the item relate to selected aspects of building accessibility and suitability, sensory issues or outcomes, or dementia-related deficits.

To ensure consistency of evaluation and judgements about the quality of evidence, a second member of the team read and evaluated a sample of 42 (19%) of the retrieved items, and any identified disagreements were discussed among the research team to ensure consistency and consensus. Consistency was generally high between reviewers (e.g. greater than 90% agreement on assessments of whether the item met each of the three inclusion criteria).

OVERVIEW OF RESULTS

The quality of items was assessed using established criteria. Readers identified the type of methodology used in the item, and were then directed to a set of questions appropriate to the type of output. Table S3 lists the quality criteria used to assess different types of research (see Appendix). These were drawn from standard protocols widely used in reviewing, including Centre for Research and Development (CRD) Report No 4, used for RCT (NHS Centre for Reviews and Dissemination

[NHS CRD], 2001); Cochrane Effective Practice and Organisation of Care (EPOC) checklists used for controlled before and after studies (Effective Practice and Organisation of Care [EPOC], 2015); and Critical Appraisal Skills Programme (CASP) assessment criteria (Critical Appraisal Skills Programme [CASP], 2013), used for literature reviews and qualitative studies. Having responded to a series of questions relating to the quality of the item, readers were then asked to judge whether the item was of low (major limitations), medium (important limitations) or high (minor limitations only) quality and to state their reasons for their judgement. This made it possible for the justifications as well as the judgements to be checked and verified, and for quality control to be exercised.

Table 3 shows a summary of reviewed and evaluated items by study type and quality assessment. Reviewers identified the study type for each study from one of the categories listed in Table 3 and were then automatically routed to the correct evaluation criteria for that type of study. The largest category was 'Research studies – Other designs'. A total of 75 items (43%) were deemed to fall into this category. Qualitative studies formed the largest single study type of those included on the proforma (36 items, 21%). In line with the prioritisation of primary studies for full-text retrieval, only 6 of the 173 items included (3%) are literature reviews. In terms of quality assessment, 38 items (22%) were assessed as being of high quality, 104 items (60%) as of medium quality and the remaining 31 (18%) as of low quality. Many reviews would have excluded the low-quality studies at this stage. However, this is a rapidly developing area of research in which very small or purely indicative studies are nevertheless relevant to the accumulation of knowledge, and we have therefore included them, with caveats noting the tentative nature of their contributions.

Reviewers felt that the great majority of included items (149 items, 86%) described a single research study or two or

Table 3. Summary of Reviewed and Evaluated Items by Item Type and Quality Assessment.

Item Type	Quality Assessment			Totals
	High	Medium	Low	
Controlled or non-controlled before and after studies	3	7	3	13
Controlled clinical trials	4	7	0	10
Cohort studies	0	3	0	3
Interrupted time series studies	1	2	0	3
Literature reviews, including systematic reviews	3	0	3	6
Other non-research items (e.g. expert opinion, accounts of personal experience)	1	9	8	18
Qualitative studies	7	26	3	36
RCT	3	5	0	8
Research studies − other designs, e.g. case control, case series and cross-sectional studies	16	45	14	75
Totals	**38**	**104**	**31**	**173**

more linked studies, again reflecting the prioritisation of primary research studies in the full-text retrieval process. Seven of the remaining items presented purely theoretical perspectives, and three offered design practice guidelines without reference to specific research studies.

Half of the included papers (89 items) talked about dementia without identifying type, with further items adding a descriptive term, for example, 'mild dementia' or 'severe dementia'. Where a type was identified, it was primarily AD (39 items, 23%, including three items referring to AD and/or vascular dementia). A further 14 items (8%) referred primarily to cognitive impairment or mild cognitive impairment (MCI) rather than dementia.

Table 4 presents information on the types of buildings and/or environments covered by the included items. More than two-thirds of included items (127 items, 73%) related to residential environments. In terms of specific type of residential building, 107 items were identified as specific to care homes (62% of all included items, and 70% of items identified as relating to residential accommodation), 28 to general purpose housing, that is, private accommodation, five to housing with support, three to housing specifically designed with older people in mind and five items related to Special Care Units (SCUs). The disparity between numbers identified as relating to residential accommodation and the sum of numbers relating to specific types of residential accommodation is due to care homes being described as 'nursing homes' in some publications and being regarded as healthcare rather than residential environments by reviewers and to SCUs being designated as healthcare rather than residential environments by some reviewers. These reflect genuine ambiguities in the literature.

In all, 27 items (16%) were evaluated as relating to healthcare environments (12 items relating to hospital environments

Table 4. Summary of Types of Buildings and/or Environments Covered by the Included Items.

Type of Building/Environment	Number of Included Items
Residential buildings	127
Hospitals	12
Other healthcare environments (e.g. doctors' or dentists' surgeries, health centres, Special Care Units (SCUs))	15
Public' buildings (e.g. museums, leisure centres, community centres, etc.)	2
Does not relate to specific building type(s)	9
Other (described variously as 'apartments', 'group living', 'institutions', 'nursing homes', 'Special Care Facilities', 'therapeutic gardens', 'neighbourhoods', 'urban environments')	8
Total	173

and a further 15 to other healthcare environments). Only two items were seen as specific to public buildings rather than health or residential buildings, with nine items not specific to any type of building.

Table 5 summarises the included items by categories of outcomes of interest. Included publications could have outcomes of interest in none of the categories (e.g. in the case of some qualitative research) or in more than one category. Included papers had outcomes of interest in an average of 2.4 categories (minimum 0, maximum 7, std. dev. 1.6). Emotional health-related outcomes are the most frequently considered in the included literature, with 53% of items

Table 5. Included Items by Outcomes of Interest.

Category of Outcome	Number of Items with Outcomes of Interest in This Category*	Percentage of Items with Outcomes of Interest in This Category
Physiological health-related outcomes (e.g. strength, mobility, calorie intake, heart rate)	35	20
Emotional health-related outcomes (e.g. quality of life, happiness or well-being, mental health status, depression, independence)	92	53
Economic outcomes (e.g. quality-adjusted life years (QALYs), length of hospital stays))	6	3
Service use-related outcomes (e.g. hours of care provided, hospital admissions, GP visits)	9	5
Sleep, sleeping patterns or other sleep-related outcomes	15	9
Engagement, patterns of engagement or other engagement-related outcomes	52	30
	70	40

Behavioural and Psychological Symptoms of Dementia (BPSD) (also called non-cognitive symptoms, neuropsychiatric symptoms, challenging behaviours)		
Cognition-related outcomes (e.g. relating to memory, attention, language, speech recognition, confusion, reasoning, judgement, problem solving and the orientation to time place and person)	58	34
Function-related outcomes, including abilities to manage everyday activities, number of falls, etc.	71	41

Note: *Included items could have outcomes of interest in no categories or in more than one category

having outcomes of interest in this category, with function and BPSD-related outcomes the next most frequently researched categories (of interest in 41% and 40% of items, respectively).

Economic and service use outcomes are least frequently included in the items reviewed, with just 3% of studies including the former and 5% the latter. Considered in conjunction with the fact that none of the included items were classified for economic analysis, this suggests a gap in the research evidence relating to these aspects of the value of optimising environments for people with dementia.

Table 6 considers the coverage of the included items in terms of how their conclusions, recommendations and/or any design guidance offered relate to a number of selected topics or subject areas. Each item could be evaluated as having conclusions or recommendations or offering guidance in relation to multiple topic areas. Included items were evaluated as relating to a mean of 5.3 of the selected topics or subject areas shown in Table 6 (std. dev. 3.9, minimum 0, maximum 17). A large proportion of the included items were evaluated as providing relatively focused guidance: 105 included texts (61% of all texts) related to five or fewer of the selected topic areas. A far smaller proportion were wider in application, with 16% (28 items) relating to 10 or more topics or subject areas.

In considering selected general features of buildings and environments, just over a third of the included literature (59 items) has conclusions or recommendations or offers guidance on specific rooms or areas within buildings. By contrast, there seems to be relatively little published work providing insights into optimal design in relation to furniture and furnishings (only 22 items, 13% of included texts).

There are areas of overlap in the selected design issues, and this may in part account for the high apparent coverage

Table 6. Relationship of the Conclusions, Recommendations and/or Design Guidance in Included Literature to Selected Topics and Subject Areas.

Informing Selected General Features	Number of Items	Percentage of All Included Items
A specific room or area within a building (e.g. entrance to public building, kitchen in home)	59	34
Key features of a building (e.g. entrances, exits, floors, stairs, windows, corridors)	49	28
Internal fixtures and fittings (e.g. light switches, plug sockets, baths, sinks and toilets)	38	22
Internal finishes (e.g. wall and other surface textures, paint types)	28	16
Furniture and furnishings (e.g. wardrobes, drawers, carpets and other floorings)	22	13
Outside areas attached to buildings (e.g. gardens, driveways)	30	17
Informing selected general building design issues		
Accessibility of building or parts of building for people with dementia	44	25
Usability of building or parts of building by people with dementia	80	46
Suitability of building or parts of building for use by people with dementia	109	63

Table 6. (*Continued*)

Informing Selected General Features	Number of Items	Percentage of All Included Items
Safety of building or parts of building for people with dementia	45	26
Enhancement of buildings or environments using technology	50	29
Relating to impact of design on senses		
Hearing-related, including audibility, noise or sound	42	24
Sight-related, including visibility or affecting vision, colour and contrast, tone, lighting levels, reflection and glare	92	53
Taste-related	8	5
Smell-related	21	12
Related to sense of touch, including texture and tactile enhancement, vibration	25	14
Relating to addressing selected dementia-related deficits		
Signage, wayfinding, landmarks and orientation	58	34
Appearance, familiarity or recognisability of areas or objects	74	43
Personalisation or individualisation of parts of buildings, fittings or furnishings	48	28

of these areas in the included texts. Suitability has the greatest depth of coverage, with 109 items (63%) relating in some way to this subject. Conversely, accessibility and safety are the least well covered of the selected issues, each being addressed by around a quarter of the included texts.

When considering design issues as they relate to the senses, the included literature is primarily concerned with sight-related issues, with 92 items (53%) referring in some way to this. There seems to be a relative paucity of research literature examining aspects of design as they relate to taste and smell, and this may be an area where further research is required.

As might be expected, all three of the areas related to dementia-specific deficits have been well covered by the conclusions, recommendations and/or guidance offered by items included in the review. Of the included items, 43% speak to the appearance, familiarity or recognisability of areas or objects. Just over a third (58 items) relate to wayfinding or orientation and inform the use of signage and landmarks. Personalisation or individualisation of parts of buildings, fittings or furnishings is a concern in 28% of the included studies (48 items).

Table 7 relates the conclusions, recommendations and guidance contained in the items reviewed to the DSDC dementia design audit tools for residential environments and healthcare environments, respectively. The focus of these is not dissimilar to other published guidance, such as that provided by the Kings Fund (2013) which is particularly concerned with healthcare environments. Rather than focus on general design attributes as Fleming and Purandare (2010) do, we consider particular areas and features of the home environment.

In relation to the provision of evidence-based recommendations for residential environments, there is good coverage of lounges and dining areas from reviewed items, with each

Table 7. Numbers of Included Items Informing Sections of DSDC Dementia Design Audit Tools.

Sections of the DSDC Residential Environments Design Audit Tool	Number of Items	Percentage of All Included Items
Entrance, corridors, wayfinding and lift	34	20
Lounge area	41	24
Dining room	41	24
Meaningful occupation and activity	45	26
Examination room	4	2
Hairdressing room	5	3
Bedrooms	33	19
En-suite bathrooms	20	11
Communal toilets/bathrooms	20	11
External areas	25	14
General principles for the caring environment as a whole	89	51
Sections of the DSDC healthcare environments design audit tool		
Entrance, corridors, wayfinding and lift	15	9
Nurse's station	9	5
Waiting room	4	2
Bedroom area	17	10
En-suite or adjacent toilets or bathrooms	9	5
Communal toilets/bathrooms	6	3
Physiotherapy and occupational therapy rooms	6	3

Table 7. (*Continued*)

Sections of the DSDC Residential Environments Design Audit Tool	Number of Items	Percentage of All Included Items
Day room	13	7
External areas	8	5
General principles for the environment as a whole	36	21

being included in approximately a quarter of the included items. The current review also provides research-based evidence assessed as relating to the more abstract sections of the residential environments design audit tool: 'Meaningful occupation and activity' (46 items, 27%) and 'General principles for the caring environment as a whole' (89 items, 51%) are both well represented in the literature. Perhaps unsurprisingly, Table 7 shows that few studies have been reviewed which will provide insight into the optimal design of examination rooms (four items) or hairdressing rooms (five items) in caring environments.

Only 27 included texts were assessed as relating primarily to hospitals or other healthcare environments (see Table 4), and this is reflected in the lower numbers of items with conclusions, recommendations or guidance which touches upon areas covered by the sections of the DSDC design audit tool for healthcare environments. Most of the healthcare-specific areas are poorly represented in the included literature: there seems to be very little research to inform best practice in the design of nurses' stations (nine items), waiting rooms (four items) and physiotherapy and occupational therapy rooms

(six items). Only 'General principles for the environment as a whole' is explored in depth in the reviewed evidence base, with 36 items (21%) evaluated as relating to it.

DISCUSSION OF LITERATURE

In discussing the literature, we aim to present it to maximise usefulness for informing practical work on design. The topics under which research is presented reflect the literature and the questions researchers have addressed. They are given in alphabetical order, with a concluding section on methodological issues. It should be noted that there is overlap between the various categories, and that findings in one area may also be relevant for others.

Assistive Technology

Items considering assistive technologies were included in the review if they related to aspects of design or environment or were embedded and thus could be considered a part of the environment, as, for example, when Martin and Rankin (2002) reported that the South and East Belfast Health and Social Services Trust was to commission purpose-built accommodation for adults with cognitive impairments that would incorporate presence sensors, appliance usage monitors and door contacts. We excluded items which described or tested single items of technology without considering them in relation to these contexts.

Mäki and Topo (2009) make a number of important general observations in relation to designing technologies and environments for people with memory problems or dementia. They suggest that universal design principles can be a helpful

starting point, but need to be supplemented with dementia-specific knowledge; that people with dementia should always be involved in the design process; and that it is essential that technologies are thoroughly tested in a real-world environment and not under laboratory conditions. Though made in relation to the development of a specific technology, their observations that extraneous material can disturb users with dementia and that, where presented, graphic information needs to include only what is necessary and should be presented in the order in which is it required are relevant to all environmental contexts.

This is an area in which there is a large body of research, but in which the quality of evidence has come into question. In 2008 for example, Martin, Kelly, Kernohan, McCreight, and Nugent (2008) set out to systematically review the evidence for efficacy of smart home environments, but found no studies that met their inclusion criteria, which related to controlled studies. Our more inclusive approach has identified several studies, but there continue to be limitations to research in this area.

Many of the studies we identified were still exploring prototypes, and this area remains undeveloped in terms of large-scale implementation in care settings for people with dementia. An example is the NOCTURNAL study (Martin et al., 2013), which tested a night-time monitoring system for people with dementia living at home. The system included elements which could provide comfort if people's sleep was disturbed, or if they got up at night. The test, involving eight people, demonstrated that the system could work and offer therapeutic effects, but it does not provide generalisable results. Similarly, Chang et al. (2012) in Taiwan were able to establish that their monitoring system for use in care settings was able to effectively monitor vital signs, but drew no further conclusions, and Mihailidis, Boger, Craig, and Hoey's

(2008) test of a prototype of COACH (Cognitive Orthosis for Assisting activities in the Home), an assistive device designed to guide people with dementia through 'ADLs' using a series of audio and/or video prompts, concluded that the system showed promise as a tool to help support older adults with moderate-levels of dementia and their caregivers but needed both further modification and more extensive testing.

Aloulou et al. (2013) in Singapore explored the requirements of a system of assistive technology in a nursing home, identifying that the system could detect deterioration in people's condition by monitoring their patterns of daily activity. This study is typical of many studies of ambient assisted living ('AAL') technologies: it demonstrates an issue (people with dementia needing support), identifies a technological capability of a system (to monitor activity over time) and proposes the latter as a solution to the former. It does not demonstrate effectiveness or outcomes. Similarly, Charlon, Fourty, Bourennane, and Campo (2013) tested an ambient system capable of detecting falls in a care environment, for example during the night when care workers may not be present. They did not establish effectiveness, merely operation, as the study included only two people who were monitored. Furthermore, Cheng and Zhuang (2010) tested an in-home monitoring system that used bluetooth technology. Like others, they found that their system operated and looked possible to implement, but they were unable to demonstrate its operation in reality. Chen, Kam, Zhang, Liu, and Shue (2005) developed a system which could monitor people's activities in their bathrooms. Again, the system was broadly capable of doing what it was set up to do, and the authors were conscious of privacy issues raised by it but argued that it could replace more intrusive approaches – again, a note of potential rather than reality.

Other examples focusing on operation of devices include Chang et al. (2010) who tested the prototype for an approach

to providing indoor wayfinding assistance for people with cognitive disabilities, including people with dementia, based on passive near-field radio-frequency identification (RFID) tags embedded in the environment and hand-held smart-phone/tablet type scanning devices. They found that while passive RFIDs generally provided good context for triggering navigation prompts, individual differences in effectiveness varied. Lanze, Riepe, and Knorzer (2014) tested an alternative autonomous spatial orientation system which also relied on a hand-held mobile device, finding this to produce superior navigational results to aerial maps on which the routes had been highlighted, but noting that intermediate reassurance was necessary for more than half of the routes on which the navigational technology was being used.

A small number of studies which we now discuss have looked at more practical applications of technology in real-world situations. They highlight issues of context and professional relationships, emphasising that a technology that operates is only one element of an effective solution. Technologists, care staff and users of the system need to accept and understand it.

The ENABLE project (Adlam et al., 2004) tested a number of technological devices in several European countries in people's own homes. The project aimed to get feedback from people using the devices, which had been technically developed but not fully tested. In practice, many unpredicted difficulties were encountered, including difficulties of interaction between the various professionals involved as well as the people with dementia. This and similar experiences reinforce the importance of understanding the wider dynamics of technology implementation, and that even a system that works technically is far from easily translated into practice.

Al-Oraibi, Fordham, and Lambert (2012), who examined the impact on the incidence of falls following the installation of an upgraded call system in two care homes in Norfolk, tend to

confirm this issue. They were able to demonstrate that in a care home where fewer people with severe dementia lived, the call system was associated with significantly fewer falls, but that this could not be demonstrated in the care home where residents generally had more severe dementia. These findings cannot be interpreted as showing that the system worked or did not work: they suggest a need to examine much more closely what factors were affecting the working of the system.

Relatedly, Engstrom, Lindqvist, Ljunggren, and Carlsson (2009) examination of staff's responses to technological support packages for people with dementia in a residential setting emphasised the significance of context for gaining their confidence in the system, including the organisation of the care home and the approach of the employers, who need to recognise staff's legitimate concerns about, for example, the potential 'inhumanity' of the technological systems.

Gitlin, Winter, and Dennis (2010) explored which assistive devices were most useful for people with dementia living at home. This study was able to demonstrate preferences among users for devices supporting engagement and entertainment through meaningful activity, as well as devices supporting bathing and using the toilet. The acceptability of these devices was partly explained by the particular challenges that family caregivers experienced, connected to communication and interaction and to personal and intimate care. Their study raises the issue of individual capabilities and wishes, also covered by others. For example, Malinowsky, Almkvist, Nygård, and Kottorp (2012) explored individual capacity to use everyday technology in a sample of people with mild Alzheimer's. They identified that capacity varied not only between individuals but also for single individuals from time to time, emphasising the complexity of individual lives.

One study, Casas, Marco, Falcó, Artigas, and Abascal (2006), reviewed ethical issues including privacy and consent

in a case study of a location monitoring system used in a care facility in Spain. They make the important point that technologists are not necessarily aware of ethical issues when they design systems and emphasise, as do others, the need for the use of assistive technologies to relate to real issues of care and to recognise the ethical dimensions of these.

Bathrooms

There is limited research specifically focusing on bathrooms, but bathroom design can be informed by findings in other areas, such as work on colour and contrast, lighting and way-finding. Specific work on bathrooms emphasises needs for accessibility, familiar fittings and helpful signage.

A number of the studies touch upon design-related aspects of bathrooms in their considerations, for example, Burton and Sheehan (2010), whose qualitative exploration of residents' perceptions of care home design features that promote well-being found that accessible bathrooms were important to residents. However, we found only one item which specifically considered bathrooms (Noreika, Kujoth, & Torgrude, 2002), and another three that looked at the design of specific bathroom-related aspects: Boger, Craig, and Mihalidis (2013), which looked at taps; Wilkinson, Henschke, and Handscombe (1995), which explored how toilets should be labelled for people with dementia; and Chen et al. (2005), who described and tested an automated bathroom activity monitoring system based on acoustics.

Noreika et al. (2002) used experiences of bathrooms specifically designed for a new care facility to inform future design. For example, they learned that better seals were needed to prevent water leaking from the bathrooms. This

study illustrates the importance of continued learning from experience.

An example of a study that did produce useful conclusions is Boger et al.'s (2013) study of taps (they use the term faucets). Testing several different designs across 1309 hand washes by people with dementia, they demonstrate that more familiar designs mean people with dementia are less likely to need help, that they make fewer mistakes and that they are more satisfied with the process than if the designs are unfamiliar. This study has important implications for other items in daily use, although the authors are careful to emphasise that for different devices, further study may be needed.

Wilkinson et al. (1995) surveyed institutions before interviewing older people in both acute hospital and care home settings to find out their preferences in relation to the labelling of toilets. They found that people with moderate dementia preferred the use of the word 'Toilet' and a picture of a toilet rather than the international symbol for person and recommended using both for labelling toilet doors for people with dementia. An important aspect of this study, not frequently repeated, is the involvement of users of the services in the design decisions.

Care Homes

Extensive international research on many aspects of care homes covers a wide variety of types of care home of multiple designs and care ethos. Palm, Bartholomeyczik, Roes, and Holle, 2014) identify five different types of specialist units in Germany, which vary in terms of whether people with dementia are integrated, their size, funding, staffing and whether or not all residents have single rooms. They suggest that this range may produce different outcomes for residents.

Wolf-Ostermann, Worch, Fischer, Wulff, and Gräske (2012) compare different care settings for people with dementia in Germany, including innovative housing arrangements separate from care homes but supporting people with dementia. They were unable to identify different outcomes, and recommend that choice of dwelling should therefore simply rely on the preferences of the person with dementia.

Many studies have considered aspects of care home design, and several recurrent themes emerge from this work.

A succession of studies have suggested that a more 'home-like' environment in a residential care setting is beneficial for people with dementia. The definition of 'homelike' varies somewhat, including between countries, but tends to emphasise smaller-scale, familiar objects and space to oneself. Smit, Willemse, de Lange, and Pot (2014) in the Netherlands, using Dementia Care Mapping (DCM) in 10 care facilities for people with dementia, found that a more 'homelike' environment in dementia care facilities was more supportive of engagement in activities, particularly some they found to enhance well-being effectively, namely reminiscence, leisure activities and 'vocational occupation' involving specific tasks such as housework. Significantly, one of the key aspects of the more homelike environment was more social interaction, although they were not able to show that this specifically enhanced well-being. Morgan-Brown, Newton, and Ormerod (2013) examined two Irish nursing homes, with similar results: the more homelike environment that was introduced appeared to promote social interaction. They note that these occurred linked with a more person-centred approach to care. Gnaedinger, Robinson, Sudbury, and Dutchak (2006) in British Columbia, Canada, also found that renovations to make care home settings more homelike and smaller yielded positive results, as did Schwarz, Chaudhury, and Tofle (2004) in the USA. Heggestad, Nortvedt, and Slettebø (2013)

examined care homes in Norway from the perspectives of
people with dementia and found that they experienced loss of
dignity due to institutional regimes. They recommend that
care homes should be more 'homelike' to uphold dignity.
Benbow (2012) reviews models of group living, describing
design features appropriate to these settings: like other
authors, this draws on previously set out design guidelines.
Danes (2012) evaluates the influence of 'Woodside Place', an
early example of a larger US-based facility organised into
smaller 'households' built in the 1980s, on the subsequent
development of the 'small house movement'.

Milke, Beck, Danes, and Leask (2001) noted the prolifer-
ation of different designs for residential care settings and
questioned the apparent underlying assumption that small
variations in architectural design would have little effect on
staff and resident activity. Using the Therapeutic
Environment Screening Scale (TESS-2 +) as an architectural
basis for assessing the significance of data, they carried out
activity and behaviour mapping in five ostensibly similar care
homes built along the lines of the Woodside Place model in
different sites across the USA, the main difference between
them being that two were designed with two 20-resident
housing units and the other three had three 12-resident units.
The authors noted similarities in behaviour across all five
houses, for example, that despite the designed-in proximity to
each other 'households' did not form according to unit resi-
dency, but that residents formed small clusters based on nat-
urally formed friendships, early or late rising and other
factors. Critically, they also noted differences in patterns of
use of different areas of the accommodation between sites by
both staff and residents, for example, that the sites with
12-bed units made greater use of common areas for activities,
whereas the sites with 20-bed units tended to arrange activ-
ities within the 'houses', making far more limited use of

common spaces. They concluded that behaviour was affected both by the design of accommodation and by the way that staff chose to organise activities.

An Australian study (Wilkes, Fleming, Wilkes, Cioffi, & Le Miere, 2005) explored the effect on agitation of a new care setting which conformed to widely disseminated guidelines, including single rooms with en-suite facilities, more personalisation of bedrooms, external access, involvement in day-to-day activities and a Snoezelen room. They were able to demonstrate reductions in verbally agitated behaviours, which were maintained through the six months of the study.

However, research findings in this area are not unanimous. Samus et al. (2005) considered links between quality of life, environment and neuropsychiatric symptoms for people with dementia in care home settings. In their study, the size of the facility was significant (smaller being better), but 'homelike' environments were not significantly associated with quality of life. Experiencing neuropsychiatric symptoms did adversely affect quality of life.

An indication as to why environmental changes may not always produce beneficial results appears in studies which look at wider aspects of resident experiences, particularly in relation to the models of care being delivered within care home environments, whether they conform to environmental guidelines or not. For example, Garcia et al.'s study (Garcia et al., 2012) collected feedback from staff and family regarding the impact of the care home environment for the behaviour of people with dementia and their quality of life. Whilst these respondents agreed that the environment could make a difference, and that noise could have particularly negative effects, the study concluded that environmental design issues alone were insufficient, and that the care regime was also influential.

Garcia et al.'s (2012) conclusions accord with the findings of a qualitative component of a larger research project examining environment–behaviour relationships in dementia care settings reported by Morgan and Stewart (1997, 1999). The study questioned family members of residents and staff working in 'special care units' (SCUs), which are self-contained units within larger care homes specifically designed to meet the needs of residents with dementia, about residents' needs in relation to environment. They found that whilst participants identified needs in relation to both the physical and social environments, the latter was perceived to have more impact on quality of life and functional ability.

Falk, Wijk, and Persson (2009) study adds to the comments we have made about the complexity of care settings and the difficulty of identifying what aspects of design make a difference to what and how other factors including the model of care come into play. Unable to observe an improvement in residents following design modifications to a care setting, they observe that perhaps the deteriorating condition of the residents has made this unclear, and conclude that design modifications alone may have little effect.

Chenoweth et al. (2014) attempt to explore this issue more rigorously. The PerCEN cluster RCT (Chenoweth et al., 2014) aimed to examine whether person-centred environments – that is, environments modified to be particularly suitable for people with dementia – could complement and enhance the known positive effects of person-centred care. They provide little detail on the specification of the person-centred environments, describing these (p1150) as including 'improvements to the safety, accessibility and utility of outdoor spaces, provision of a greater variety of social spaces and using colour and objects for wayfinding and to improve feelings of familiarity'. These echo recent design guidelines which are commonly mentioned in recent literature. The

study was able to demonstrate some improvements in residents' emotional responses and in the quality-of-care interactions, but was unable to show the hypothesised quality-of-life improvements and reductions to agitation. This may be due to the considerable limitations of the study, which particularly related to the difficulties of controlling the conditions in the care homes. The study does illustrate that environmental and care model issues seem to be closely intertwined.

Further examples of studies which assess aspects of care home design are given below.

Barnes (2006) explored the nature and uses of space in 38 care homes in Sheffield, considering gradation (i.e. variety) of space and its relationship to residents' quality of life. She found that quality of life was improved where residents had a choice of spaces to be in, and where they had more control over their environment (in terms of décor and furniture, heating, lighting, going outside and being able to lock bedroom doors). She emphasises however that gradation of space can only have its positive effects if residents have genuine access to the spaces available.

Innes, Kelly, and Dincarslan (2011) explored with people with dementia and family carers what design and environmental features of the care home setting were important for them. These respondents particularly valued outside space and wayfinding aids, including signage. In this study, residents did not particularly value en-suite bathroom provision, something which the authors note, features significantly in design guidance. They do note however that in addition to design, the use of space has to be appropriate, and that the respondents struggled to identify uses for en-suite bathrooms.

Low, Draper, and Brodaty (2004) developed a scale to assess harmful behaviours of people with dementia (i.e. behaviours adversely affecting their quality of life) and applied

this in a large study (647 residents in 11 nursing homes) which aimed to explore the relationships between harmful behaviours and the nursing home environment. They found associations between higher incidences of harmful behaviours and stronger security measures, shared rooms, higher care needs, less staff availability and training, and a regime which was not orientated towards managing behaviours. They concluded that the factors involved were highly complex and little understood, and that there would not be simple answers to addressing issues of harmful behaviours.

Morgan, Stewart, D'arcy, and Werezak (2004) explored the performance of nursing homes in rural Canada, comparing those with specialist dementia units and those without. The specialist units had been set up to incorporate recommended design features considered beneficial for people with dementia: these are now widely reported as being in use, though it is not always clear where they have been derived. The environments were assessed using the Physical Environment Assessment Protocol (PEAP) tool, and the specialist units were found to have more supportive features in six of the dimensions in PEAP: awareness and orientation, safety and security, regulation of stimulation, quality of stimulation, personal control and continuity of the self. This study merely indicates that the dementia units were implementing the recommended design guidelines in common with many other care facilities: it does not test the efficacy of the recommendations.

Warren et al. (2001) compared care homes in Canada, which were orientated towards a social model of care, with 'SCUs' which operated according to a more medical model of care. They found that the social model, which included physical design features including a 'cluster' environment whereby people lived in smaller groups, provided greater independence for residents, who had more freedom and were less likely to

be taking psychotropic medications, despite being more frail than those living in the SCUs.

Swanson, Maas, and Buckwalter (1993) looked at the incidence of 'catastrophic reactions' of people with AD in an SCU when compared to 'traditional integrated' units in a single American long-term care facility. Catastrophic reactions were defined as reactions or mood changes in response to seemingly minimal stimuli characterised by weeping, blushing, anger, agitation or stubbornness. The study found that there was a greater reduction in catastrophic incidences in the SCU participants compared to the control group, despite larger increases in the numbers of interactions of participants in the experimental group with both staff and family. The authors concluded that modifying demands from both physical and caring environments can reduce stress, reduce inappropriate behaviours and promote functional adaptive behaviour, but that more research was needed into precisely which elements of the physical environment in combination with which caring strategies were most effective in reducing demands and stress.

Volicer et al. (1994) compared outcomes for people with diagnoses of probable AD in a dementia SCU and in traditional long-term residential care in two US Veterans Administration hospitals, finding superior outcomes for SCUs in terms of cost and resident discomfort but worse outcomes in relation to resident mortality. They noted the specialist training in dementia care for staff and the distinctive SCU philosophy which emphasised residents' comfort above maximal survival and in some cases precluded transfer to acute hospital settings, use of antibiotics and use of feeding tubes. They found that levels of observed discomfort were lower for SCU residents, as were numbers of acute hospital transfers and medical costs, amounting to an average 3-monthly cost difference of 1,477 USD per resident between settings.

However, residents of the SCU with lower levels of severity of dementia had a higher mortality rate than residents in traditional care.

The small feasibility study of Bianchetti, Benvenuti, Ghisla, Frisoni, and Trabucchi (1997) evaluated the SCU model in an Italian context. They found that residents transferred from traditional nursing home wards to SCUs exhibited significantly fewer behavioural problems, but this was likely to be the result of changes in caring practices and in particular lower use of physical constraints in the SCU compared to elsewhere in the home. Residence in an SCU was not found to improve functional abilities or cognitive status.

Skea and Lindesay (1996) compared a more social care focused care environment with a more nursing-orientated one, following the closure of long-stay psychiatric hospitals in Leicestershire where people with severe dementia had earlier been accommodated. They found better quality of life and more interaction taking place in the unit which was more social care focused. The nursing-orientated environment had small wards, shared by 4−6 people and a small number of single rooms, with a shared, separate dining and lounge area. The other unit consisted of house groups of nine people, each with a single en-suite bedroom, and there was a central lounge/diner with a kitchen for preparing snacks and drinks. The authors emphasise the differences in the models of care as being the decisive factors, rather than the design of the environment.

Morgan, Semchuk, and Stewart (2003) explored the physical and social environments of care homes located in a rural health authority area in Saskatchewan, Canada. The study included seven publicly funded care homes with spaces for 15−35 residents, none of which had separate provision for residents with dementia. Using the PEAP assessment tool, the authors found that the homes were most supportive in

provision of privacy and least supportive on maximising awareness and orientation. Six needs of residents with dementia perceived as difficult to meet in the homes were identified during focus groups with staff: two relating to the physical environment (safety and a calm, quiet environment) and four relating to the social environment (meaningful activity and one-to-one contact, opportunity to use remaining abilities, flexible policy and knowledgeable caregivers who enjoy working with persons with dementia). Staff acknowledged specialist provision for residents with dementia as one way of addressing needs, but saw this as presenting particular challenges in the context of smaller, rural care homes.

Annerstedt described 'group living', a new model of care developed for people with dementia in Sweden in the 1980s (Annerstedt, 1993, 1994). This was a type of small-group environment, in which each resident had an en-suite bedroom, and there was shared living room, kitchen and dining area. Within this setting, the care model emphasised a key worker system, the involvement of relatives in a person's care and a version of person-centred care, adapted to the resident's needs, wishes and preferences. Annerstedt is supportive of the group living model.

Jensen's (1997) report of a multi-method study exploring housing prospects for older people with dementia in Denmark suggests that at that time Danish people perceived the small-group houses of 6−8 people to be the best model of residential accommodation for older people with dementia.

However, Verbeek et al.'s (2010) study of the effects of small-scale living facilities on residents, their family caregivers and staff does not support the use of a small-scale living model. The study, which involved residents, staff and family carers in 28 houses with eight or fewer residents and 212 SCUs of at least 20 residents in larger homes providing nursing care for older people, found no significant effects of

small-scale living on quality of life or neuropsychiatric symptoms for residents, and no significant differences in job satisfaction and motivation between staff working in either type of facility, although it did find that family carers of residents in small-scale houses perceived less burden and were more satisfied with staff compared to family carers of people with dementia in special units. These results led the authors to conclude that although there appeared to be policy support for small-scale residential accommodation for people with dementia, other options for providing high-quality dementia care should be considered.

Several studies have sought to understand residents' needs in terms of care home environments at specific times. For example, the qualitative study of Aminzadeha, Molnara, Dalzielb, and Garciac (2013) regarding the needs and efforts of people with dementia trying to adjust to relocation to residential accommodation found that in order to recreate a sense of home, people needed to settle in, fit in and find meaning in the transition. Providing appropriately individualised and familiar physical environments can play a part in supporting people with dementia to reconstruct 'home' in a residential care environment.

Communication and Interaction

Research in this area suggests that environmental factors can influence the prevalence and success or otherwise of communication and interaction. These may be adversely affected by factors such as clutter, noise and poor lighting, with a more homely environment again being widely seen as beneficial.

Bruce, Brush, Sanford, and Calkins (2013) discuss environmental issues that can negatively affect communication for people with dementia, focusing in particular on the need for

speech therapists to be conscious of these and to address them. They evaluate the usefulness of their Environment and Communication Assessment Toolkit for Dementia Care (ECAT) with 71 speech and language therapists in the USA. They found that it raised awareness among them of the potential impact of environmental issues such as noise, lack of cues in the environment, poor lighting or clutter.

Increasing social interaction has been identified as a desirable outcome in more recent literature. Ferdous and Moore (2014) note that research in this area has been sparse, despite many authors emphasising the importance of social interaction for living better with dementia (although cf Peatross' (2001) exploration of the spatial and visual properties of buildings that have implications for space use, considered in the contexts of three dementia units and three juvenile detention centres in the USA). Their study, which used observational and space-syntax theories and methods, found that social interactions were promoted by greater possibilities for privacy, and in smaller spaces than in the expected more open and high visibility areas. Their work focused on the public areas of three long-term care facilities in the US, and raise further questions about other kinds of spaces in other settings, as well as settings that are more private. They make a strong case that this neglected area of attention needs further consideration.

Morgan-Brown and Chard (2014) suggest that the importance of social interaction for people with dementia has already been established. They found that changing two Irish nursing homes to a more 'household'-like design model, in which one member of staff was a 'homemaker' who served meals and residents could participate in everyday household activities, allowed for routines that were more flexible and provided residents with more activity support, interaction and choice in daily living. They concluded that the household

environments enabled residents to engage in more social interaction, and to initiate activities more frequently than in the older environments. The theme of 'homeliness' was reiterated in a study by Hutchings et al. (2011) of people with dementia who were relocated from a more institutional type of facility to a more homelike one, and showed positive impacts from the points of view of family caregivers.

Environmental Factors and Agitation

A number of studies set out to explore environmental factors which might give rise to agitation and environmental design modifications which might ameliorate any such effects. Researchers have linked agitation to lack of engagement and have debated the impacts of lighting and noise.

Kittur and Ruskin's (1999) study presented two case studies linking agitated behaviour by a person with dementia to self-misperception of their reflection in mirrors. A simple intervention in which all mirrors accessible to the case study individuals were covered completely alleviated agitation in both cases.

Sloane et al.'s (1998) observational study aimed to determine the point prevalence of agitated behaviours in a sample of 53 SCUs for people with dementia in care homes in the USA and to determine the extent to which agitation was associated with different aspects of the environment. The observers recorded observations of eight specific agitated behaviours and generated two indexes of resident agitation on each visit. They concluded that both the physical environment and the actions of staff may have significant impacts on agitation levels, and the provision of quality care requires simultaneous attention to the physical environment and to staff training, performance and satisfaction.

Zeisel et al. (2003) investigated environmental correlates to behavioural health outcomes of residents with AD in a purposeful sample of 15 SCUs in New England and eastern New York, USA. The study generated and tested an 'Environment–Behaviours' (E-B) factors model and associated hypotheses based on existing research. Included SCUs were chosen to maximise variability in independent environmental variables identified in the model but all met the same basic inclusion criteria: they operated as self-contained units, provided accommodation only for people with diagnoses of dementia, had dedicated staff, were physically distinct from the rest of the facility and restricted residents' movements to within the SCU unless accompanied by staff. The study found relationships between physical environmental factors and behavioural outcomes even when resident and other facility-level characteristics were taken into account. In particular, higher levels of privacy for residents, personalisation in bedrooms, a more 'residential' character to the SCU and an environment intelligible to residents were all associated with lower levels of aggressive and agitated behaviours and psychological problems. In addition, SCU environments with common areas that varied in ambiance and careful camouflaging of exits from the SCU were associated with lower levels of depression, social withdrawal and misidentification. The authors argue for considering environments as multi-faceted and assert that 'it is becoming increasingly clear that a combination of drug treatment, supportive environments, and focused caregiving approaches provides the highest likelihood that those with Alzheimer's disease can indeed live more satisfying lives' (Zeisel et al., 2003, p. 710).

Zuidema, de Jonghe, Verhey, and Koopmans (2010) similarly explored environmental correlates of neuropsychiatric symptoms in people with dementia receiving care in 56 SCUs with between 10 and 42 residents located in 26 different

nursing homes in the Netherlands. Their cross-sectional cohort study included two-week observations and assessments of 1289 residents using the Neuropsychiatric Inventory−Nursing Home version (NPI−NH) and the Cohen-Mansfield Agitation Inventory (CMAI), together with structured interviews with the licensed nurses who carried out the observations with a view to eliciting specific observations of all neuropsychiatric symptoms. They found that differences in the prevalence of neuropsychiatric symptoms between SCUs could not be fully explained by patient-related factors such as cognition and psychoactive medication. Whilst multi-level modelling suggested an influence of the environment, the correlates used in the study could not explain differences in symptom prevalence between SCUs. Residents in SCUs with higher staff-to-resident ratios showed less apathy, but in contrast to other studies such as Sloane et al. (1998), no association was found between number of patients per unit or per living room, the presence of a walking circuit, staff/patient ratio or the time spent on direct patient care and neuropsychiatric symptoms. The authors suggested that the explanation for different findings might lie in the fact that Dutch care homes generally have more than one SCU, so residents may have been placed in or moved to an SCU with the environmental features perceived to be most beneficial to them. They noted the relative lack of sophistication of their environmental measures as a limitation of the study. Zuidema et al. (2010) also noted that the SCUs in their study had a minimum of 10 residents and drew attention to the need to gather conclusive evidence of the effects of smaller units on neuropsychiatric units in light of policy in the Netherlands towards small-scale housing for 6-12 residents with dementia.

A series of studies by Cohen-Mansfield and colleagues have sought to explore the impact of different environmental

factors on the behaviours of people with dementia. The observational study of Cohen-Mansfield, Werner, and Marx (1990) of highly agitated care home residents in a unit for residents with cognitive impairments revealed links between physical locations and the incidence of specific agitated behaviours. They found that agitated behaviours occurred primarily outside of residents' own rooms; pacing was observed most frequently in the corridor, nurses' station and other residents' rooms; and verbally agitated and aggressive behaviours generally occurred in locations such as the toilet, where residents might be in need of help. They observed fewer incidents of agitated behaviours in the more dynamic environment of the activity room compared to the corridor. Their findings cast doubt on the hypothesis that agitated behaviours are prompted by change and/or lack of familiarity.

The controlled clinical study of Cohen-Mansfield and Werner (1998) looked at the effects of enriching the environments of older care home residents who pace and wander using visual, auditory and olfactory stimuli suggestive of two different familiar environments: 'homely' and 'nature/outdoor', respectively. They found that residents seemed to prefer the enhanced environments, choosing to sit and to spend more time in them, and concluded that enhancing the typical care home environment can reduce pacing and lead to improvement in residents' mood.

Later, using a randomized, controlled, observational cross-sectional study design involving 193 people with dementia living in seven care homes, Cohen-Mansfield et al. (2012) sought to explore the impact of personal attributes, environmental attributes and the presentation of different categories of stimuli on agitation in care home residents with dementia. They found that personal and stimulus attributes independently and concurrently predicted levels of agitation, with higher cognitive functioning and ability to carry out

ADLs associated with lower agitation and all stimuli except music significantly reducing total agitation. Lighting, background noise and number of persons in proximity were not associated with significant changes in agitation levels, although the authors suggested that this might be due to limited variation in variables during trial and reliance on subjective measures. Levels of engagement were a significant predictor of agitation, with high levels of engagement leading to lower levels of agitation, but low levels of engagement prompting more agitation than no engagement. They saw their results as supporting the hypothesis that physical agitation is prompted by lack of activity and boredom and that with verbal agitation, it occurs as a result of other unmet needs such as discomfort or loneliness.

The conclusions of Cohen-Mansfield et al. (2012) with regard to lighting seem to contradict the findings of La Garce (2004), who describes a controlled clinical trial of the effects of specific lighting interventions on the disruptive behaviours of care home residents with probable AD which controlled for the natural afternoon daylight effects in an interior environment. That study demonstrated an average reduction of 49.5% in disruptive behaviours while participants were in an experimental environment with the designed lighting interventions in place, and concluded that daylight control interventions may have a positive impact on managing behavioural disturbances of the Alzheimer's type.

In an observational study involving residents with dementia living in four care homes in Wisconsin, USA, that appears to contradict the findings of Cohen-Mansfield et al. (2012), Joosse (2012) found that sound level was a significant predictor of agitation and that accumulation of sound explained 16% of the observed variance in agitation. The findings of this study thus support design for ameliorating sound levels in care home settings. In their description of a case study

intervention to improve care for a woman with dementia with Lewy bodies (DLB), Huh, Areán, Bornfeld, and Elite-Marcandonatou (2008) observed that results from the Motivation Assessment Scale suggested that noisy and busy environments were triggers for the woman's calling out and/ or repeatedly striking doors and expressing her need to escape from such situations. They reported that the incidence of these behaviours was reduced when, as part of the multi-stranded intervention, caregivers continually adjusted their physical environment where possible to provide a quiet and calm space.

Hospitals

Literature specifically about environmental design in hospitals is limited, with some studies critical of existing environments, including Digby and Bloomer (2014) and Hung et al. (2014).

Digby and Bloomer (2014) consulted people with dementia and their families about the design of a new hospital assessment unit. The novelty of their study was to include the views of people with dementia. Seven people with dementia and four carers were interviewed about their preferences, and identified 'homeliness, privacy for the patient and for conversations, a shared space without a television and a connection to the outside' (p34) as important for them. They added that the hospital should also consider carers and provide quiet spaces and suitable amenities for them. Although this study was small, it does echo themes that appear in other research, notably the mention of 'homeliness' (see section on care homes) and respondents' initial comments that the quality of care was what mattered to them most (also noted elsewhere).

Hung et al.'s (2014) small study looked at the preferences of patients (including some with dementia) and their families

in a geriatric psychiatry unit. The study highlighted key positive features as being quietness and calm, support for people to be as independent as possible and 'sensory stimulation', that is, something of interest in the environment, including social interaction with relatives and others and, interestingly, minimal disturbance and disruption caused by confused patients, who might be calling out loudly. Provision of the latter is likely, we would suggest, to relate to the quality of care (as highlighted by Fleming et al.).

Other studies have attempted to address problems with hospital environments. For example, Zieschang et al. (2010) explored the feasibility of creating an SCU for patients with challenging behaviours resulting from dementia and/or delirium admitted for treatment to an acute care hospital in Heidelberg, Germany. Prompted by a hospital staff survey which highlighted the need for better care for such patients in that geriatric acute care setting, a six-bed SCU was created on one of the acute care wards by creating a secure section closed to through-traffic and accessed via a codelocked door. A 'living room' was provided within the SCU with homelike furniture and furnishings and a table around which patients could eat shared meals. Meaningful activities were scheduled and provided throughout the day. Pre- and post-test patient function, mobility and behavioural data were collected on 332 patients treated in the SCU over 30 months (75 nursing home residents and 248 community-dwelling patients), and length of stay (LOS) data were extracted from hospital records. Dementia was diagnosed in 86% of patients admitted to the SCU and delirium in 58%, with delirium superimposed on dementia occurring in 163 patients (57% of patients with dementia). More than a quarter of the patients treated in the SCU were referrals from other hospitals or emergency departments. Mean LOS did not vary significantly between the SCU and elsewhere in the hospital, contrary to

other studies (e.g. Lyketsos, Sheppard, and Rabins (2000) which had found hospital LOS to be longer for patients with dementia. Median scores in ability to perform ADLs and mobility improved significantly between admission, with incidence of wandering, aggression and agitation all reducing (from data available for 270 patients). The authors concluded that patients benefitted from treatment in the SCU, that functional decline during hospital stays can be avoided by improving the environment and staff interaction with the patients, and that given the relatively modest costs of creating the SCU and providing daytime activities and the absence of higher LOS reported in other studies, the SCU might also represent a cost-effective model for acute hospital treatment for people with dementia.

Another example is Waller (2012), who provides a short report describing the 'Enhancing the Healing Environment' programme (EHE), a nurse-led initiative to encourage staff to work in partnership with patients to improve the environment in which they deliver care funded by the Department of Health and delivered via The King's Fund, and including a description of Bradford Teaching Hospitals NHS Foundation Trust's improvement of the physical environment of two wards in Bradford Royal Infirmary to better support people with dementia as a case study example of the work of the programme. Projects to improve support for people with dementia in hospital environments have often included de-cluttering areas to increase space; changing colour schemes for interest and to support wayfinding; providing improved signage; improving lighting and installing more flexible lighting schemes; reconsidering flooring and sanitaryware with users with dementia in mind; and providing handrails and seating areas to encourage patients to remain active. Waller reports that an environmental assessment tool (EAT) is being developed with participating trusts as part of the EHE programme

(a range of EATs including two for use in a hospital context is now available from http://www.kingsfund.org.uk/projects/enhancing-healing-environment/ehe-design-dementia).

Mazzei, Gillan, and Cloutier (2013) focused on the design of acute care geriatric psychiatry units, observing that in the Canadian 'purpose-built' unit they observed, their six participants were less likely to try and leave, and less likely to move about in ways indicating distress or agitation (termed 'wandering' and 'pacing'). The design modifications in the new unit included murals to camouflage external doors, a circular pathway, en-suite bedrooms instead of a shard 4-bedded ward and an outdoor patio. Acknowledging that their study did not explore the reasons for wandering and pacing, and that these are often rational and purposeful, they argue that the design modifications they tested appear to show some benefit. Like others, they provide little information about the possible impact of the care provided in this new unit, focusing instead only on the physical changes that were made. This does limit the generalisability of the study and the reliability of its findings.

The qualitative study of Spencer, Foster, Whittamore, Goldberg, and Harwood (2013) explored the impact of environmental changes made to a hospital ward for people with dementia. Whilst the modification of the previously bland and uninteresting environment by introducing colour and interesting objects (such as reminiscence boxes for each patient) was appreciated by family carers, the level of engagement with them by staff and their involvement in the care of their relatives was still considered insufficient. This is a further demonstration that environmental changes can make a difference, but that the models of care being used are also influential.

Edgerton, Ritchie, and McKechnie (2010) report the outcomes because of redesigning a corridor in a psychiatric

hospital. The redesign involved 'de-institutionalising' a long central corridor, breaking up the space, introducing colours (especially blue and green) to link with the outside courtyard garden space, and to 'bring in a sense of nature'. There was no increase in the number of patients using the corridor after the redesign, but those who did use it said they found it more pleasant and interacted more whilst in it, suggesting improved well-being. The staff however found the corridor less appealing after the redesign, emphasising as the authors note that what suits people with dementia may not necessarily fit the preferences of staff.

The study of Margot-Cattin and Nygard (2006) in a secure unit for people with dementia explored the impact of access control technology, which used a system of chip cards to allow authorised access to spaces throughout the unit, and aimed to reduce the locking and unlocking of doors. Residents were able to move around more freely, though there were issues related to people throwing the cards away, as they did not understand what they did. Overall, the system appeared to yield positive results, enabling residents to move about more easily, providing a sense of privacy in their own rooms. The authors caution however that the use of a system of this kind requires careful thought – it could be used to increase control and reduce autonomy for example – and that more research is therefore needed. This echoes the issues in relation to camouflaging doors, which may be positive or negative.

Focusing on an individual item, in contrast to other studies, Duffy, Mallery, Gordon, and Carver (2005) indicate that people with dementia who are in hospital may be unable to use their call bell and therefore unable to summon help if they need it.

Kitchens

Whilst much design guidance has focused on kitchens, relatively little research has done so. Underlying principles of safety, support for order and structure, simplicity and ease of understanding, and guidance have been identified to inform design decisions about kitchens that are appropriate for people with dementia, termed 'cognitive kitchens'. Several potentially effective measures for 'therapeutic kitchens' in care settings have been identified by studying current practice. These include a 'homelike' ambience, accessibility (using universal design features) and address to issues of safety. All of these can be accomplished in a variety of different ways.

Noting that guidelines have often promoted the idea of including a therapeutic kitchen in a long-term care facility, Marsden, Meehan, and Calkins (2001) noted that these had been lesser specified and under-researched. Their study, which used a survey and a series of site visits, identified a wide range of practice and many different features that had been included in kitchens. Exploring the use of the kitchens, they report that the more popular activities for residents in care facilities are the more recreational ones, such as baking, rather than more routine chores, and that the kitchens are not always part of the main food service system in the facilities, but supplementary. They recommend that the kitchen is part of the main food service provision, noting the smell of the food, the possibility for residents to take part in its preparation and the staff—resident interaction which is thus promoted, are particularly positive features.

Johansson, Lundberg, and Borell (2011) introduce the idea of the 'cognitive kitchen'. Their starting point is an analysis of the key aspects of the kitchen in the home — food storage, preparation and consumption, social activities and as

a hub for organising family life. For a kitchen to support cognitive capacity, they identified four elements – safety, support for order and structure, simplicity and ease of understanding and guidance. They then use these underlying principles to suggest kitchen design features, such as, for example, for simplicity, appliances that have basic controls with clarity of on/off switches, and for safety, automatic switching off after a certain period of operation. This approach, which identifies principles and then considers how they might be implemented is particularly promising.

Mealtimes and Eating

Linking to some of the points made about kitchens, research suggests that design and environment can influence the nutritional intake of people with dementia as well as their enjoyment of food. Again, there is mention of more 'homely' environments, and 'family-style' mealtimes, sometimes involving staff sharing the meal, with the use of regular crockery, cutlery and glassware, and serving food from dishes, rather than pre-plating it.

Amella and Batchelor-Aselage (2014) stress the need for an individualised approach to modifications to support people with dementia at mealtimes, and suggest a multi-stranded approach to facilitate dining in which the physical environment is only one element. Their 'C3P Model' (change the person; change the people; change the place) highlights the need to consider how best to support the dining experiences of people with dementia in a more holistic way.

Andrews (2000) draws on personal experience to illustrate a more holistic approach to optimising residents' nutritional intake, recommending that in addition to aspects of the physical dining room setting such as size and ambient noise levels,

it is also necessary to consider whether the normal routines of care home staff during mealtimes could be made more supportive and to consider the needs and preferences of the individual, for example by providing a larger breakfast for people who find eating a full meal later in the day more challenging. Bakker (2003) similarly notes the influence of different design factors in nutritional status as part of a more general discussion of sensory loss, dementia and environments. She identifies 'lighting, table and tableware, food choice and appearance, cueing and tablemates' as all playing a part in how a person with dementia experiences mealtimes.

Various more specific issues have been covered in relation to mealtimes and eating, and these provide helpful indications for designing mealtimes and dining rooms.

Pouyet, Giboreau, Benattar, and Cuvelier (2014) note that finger foods may be helpful for people with AD who find using cutlery increasingly difficult. Their study explored which kinds of foods were preferred in eight nursing homes in Paris. This study is important for drawing attention to issues about the presentation and appeal of food for people with dementia, which may change during their dementia journey.

A study by Nijs, de Graaf, Kok, and van Staveren (2006) examined the effects of 'family-style mealtimes' on quality of life, physical performance and body weight of residents living with chronic somatic diseases in Dutch care homes. A total of 95 residents took part in 'Family-style mealtimes' which involved tables set with tablecloths, glassware, crockery and cutlery and napkins, a choice of cooked foods served from dishes and with staff sitting with residents and no clearing up until everybody was finished. A total of 83 residents were in the control group, which received a 'pre-plated' mealtime. This involved meals which were chosen a fortnight in advance sidents being served to residents who were required

to wear bibs by staff who did not sit down at mealtimes. The meals were served pre-plated on trays at tables with no table-cloths and plastic drinking glasses were used. Ready-to-eat sandwiches were served at breakfast and supper times. They found that family-style mealtimes prevented a decline in the quality of life, physical performance and body weight of care home residents. The authors suggested that in their view their principal conclusion could be extended to all care home residents. Importantly, they also acknowledged that 'The protocol we used has to be considered as one package as we cannot say which part of the intervention protocol had most effect on the residents' (Nijs et al., 2006, p. 4).

Roberts (2011) also compared the 'usual' dining experience for residents of an SCU for 50–60 people with dementia in the USA with one which echoes Nijs et al.'s 'family-style mealtimes'. In this case, the intervention was an invitation once a week to six different residents to have lunch with the activities director in a more intimate kitchen/dining room setting where meals were prepared with residents in attendance and served from dishes rather than the pre-portioned plates provided in the home's main dining room. Her observations found that whilst mealtimes were highly anticipated in both settings, residents at the special lunches were more animated and engaged, talked more and were interested in staying after the meal had finished. She concluded that complex relational ties between the operational, managerial and environmental features of the settings determined residents' social interaction and satisfaction with their mealtime experiences.

Carrier, West, and Ouellet (2009) explored relationships between food service in residential care settings and the quality of life in care settings, finding that many aspects of food service made differences to quality of life. For people with dementia, factors enhancing quality of life included dining companions, autonomy in eating, sufficient staff, china dishes (rather than plastic) and menu variety.

Cleary (2009) describes one case study of a person with dementia experiencing dysphagia (difficulty swallowing) due to dementia, identifying practices which supported them to eat better. These included providing one item of food at a time, a barrier around the place setting (which helped with concentration) and a seat which faced the side of the dining room to minimise distraction. The person was able to eat more successfully with these arrangements.

Wong, Burford, Wyles, Mundy, and Sainsbury (2008) set out to identify ways to improve the nutrition of patients in a hospital. Several measures were found to be helpful, including permitting 'grazing', assistance with feeding by volunteers and playing 'soothing' music at mealtimes. They were able to demonstrate an increase in caloric intake with these measures. In a small study with 12 participants observed over 24 meals Thomas and Smith (2009) also found that music during mealtimes promoted nutrition, with subjects consuming 20% more calories when familiar background music was played compared to an eating environment without music

Nolan and Matthews' (2004) study addresses the issue of resident agitation regarding mealtimes, such as uncertainty (and consequent repeated asking about) when meals would be ready and about the timing of meals. They simply provided a clock and a clear sign with the information on it. This very simple measure did reduce the levels of agitation, and in doing so, helped staff–resident interactions.

Multi-sensory Environments

'Snoezelen' rooms or multi-sensory environments have long been considered by some as having positive effects for people with dementia. Research findings have been varied, and

overall do not suggest that these are markedly effective, or cost-effective. Some examples are given below.

Maseda, Sánchez, Marante, González-Abraldes, Buján et al. (2014) conducted a small (30 participant) controlled longitudinal trial of such a multi-sensory environment. Whilst those participants experiencing the multi-sensory environment did show improvements in non-aggressive behaviour and in agitation scores, these were not significantly different from those in the group receiving an alternative activity intervention and the control group, respectively.

A second study by Maseda, Sánchez, Marante, González-Abraldes, de Labra et al. (2014) sought to compare the effects of multi-sensory stimulation in a multi-sensory stimulation environment (MSSE) such as a Snoezelen room and one-to-one activity sessions on mood, behaviour, heart rate and blood oxygen saturation. A total of 20 care home residents with diagnoses of dementia were assigned to one of two treatment groups and took part in two sessions of up to 30 minutes per week for 16 weeks. Both treatments involved one-to-one sessions with a therapist. Participants in the MSSE group were exposed to a range of visual, auditory, olfactory and tactile stimuli; those in the activity group were asked to take part in and directed through a range of activities such as playing cards, quizzes or viewing photographs. Participants in both groups were observed to be speaking more spontaneously, relating better to others, more attentive to their environments, more active/alert, less bored/inactive and more relaxed/content immediately after their treatments, and both groups exhibited lowered heart rates and increased oxygen saturation values immediately after when compared to before-treatment sessions. The absence of differential results for the two groups led the authors to conclude that environment is not the determining factor in meeting target outcomes

and that one-to-one interaction with the therapist is the therapeutically active factor on behaviour and physiology.

Further studies have produced possibly disappointing results for advocates of multi-sensory environments. They include Anderson, Bird, MacPherson, McDonough, and Davis (2011), who compared a Snoezelen room with provision of garden access. They were unable to find differences in the impacts of these environments, one of which contained expensive equipment, and the other of which (the garden) was much cheaper to provide. They note that simple, cheap measures may be as effective as costly specialist developments. Riley-Doucet (2009) explored the use of multi-sensory environments in people's own homes, with mixed results. Whilst carers reported that the intervention promoted a calm and relaxing environment, they did not find it provided them with respite. Ward-Smith, Llanque, and Curran (2009) found that the use of a multi-sensory environment in a care setting reduced but did not eliminate incidences of 'disruptive behaviour' including shouting, hitting, escape attempts, pacing and aggression. In a short-duration intervention study, Goto, Kamal, Puzio, and Kobylarz (2014) compared the responses of 36 care home residents with advanced dementia to a Snoezelen room and a temporary indoor Japanese garden, respectively. They found that residents' heart rates during visits to the garden were significantly lower than when measured in their own rooms, but no similar effect was observed for the Snoezelen room. Behaviours towards the garden room were generally positive, compared to neutral or negative responses to the Snoezelen room. Negative behavioural signs were also observed when residents were returned to the garden room once the intervention had been completed and the installation had been removed. Unusually, Cox, Burns, and Savage (2004) found that a Snoezelen room, a garden and the living room of a care home all produced improved affect

for residents with dementia. Exploring this further through qualitative interviews however, they concluded that it was the approach of the caregivers that was most significant in promoting the beneficial effects.

Outside Spaces

The significance of and value attached to outdoor environments for people with dementia has attracted increasing attention and is demonstrated for example in the interviews by Duggan, Blackman, Martyr, and Van Schaik (2008) with people having early dementia. They report that going outside is valued for exercise, fresh air, meeting neighbours, enjoying the countryside and emotional well-being: as dementia develops, opportunities to enjoy these benefits can decrease, leading to reduced quality of life.

An early study by Mooney and Nicell (1992) investigated the importance of exterior environments for care home residents with AD. In comparing incident reports for homes with and without access to specially designed outdoor spaces, the authors found that specially designed exterior environments could help to reduce incidents of aggressive behaviour and that designing keeping in mind users with dementia could both improve access and use by residents and contribute to the management of risks of using outdoor spaces. Later studies have shown similar results. For example, Detweiler, Murphy, Myers, and Kim (2008) and Detweiler, Murphy, Kim, Myers, and Ashai (2009) explored the relationship between the use of a 'wander garden', falls and levels of psychiatric medication for residents in a dementia care setting, finding that those who used the garden more often had reduced levels of medication and fewer falls. The earlier study demonstrated a reduction in agitation. Edwards, McDonnell,

and Merl (2012) considered the impact of a therapeutic garden on quality of life for care home residents, demonstrating improved quality of life, reduced depression scores and reduced agitation scores, as well as positive findings from qualitative interviews with staff, residents and family members.

Beckwith and Gilster (1997) present the 'paradise garden' as a model for gardens for people with dementia. They argue that the paradise garden has been shaped by deeply ingrained human survival instincts to which people respond at a subconscious level and that the key elements of enclosing wall, water, canopy and a mount or hill, can be found in gardens throughout recorded history.

Moore (2007) draws on Kaplan's Attention Restoration Theory (ART) to both explain the therapeutic effects of gardens for people with dementia and to provide design guidance for outdoor spaces for use by this population in terms of the four key elements of restorative environments identified in ART, namely: being away, fascination, extent and compatibility.

Hernandez' (2007) post-occupancy evaluations of the outdoor spaces of two SCUs of assisted living facilities for people with dementia in Midwest USA also considers the role of gardens in the therapeutic restoration of people with dementia and critically examines how well therapeutic spaces are integrated into the designs of outdoor spaces in this context. The author concluded that 'therapeutic gardens' directly impact the quality of life for residents, staff and family members, that they should be incorporated as standard in any residential accommodation for people with dementia and that architects, healthcare professionals and (unusually) residents should all be involved in the design of such spaces.

Heath's (2004) post-occupancy evaluation of a garden attached to a care home in British Columbia uncovered

several negative aspects which are instructive for other designs of garden. This garden had eight separate areas, each designed for a different purpose, such as contemplation, pleasure, socializing and also with one section in which residents could take part in their hobby of gardening. Some important issues related to accessibility were that residents had some difficulties accessing the garden, partly because staff did not have time to escort them. The 'hobby' garden was fully planted, which made it difficult for residents to garden themselves. There was little open space, and residents and family visitors suggested that the garden was too elaborate.

The qualitative study of Lovering, Cott, and Wells (2002) of an outdoor space, specially designed to improve the quality of life of people with dementia and conducted three years after it was built, drew on landscape architectural drawings, non-participant observation, focus groups and in-depth interviews to understand how the garden was being used and whether it was fit for its intended purpose. The authors found that in order to sustain its successful use, such a space needed to be viewed by the organisation as an integral part of the institution and services; designed in accordance with agreed principles for dementia-friendly outdoor spaces; used in the delivery of support by staff with the creativity, knowledge and skills to maximise the garden's potential for promoting residents' well-being; and maintained in a way that is integrated with users' needs and reinforces dementia-friendly design principles.

Public outdoor spaces have received less attention: Brittain, Corner, Robinson, and Bond (2010) noted that the outside public environment can sometimes be challenging for people with dementia who may feel rather 'out of place' and frightened, and therefore may not realise the benefits of going out and about. They identify the potential of everyday

technologies to support people when they are in outside public spaces and note that several respondents used mobile phones as supportive technology when going out. Against the background of perceived hostile outside public spaces, Mitchell and Burton (2010) considered ways to make neighbourhoods more dementia-friendly, that is to say 'welcoming, safe, easy and enjoyable'. They referred to six previously identified (Mitchell et al., 2003) principles of design which if fully addressed would create developments with dementia-friendly characteristics, namely 'familiarity, legibility, distinctiveness, accessibility, comfort and safety'. They make detailed recommendations for the design of neighbourhoods, including irregular street patterns, buffer zones between footpaths and traffic, seating, signage, appropriate surfaces for walking and many others. This detailed, research-based guidance is particularly comprehensive, and it is possible to see how the recommendations derive from the research conducted. It is supported by other work such as Blackman, van Schaik, and Martyr (2007) which used virtual reality to test what people with dementia found more comfortable in the external environment.

Other Services

Material on services other than care homes, care at home and hospitals is rare. Here we list the examples included in the review, which echo widespread reference to the need for a familiar environment that can support choice and privacy.

Liou and Jarrott (2013) compared two adult day care facilities in Taiwan, one using a more medical model of care in a hospital setting and the other being more homelike. Whilst they recommend the more homelike setting in their conclusions, they note that both settings display evidence of infantilization of elders with dementia, lack of dignity and

lack of autonomy. This emphasises that the environment alone cannot ensure appropriate care: staff attitudes and behaviours are also important. They suggest that an appropriate environment is necessary but not sufficient, echoing other findings which have referred to the care regime.

Reimer, Slaughter, Donaldson, Currie, and Eliasziw (2004) explored the quality of life of people with dementia living in a care facility which had six bungalows with on-site care, as compared with more traditional institutional environments. They identified positive impacts on quality of life, which they attribute to more homelike arrangements, greater choice and privacy and more meaningful activities. This work resonates with the studies which looked at changes in care home design and their impact.

Particular Items

Several items included referred to particular details of design or single-item interventions that were suggested to offer a range of benefits. Whilst in several cases the research findings were plausible, they were not necessarily able to explain how the benefits worked, or what it was about the items that had the effect.

One example of this is a set of papers about aquariums (Edwards, Beck, & Lim, 2014 and others). They introduced aquariums into several care settings and found improvements in various behaviours of the residents with dementia, including 'uncooperative', 'irrational', 'inappropriate' and sleep behaviours. Aside from the value assumptions entailed in these descriptions of behaviour (see cross-reference), the study is unable to elucidate whether for example the effects are specific to aquariums (to do with the movement of fish perhaps) or whether simply having something novel and

interesting in the environment was making a difference. In another study (Edwards & Beck, 2013), they observe a relationship between the presence of an aquarium and improved daily food intake among dementia unit residents: in this paper, they suggest that the appeal of the aquarium is due to an innate attraction to the natural environment. Their findings do not support this assertion.

Chang, Lu, Lin, and Chen (2013) look at the effect of visual arts on care home residents' satisfaction with their living environment. They find that an arts-based intervention integrating the four storeys of a Taiwanese care home through visual art, reminiscence and gardening based on the local culture and history created a hospitable and familiar environment and significantly improved residents' recall of past events.

Quality of Life

Much of the literature focuses on outcomes such as reducing agitation, supporting wayfinding and compensating for various problems that people with dementia may experience. Surprisingly few researchers have explicitly considered the quality of life of people with dementia. This is an important but somewhat neglected outcome.

The DICE study (Parker et al., 2004) is a landmark study of relationships between care home environments and residents' quality of life. The environmental measurement tool was SCEAM (the Sheffield Care Environment Assessment Matrix), which was generated from existing measures and literature review to highlight design features that were relevant for residents of care homes. SCEAM is a complex and comprehensive tool which lists several design domains (privacy, personalisation, choice and control, community, safety and

health, support for physical frailty, comfort, support for cognitive frailty, awareness of outside world, normalness and authenticity and provision for staff), each with multiple features, against which the environments were assessed. They found that the tool was capable of identifying features which promoted quality of life and recommend its wider use for assessing care environments, including those where people with dementia live.

Fleming, Goodenough, Low, Chenoweth, and Brodaty (2016) explore the impact of the environment on quality of life for people with dementia. They note that whilst many design features have been shown to assist with some of the problems that people with dementia experience, little work has specifically considered issues of quality of life and how environment can affect that. At their time of writing, they identified that there were no studies that had found clear relationships between improved environmental quality (improved that is according to literature on designing environments for people with dementia) and the quality of life of people with dementia. Researchers had tended to focus on single elements of design and had been able to demonstrate some positive effects. We would add that, given the difficulties of isolating particular effects in care environments, Fleming et al.'s (2016) novel approach is well-merited. They use the Environmental Audit Tool (EAT) to assess the environments: this focuses on unobtrusive safety features, small size, good visual access, enhancement of helpful cues, reduction of unhelpful stimulation, familiarity, provision of an interesting internal and external pathway, links to the community, provision of space to be alone and with others and provision of opportunities to engage in the ordinary ADLs (2016, p. 665). DEMQOL (Smith et al., 2007) was used to measure quality of life. Their study managed to find support for the hypothesis that improved environment can enhance QoL (bearing in

mind of course that the measures were defined in particular ways). They acknowledge that their findings contradicted earlier work that had been unable to demonstrate such an association. They also acknowledge that their study did not consider the quality of care in the environment, a factor which other works suggest to be highly significant.

Slaughter and Hayduk (2012) demonstrated that environments could have at least as great an effect as cognitive status in delaying or promoting the onset of walking and eating disability for people with dementia in their study of 120 people with dementia in 15 Canadian nursing homes. Using the PEAP (Norris-Baker, Weisman, Lawton, Sloane, & Kaup, 1999), an instrument which focuses on nine environmental issues (awareness and orientation, safety and security, provision of privacy, regulation of stimulation, quality of stimulation, support of functional abilities, opportunities for personal control, facilitation of social contact and continuity of the self with the past through personal and familiar objects), they were able to show that environment did have significant effects, and that recommended design features could thus prevent disability onset. PEAP is a well-validated tool for measuring environments in care facilities, and this study is therefore important.

Sensory Issues

Bakker (2003) notes that dementia 'significantly change[s] how people interpret what they see, hear, taste, feel and smell' and that the ability of people with dementia to interpret sensory information is 'highly individual and in constant flux' (Bakker, 2003, p. 46). This is not generally acknowledged in the studies reviewed, though several have explored

sensory changes experienced by people with dementia, and how environments may mitigate these.

Wijk and Sivik's (1995) pilot study of colour perception in 12 people with AD relative to a matched control group with no diagnosis of dementia suggested that participants with dementia were as able to remember the names of and identify common colours and discriminate between relatively similar colours and had broadly similar colour preferences to the control group when selecting the 'most beautiful' from a list of selected colours, with blue, red and green being preferred to orange, yellow and brown. The authors concluded that people with dementia may become more dependent on colour information as their cognitive impairments become more severe, but cautioned that colour and contrast in the environment have the capacity to both guide where used well and confuse where used poorly.

Burke (2003) also recognises the potential importance of colour, arguing that people with dementia primarily rely on vision for daily wayfinding tasks, and since the majority of people with dementia will have reduced visual abilities, colour and tonal contrast assume greater significance. Tonal contrast strategies should be addressed at the commencement of the design process, and aesthetics should be considered only after the needs and abilities of those who will be living in the accommodation have been taken into account.

The work recently completed at Stirling funded by the Thomas Pocklington Trust (Greasley-Adams, Bowes, Dawson, & McCabe, 2014) provides detailed, research-based recommendations for design for people with dementia and sight loss. It considers lighting, colour and contrast, entrances and exits, outside spaces, kitchens and bathrooms, providing suggestions in each of these areas. This is one of few pieces of work that particularly emphasises that what suits one person

with dementia may not suit another, and the resultant need for judgement in implementing design guidelines.

Other work has covered a range of sensory issues. Several items focused on lighting, with rather mixed results, though effects of lighting on sleep and circadian rhythms were reported.

Rheaume, Manning, Harper, and Volicer (1998) report on three case studies which demonstrated the beneficial effect of light therapy, one of which also suggested that light therapy could be effective in the treatment of agitated behaviour.

The RCT of Riemersma-van der Lek et al. (2008) sought to understand the effects of bright light and melatonin on cognitive and non-cognitive functions of older care home residents in the Netherlands. A total of 189 residents of 12 residential facilities were involved. Facilities were randomised to either whole day bright light (approx. 1,000 lux) or dim light (approx. 300 lux) conditions delivered via light installations in common living rooms where participants spent much of their time, with residents randomised to receive evening doses of melatonin or a placebo pill. The study found that bright light had a modest benefit in improving some cognitive and non-cognitive symptoms of dementia. Melatonin in combination with bright light had positive effects on agitated behaviours and sleep-related measures, but melatonin alone had negative effects on mood. The authors recommended that bright light be considered for use in care homes of residents with dementia, but that melatonin supplements should be at low dosages and only be given in combination with light therapy.

Nowak and Davis (2011) explore the impact of therapeutic lighting on sleep patterns of people with dementia, involving 20 women with AD in an experimental study complemented by qualitative interviews. The study indicated that the lighting appeared to improve sleep patterns, cognition

and mood. Despite some limitations, including small sample size, this study showed positive results.

Barrick et al. (2012), however, explored the effect of bright light therapy on agitation. They found that it did not reduce agitation, and could in fact increase it. However, van Hoof, Aarts, Rense, and Schoutens (2009) explored bright ambient lighting of bluish and yellowish light and their effects on restlessness and circadian rhythms. Contrary to Barrick et al.'s (2012) work, they found that the bluish light appeared to improve restlessness.

Sloane et al.'s (2007) study similarly aimed to examine the impact of bright ambient lighting for sleep and circadian rhythms of people with dementia. Their results indicated a 'modest but measurable effect', improving night-time sleep for several minutes, and circadian phase advances for a mean 29 minutes (morning) and 15 minutes (evening). Gasio et al.'s (2003) small-scale study (13 participants, 3-week intervention period) demonstrated that circadian timing system remains functionally responsive in people with dementia and low-intensity dawn–dusk simulation positively affects aspects of sleep compared to a dim red light control condition. In particular, the main sleep episode occurred 1.14 hours earlier, lasted for longer and was accompanied by longer periods of immobility and reduced nocturnal activity.

However, Ancoli-Israel, Martin, Kripke, Marler, and Klauber (2002) conducted an RCT of increased exposure to bright light to try and improve sleep and circadian rhythms in care homes for people with dementia. They were able to show improvements in circadian rhythms, but not in sleep. The RCT of Lyketsos, Veiel, Baker, and Steele (1999) with regard to bright light therapy, whilst very small (only eight participants completed the study), was able to show improvements in sleep patterns for people with dementia who had been agitated.

Ancoli-Israel et al.'s later study (Ancoli-Israel et al., 2003) compared the effects of morning and evening bright light exposure to a control condition equivalent to normal care home lighting levels. They found that both morning and evening exposure to bright light did not affect total daily sleep or wake time but both resulted in better night-time sleep consolidation, that is, participants experienced fewer but longer bouts of sleep. Based on their findings, the authors recommended that care homes consider increasing ambient lighting in multipurpose rooms, where care home residents with dementia spend much of their time during the day, as potentially the most-efficient approach for improving sleep and circadian activity rhythms for residents with dementia.

More broadly, Wong, Skitmore, Buys, and Wang (2014), working in Hong Kong, explored which aspects of care environments made the difference in terms of adverse incidents (particularly focused around patient behaviour) experienced by staff in four long-term care facilities. These staff reported that heating/air conditioning, lighting and noise appeared especially significant, and the authors produce a set of guidelines to alleviate some of the problems identified, such as minimising noise, maintaining an even temperature and ventilation quality and others. It is notable that several of the problems identified and the solutions suggested are specific to the context: for example, there is a suggestion to reduce the numbers of people sharing rooms and to paint beds different colours so that they can be more easily located by residents.

van Hoof, Kort, Hensen, Duijnstee, and Rutten (2010) focused on heating issues, noting that people with dementia may have altered thermo-regulation, and the need for protection against extremes of heat or cold. Using literature review and reanalysis of qualitative data, they identify a range of issues around temperature in environments and a wide range of preferences and issues. They acknowledge however that

given the current state of knowledge, they can suggest little more than a need to pay attention to these potential issues, and to use 'trial and error' to ensure people with dementia are not being distressed by ambient temperatures.

Garre-Olmo et al.'s (2012) examination of the impact of environmental factors on quality of life for care home residents in eight Spanish care homes produced significant results regarding temperature, noise and lighting: hot rooms and high noise levels had negative effects as did low-lighting levels in bedrooms.

The small study of building materials by Hwang (2014) notes that perceptual disturbances of people with dementia need to be considered when choosing building materials, as materials with pronounced, irregular lines or criss-crossing patterns may be linked to disturbance. This would be confirmed by Greasley-Adams et al. (2014).

Support at Home

Support at home and consideration of the domestic environment were early concerns of the design literature. Gitlin and Cocoran's (1996) early study was one of the first to consider environmental modifications at home as potentially supporting care and maintainance of people with dementia at home. They recommend a series of modifications to objects (e.g. disabling some appliances for greater safety or removing clutter to improve wayfinding), measures to make tasks easier (using verbal coaching and/or written and tactile cueing, providing one item at a time during dressing), the use of assistive devices (such as grab bars, safety locks, stair lifts, etc.) and home alterations (including widening doorways, installing ramps and stairways). They see these modifications as having potential to improve carer well-being.

A study from the same period (Mann, Hurren, & Charvat, 1996) tracked changes in assistive device usage and home modifications of 19 people with AD living at home in Buffalo, New York, over a 12-month period. Mann et al. found that as participants' physical and mental status declined, the types of assistive devices used tended to switch from those used by participants to ameliorate the effects of cognitive impairment to devices that assisted caregivers in supporting the participants, such as lifts and wheelchairs. Ten participants made home modifications, and a total of 17 modifications were made. These tended to be aimed at reducing incidences of behaviours such as wandering (primarily via addition of double-keyed deadbolt front door locks) and rummaging through wardrobes, drawers and storage spaces (by removing clothing and unnecessary items from bedrooms) and making the bathroom safer and easier to use.

The qualitative study of Olsen, Ehrenkrantz, and Hutchings (1996) looked at the provision of safe and supportive home environments for people with dementia through home modifications and technology. Their interviews with caregivers led to the identification of a successful home modification strategy following a three-stage movement-access continuum: assistance, restriction with compensation and wheelchair accessibility, which the authors argue encourages independence and movement when appropriate while providing safely and control where necessary. The paper provides examples of home modifications appropriate to each stage of the continuum, for example, at the assistance stage, raising the front of the refrigerator so that if the door was left open it would close by itself.

In a similar vein, Colombo, Vitali, Molla, Gioia, and Milani (1998) describe a home environment modification programme involving 26 people with dementia and their

households that was part of 'Technology, Ethics and Dementia', a larger, European community-supported study. They suggest that the adaptations enabled people to remain in their own homes for longer.

More recent work has tended to address similar themes and continues to regret that the evidence base continues to be relatively weak. For example, to support ageing in place for people with dementia, van Hoof et al. (Riemersma-van der Lek et al., 2008; van Hoof, Blom, Post, & Bastein, 2013) designed a demonstration home informed by literature review and focus groups. They note that existing guidelines have only a weak evidence base and argue for more studies at a larger scale to be completed. However, they also note that existing guidelines have not generally been presented as prescriptive, but as suggestive, and that they need to be understood and used in that way. They refer to the work of Mitchell (1999), who argues that the experience of practitioners (and, we would add, people with dementia themselves) is also important for informing effective environmental design. A similar focus on the agency of people themselves is evident in Bassuk's (1999) discussion of programmes to support ageing in place for 'naturally occurring retirement communities' (NORCs) in the USA that support older people living in the community. A NORC is a building, apartment complex or neighbourhood originally designed for use by different household configurations but which over time has come to have predominantly older residents. One NORC supportive services programme in New York State included a design consultation with residents of the NORC to identify ways to make their homes more suited to their needs and created links with manufacturers to enable improvements to be made available through the programme at reduced cost.

In some more recent research in this area, methods used have become more focused in an attempt to find clearer evidence, whilst reflecting the difficulties of conducting research in people's own homes. Marquardt (2011) explored the impact of space syntax for ADLs using data collected in people's own homes. They hypothesised that homes less divided up into separate rooms and greater intelligibility of space would support better performance on ADLs for people with dementia. They found to the contrary that greater division of space into rooms with specific, intelligible functions was more supportive of ADLs. They conclude that further research is required into the impacts of space syntax.

Gitlin, Corcoran, Winter, Boyce, and Hauck (2001) conducted an RCT of an intervention delivered by OTs which included education in environmental modifications of the home that carers could make to improve the life of the person with dementia. These were the removal of clutter and simplification of tasks, for example, laying out clothing in the order in which it needed to be put on. They were able to show that the intervention was effective in slowing decline in ADLs, enhancing self-efficacy and reducing upset and behaviours that caregivers found difficult.

Messecar, Archbold, Stewart, and Kirschling (2002) worked with 24 family caregivers, with particular emphasis on their views and experiences to identify what environmental changes they had made in the homes of the people they cared for to facilitate their support. They identified a wide range of modifications which caregivers had found effective, which covered several aspects of support. They included organising the home, supplementing capacity, structuring the day, protection and safety, working around problems with the home environment, enriching the home environment and support for moving to a different home. This more-rigorous approach adds to the body of knowledge and contrasts with

work such as that of Chaplin (2011) who simply outlines the potential of home improvement work aimed at 'dementia-proofing' and 'retro-fitting' to allow people with dementia to live safely in their own homes to enhance reminiscence-based 'life experience' work and Gould and Basta (2013) who discuss 'Skills2Care', a home-based programme, that incorporates elements relating to improving the home environment to provide greater support and safety, supporting ADLs and instrumental ADLs, providing caregiver education, skill building and providing information on approaches to self-care. Such work, whilst practically orientated, tends not to make explicit links with the evidence base.

Using Guidelines/Evidence

Various sets of design guidance have been published, though there is little documentation of their use and impact, lack of clarity on the evidence base used and whether they have been updated. Some of this literature refers to Stirling's design work, and design exemplars. For example, Philpott (2006) discusses a visit to the Iris Murdoch Building, 'a paragon of design for people with dementia', McCabe and Sim (2006) describe working in the Iris Murdoch Building and Farrelly (2014) suggests that Stirling's *Dementia Design Audit Tool Part 2: Workbook* should be used as guidance in redesign of clinical areas.

Other audit processes described include, first, Moore et al.'s (2011) cross-sectional study aimed at examining the physical environment of Australian care homes for older people with a view to improving the well-being and safety of residents. Nine facilities were assessed using a 147-item audit tool adapted from an audit tool designed to foster age-friendly hospital environments. They found that across all sites more

than a third of items (34%) required attention, with action most commonly required in relation to domains covering signage, visual perception and lighting, and outdoor areas.

Second, Fleming, Fay, and Robinson (2012) examined the extent to which research-based guidelines were being used in 10 Australian care facilities for people with dementia. They did not find universal awareness of guidelines, but did find that where professionals were aware of them, they were used. They argue for more educational effort in disseminating guidelines. Third, Lee, Yoon, Lim, An, and Hwang's (2012) approach to development was to use selected literature and workshops of professionals to generate recommendations for design modifications that might make housing more suitable for older people with dementia.

There are some sets of guidelines which have been formally assessed. In an early example, the Multiphasic Environmental Assessment Procedure (MEAP) developed by Moos and Lemke (1984, 1996) provides a conceptually integrated method for measuring the quality of residential facilities for older adults and contains a set of instruments to measure: physical and architectural resources; policy and programme resources; resident and staff resources; and social climate resources. Normative data exist for a range of different types of accommodation in the USA. Netten (1991) subsequently used the Social Care Environment Scale (SCES) from MEAP in her study of 13 UK homes for older people.

PEAP (Norris-Baker et al., 1999) is a well-validated tool that can be used to assess environments in care facilities. As previously noted, it focuses on nine environmental issues, which are awareness and orientation, safety and security, provision of privacy, regulation of stimulation, quality of stimulation, support of functional abilities, opportunities for personal control, facilitation of social contact and continuity of the self with the past through personal and familiar objects.

Smith et al. (2012) conducted a validation study of the EAT which is designed to assess environments in which people with dementia live to see if they conform to certain design principles (derived from earlier work). The study showed that EAT had good validity, although they do suggest further work may be needed due to the work having been conducted in purpose-built units which may be particularly strongly orientated towards implementing the guidelines.

'Wandering'

People with dementia are sometimes observed to spend a lot of time moving about, and this is often termed 'wandering' and seen as problematic, as it may lead to adverse consequences such as fatigue or injury. 'Wandering' is not necessarily negative however; moving about can also be interpreted as purposeful, for example looking for people or places, getting exercise, wanting to get out and about and having difficulty doing so. A number of studies address 'wandering' as an issue linked to environments, generally seeking ways to control or reduce it.

The earlier studies identified tended to focus on particular design features and their impact, with a particular focus on controlling movement. For example, Dickinson, McLain-Kark, and Marshall-Baker (1995) investigated the use of visual barriers to prevent residents from exiting from a dementia care unit, finding that fitting a closed blind to the window reduced exiting by 44% and fitting a cloth barrier to the door reduced exiting by 96%. They concluded that visual barriers could be successful in controlling exiting, and recommended occluding the view and light through doors and having doors in colours and with handles that 'blended in' where exiting was a concern. With a similar desire to reduce 'wandering',

Hewawasam (1996) found that two-dimensional grid patterns laid out on the floor could be perceived by some people with dementia as a barrier and thus reduce ambulation and exiting behaviours. In a small study (10 participants), grids were effective with people with a diagnosis of AD dementia, but did not work as well with people with diagnoses of other forms of dementia.

This theme continues in Price et al.'s (2001) Cochrane review which attempted to assess whether subjective barriers could prevent wandering by people with dementia. By subjective barriers, they mean measures other than locked doors which have been promoted as preventing people with dementia from trying to go through doors or enter certain areas: these include (but are not confined to) floor patterns giving the appearance of barriers (as in Hewawasam's work (Hewawasam, 1996)), mirrors on doors, camouflage of doors (as reported by Dickinson et al., 1995), obscuring the view through a glass door or door panel. They found at that time no RCTs or other types of controlled trial. Of experimental studies found, most included unacceptable bias, outcomes measured were narrow, excluding anxiety and distress, quality of life and resources, and there were no studies in people's homes, or that included people with delirium. They concluded on the basis of the poor quality of the research that there was no evidence that these subjective barriers worked.

More recent research takes a more holistic perspective. For example, Yao and Algase (2006) examined the relationships between wandering behaviour and care home environments. They used a scale which measured the 'ambience' of the care facility – the degree to which it was 'soothing and engaging'. They suggest their findings support other work that establishes a link between boredom and wandering. In our view, this study remains somewhat problematic as it

assumes wandering to be problematic, whereas movement could also be beneficial.

Algase, Beattie, Antonakos, Beel-Bates, and Yao (2010) considered the impact of environment on 'wandering', looking at what people tended to do in different environments. This study involved 122 people from 28 care facilities and used quantitative methods analysing data on people's movement and aspects of the environment, including location, light, sound, crowding and ambience (an observer-defined subjective measure), the choice of these being informed by previous literature. In brighter light, when sound levels were varied, other people were around and the areas were more engaging, people were more likely to move about: the authors suggest that changing these variables could modify people's activities.

Wayfinding

Several studies focused on wayfinding in various environments, notably residential care and public spaces. This area has attracted much research, and there is evidence that several wayfinding supports can be effective. This evidence is important because wayfinding is a particular difficulty for many people with dementia.

Early studies by Passini, Rainville, Marchand, and Joanette (1998) and Passini, Pigot, Rainville, and Tetreault (2000) produced some basic findings which have been echoed through several studies. These two studies included examining the wayfinding abilities of people with AD in hospital (Passini et al., 1998) and care home settings (Passini et al., 2000), respectively. General recommendations from the earlier (Passini et al., 1998) study include paying appropriate attention to spatial organisation so that people can proceed

from one decision point to the next without having to plan out future decisions; designing circulation systems to include well-articulated safe paths; designing buildings to provide good architectural communication; and ensuring that graphical and architectural communication are complementary, with the former being simple, uncluttered and meaningful and avoiding abbreviations. Design messages from the latter (Passini et al., 2000) research include an emphasis on multiple signage; being able to see a destination; and the need for reference points to support wayfinding. They also note that anxiety may be provoked by lifts and that floor patterns can also be disorientating.

Tune and Bowie (2000) assessed the environmental quality of 46 residential and nursing care homes for people with dementia. They used the 'Rating Scales for the Assessment of Environments for the Confused Elderly' which had been developed for use in long-stay wards in the early 1990s. The rating scale includes items relating to how restrictive or otherwise care practices are, activities and facilities available, reality orientation cues (including signage), condition (including decoration, lighting, noise and smell) and the availability of space. The homes were generally poor on reality orientation, and improving this was one of their core recommendations. There was also variation across sectors, with EMI homes having more restrictive care practices, local authority homes having more activity provision and private sector homes being in better condition, but having more institutional care practices. Despite its now rather old-fashioned terminology, this study was helpful in showing that, at that time, wayfinding was not generally well-supported.

A more recent study, Caspi's (2014) ethnography, examined the nature of wayfinding difficulties experienced by people with dementia living in a US-assisted living facility, in which residents each had a small apartment (actually an en-

suite bedroom), and shared communal dining and living room facilities. Caspi identifies that people with dementia experience a range of changes that can make wayfinding difficult, including spatial disorientation, related to spatial misperceptions; memory problems that make it difficult for people to remember where they are going or to remember mistakes previously made; concentration issues; and problems with spatial and depth perception. These can make it difficult for people to get around, go where they wish to and find their way back again, and can have profound consequences for everyday life. Caspi's study examines the interactions of these difficulties with the influence of the environment (the environmental demands or 'environmental press'). A range of wayfinding issues were observed, listed as (p. 437−438) not recognising the place, various issues relating to finding one's apartment and knowing its number; and being unable to find other areas such as the dining room, activity room or bathroom. Many implications for staff are identified, relating to good practice in assisting people to find their way, and these are seen as linked with potential environmental measures: in these care facilities, the short distances, the visibility of the shared facilities and the absence of 'long institutional corridors' (p. 445) were seen as particularly helpful both for residents experiencing difficulties and for staff attempting to assist them.

Another important study was conducted by Marquardt and Schmeig (2009), who collected data in 30 German residential care facilities of people with dementia concluding that, as people advance along their dementia journey, an environment which can compensate for wayfinding difficulties becomes increasingly important. They identify smaller numbers of residents in each unit, straight corridors and a single living/dining area as particularly helpful in wayfinding.

It is conceivable that these recommendations are linked to the visibility of the whole area which other literature suggests that it helps people to find their way about.

Caffo et al.'s (2014) four-participant study compared wayfinding aids that either compensated for wayfinding difficulties or attempted to restore wayfinding capacity. The compensatory strategy used assistive technology which broadcast sound for the person to move towards. The restorative strategy attempted to train people in wayfinding. Although this was a small study, the results were more positive for the technological solution.

Gross et al. (2004) conducted a series of experiments designed to test the potential effectiveness of signage for people with dementia. They established that many care home residents were able to identify printed names and photos of themselves, they could identify their belongings using these kinds of signs and their abilities to recognise names and photographs could be improved by training.

Kincaid and Peacock (2003) explore a different aspect of wayfinding – a way of deterring people with dementia from attempting to open doors that may lead them into risky areas. Painting murals over doors reduced attempts to open them, and the authors state that in consequence, agitation was avoided. This study is important for raising ethical issues: as with the possibility that technology could produce 'inhuman care' (aforementioned), it is important to ask whether such measures might constitute restraint, and if so, whether there is an ethical justification for using them.

Methodological Issues

The review repeatedly demonstrates the difficulty of conducting controlled studies in many care settings, supporting our

strategy to explore studies using a range of methods, and assessing their quality using recognised criteria. These criteria show that the quality of evidence cannot be adjudged simply from looking at controlled studies (such as RCTs). Even in the most rigorously designed studies, it is not always possible for researchers to control potentially relevant factors. For example, the authors of the PerCEN study (Chenoweth et al., 2014), an RCT rated by our reviewers as of high quality, noted that they were unable to blind management and staff to interventions or to control for independently initiated improvements made in non-intervention homes during the study lifetime. They also saw missing data resulting from both less-than-full recruitment of care home residents and large numbers of participants lost to follow-up as imposing limitations on their study findings. In addition, they found that there were also practical difficulties which limited implementation of the planned interventions during the study timeframe and it meant that the extent to which person-centred care was actually implemented was variable across the participating care homes. The consistent implementation of person-centred environments in homes was similarly compromised where it was not seen to be fully aligned with other managerial concerns, for example, to maximise care home revenue or maintain corporate branding.

Evaluation of the evidence base around environmental effects is made more complicated by lack of consistency in the selection of environmental aspects to examine and lack of standardisation of the instruments with which to assess them. For example, a number of studies use composite measures which assess the overall 'quality' of the physical environment as a whole. For example, Fleming et al. (2016) consider the relationship between the quality of the built environment and the quality of life of people with dementia in residential care, using the EAT, a 72-item instrument arranged in

10 sub-scales reflecting the design principles which underpin it. Other observational tools with scoring designed to reflect best practice in dementia design exist, for example Therapeutic Environment Screening Scale-2 + (TESS-2 +), a 38-item checklist with single items measuring a range of domains organised under four therapeutic goals used by Milke et al. (2001). But scores are not directly comparable and may produce different results: Fleming et al.'s (2016) findings did not accord with two other studies of the relationship between environmental quality and resident quality of life, both of which used variants of TESS.

It is not always possible to use the same measures internationally. In their study of factors affecting neuropsychiatric symptoms in people with dementia living in Dutch care homes, Zuidema et al. (2010) did not use TESS or PEAP because neither tool had been translated into Dutch or validated for Dutch populations. Instead they chose to use less sophisticated environmental correlates that were 'easy to assess' but which make their findings more difficult to compare directly with those of other studies.

Several pieces of work have focused on understanding the perceptions of people affected by dementia regarding design of environments (e.g. Digby and Bloomer (2014) on hospitals, Innes et al. (2011) on care homes). However, researchers have also noted that people with dementia often find it very difficult to talk about their living accommodation in abstract ways and can be reticent to criticise their residences and staff.

There is a tendency for research to become self-perpetuating, for example, when researchers use a tool that measures certain items designated as good practice, such as the EAT used by Fleming et al. (2016). More work needs to be done to assess whether they really are good practice across different contexts. Examples relating to best practice in relation to design for people with both sight loss and dementia

identified by Greasley-Adams et al. (2014) suggest that the existence of 'contradictory' advice may hold important messages about the importance of even minor differences, a point reinforced by Milke et al. (2001) finding that quite different outcomes can result from ostensibly similar care home designs.

There is a clear need for more holistic studies: single aspect studies make it very difficult to highlight specific effects. At the same time, studies which consider two conditions with variation in a large number of different parameters (e.g. the studies of family-style mealtimes by Nijs et al. (2006) and Roberts (2011) in which changes are made across a number of different dimensions) are able to say very little about where effort should be targeted for maximum gain in terms of outcomes for people with dementia.

CONCLUSION

The evidence base on design for people with dementia is growing but remains patchy. Research studies are often small scale, and publications often lower quality, reviewing innovations that tend to have a limited evidence base. In this review, we have highlighted areas in which design recommendations are better supported by research evidence, and indicated the strength of the evidence for each study. For each section, we have highlighted key points that emerge from a qualitative synthesis of the literature. There remain significant gaps in each of the areas considered, on which further research is merited. In concluding, we consider first the emerging methodological issues, then particular care settings, rooms, fixtures and fittings, concluding with a comment on design guidelines.

Methodological Issues

We have identified methodological issues throughout the review. Much of the research identified and evaluated was small scale, inevitably limiting its generalisability, and because it was disparate, difficult to synthesise. The review was thus limited to descriptive analysis of research findings. There was limited use of the most structured research methods, including trials and other controlled designs, and a minority (38/173) of any of the studies were assessed as being of high quality. Research in this field is needed at larger scale, and using stronger methodologies — these are not necessarily quantitative or controlled studies, but need to be more clearly specified and conducted in ways which meet quality assessment standards. This is an innovative, multi-disciplinary area, which has the potential to learn from advances in evaluation methodologies, such as realist evaluation (Pawson and Tilley, 1997) and improvement science (Taylor et al., 2014), as well as more participatory methodologies which give people living with dementia themselves an active voice in building the evidence base as in for example Tanner's work (Tanner, 2012). The development of design in environments could learn from the 6SQuID approach (Wight, Wimbush, Jepson, & Doi, 2016) to developing evidence-based interventions which are practical and genuinely promise improvements.

Outcomes considered in the studies reviewed were varied. Many emphasised aspects of health, and some considered behaviours, such as agitation or 'wandering'. Quality of life and outcomes which mattered more to people with dementia themselves were also considered: this is a welcome development, especially in the context of supporting person-centred approaches.

Care Settings

The available literature indicates that research has been predominantly conducted in care homes, with limited work in other residential settings. Attention to hospitals and other healthcare environments has been limited, and there is very little research located in private homes, public buildings or outside spaces. The research on care homes highlights the importance of the approach to care, and the difficulties of separating out the impact of design features from that of mode of care delivery on the quality of care. Generally, it seems, the more 'homelike' a care home seems to be, the better, but the evidence suggests that without an appropriate model of care design modifications alone may not produce improvements for residents. There are nevertheless indications in the care homes research of how design changes can affect people with dementia, by for example reducing levels of agitation, providing better opportunities for people to move about purposefully, or assisting with improved communication between staff and residents and between residents.

Research in hospitals has generally indicated that these environments are problematic for people with dementia, amongst other things being noisy and unfamiliar. They are generally less able to provide the privacy and opportunities to spend time together that people with dementia and their families require. There have been a small number of attempts to implement promising design from elsewhere in hospitals, but little useful evidence has accumulated. This is a clear research gap.

Evidence derived from care homes generates design principles that may be applied in other home settings, including private homes, and researchers have explored this possibility. Our own research considering guidance for people living with dementia and sight loss tested findings from literature

with people in various settings including at home, with respondents being generally positive about their practicality in the context of care at home. Nevertheless, there is a need for more research which considers specifically design at home, and how design modifications alongside family and possibly also paid care may benefit people with dementia and support the carers.

Consideration of design of outdoor environments for people with dementia has been limited, and very little is included in this review. We are conscious that increasing attention is now being paid to this issue, and there is growing awareness of its importance in terms of the difficulties people with dementia face in terms of getting out and about and the benefits of doing so.

Overall, the research conducted in care settings supported the significance of the environment, but also leads us to conclude that the care provision has to be considered alongside it, complemented by an understanding of the whole person. Environments therefore need to be flexible and adaptable, to facilitate and support good care which is adaptable and sensitive to people's needs. Not only do we need better understanding of care provision alongside environment, but we also need more research on how the environment may facilitate or inhibit good quality care.

Rooms, Fixtures and Fittings

There were several examples in the review of research which focused on particular rooms in a house or care setting, and identified and tested design features relevant to those rooms or which considered particular fixtures and fitting, such as taps, switches or door signs. There is a significant literature considering assistive technology, which tends to focus on

prototypes rather than larger-scale use of technology. The review also considered research relating to more general design issues such as lighting, and colour and contrast: it was unusual for literature on particular rooms to include reference to this wider literature, illustrating a degree of fragmentation in the research record. There is disparate work on a range of design items, prototypical technologies and interventions, and research is needed which can consolidate findings and identify core principles to guide design.

In this work, the environment was considered not only as facilitating and supporting good care, but also as having a positive role to play in itself, as with the work on therapeutic kitchens. Another example is found in the work on multisensory rooms, for which considerable benefit has been claimed but for which little evidence has been established. This perspective merits further research, considering additional benefits that well-designed environments may produce.

Design Guidelines for People with Dementia

In relation to existing design guidelines, much of the stronger research supports their content, bearing in mind that professional interpretation of the meaningfulness of the results of research for implementation in real care settings has often been incorporated in the guidelines. Two key points emerge in relation to guidance in this area. First, the influence of the model of care on the effectiveness of design is clear: design modifications alone will not be fully effective unless the quality of care is high. Second, some of the variations in research results and interpretations are likely to result from the individuality of people with dementia who have been included in the studies. Given the need for care and support

to be person-centred, judgement in delivering design modifi-
cations will need to be exercised: what suits one person may
not suit another, and each area of design recommendations
could include an indication of possible differences that should
be considered.

APPENDIX

The following tables which have been referred to in the text do not appear in full in this document but are available online as downloadable supplementary files. The files have been deposited with the University of Stirling's online research data repository, DataSTORRE, and can be accessed using the following permanent link:

http://hdl.handle.net/11667/125

S1 TABLE OF GRADINGS

This table provides brief justifications for the quality assessment grade awarded to each included item (High, Medium or Low). These data were recorded by reviewers at the time of completion of the review and evaluation proforma for each item. This table is downloadable. The filename is S1 Table of Gradings.xlsx.

S2 PICO TABLE

This table provides full citations and 'PICO' data (population of interest, population sample; intervention/indicator; comparison group; indication of categories of outcomes of

interest) for studies described in the 173 publications included in and evaluated as part of the review. These data were extracted by reviewers during the review process and recorded on a review proforma. This table is downloadable. The filename is S2 PICO Table.slsx.

S3 TABLE OF ASSESSMENT CRITERIA

This table provides a fuller description of the framework for evaluation used in this review, including the questions used in assessing studies with different research designs and the sources from which those questions were derived. This table is downloadable. The filename is S3 Table of assessment criteria.pdf.

REFERENCES

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