



## Challenges of design

From a lighting perspective

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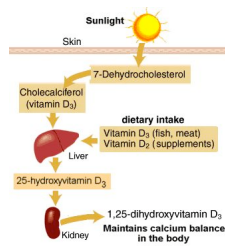


## Potential outcomes

- Reduction in No. and severity of falls
- Improved user orientation and participation
- Reduction in challenging behaviour
- Improved sleep and patient health
- Reduced stress and improved staff satisfaction



## Vitamin D



lewisnaturalhealth.com



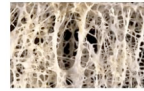
## Vitamin D

- Improves efficiency of calcium and phosphorus absorption
  - Increased bone strength
  - Increased muscle strength and performance speed

### Normal bone



### Osteoporotic bone



Photograph: Yale University, Vignery Laboratory



## Vitamin D

- 2009 meta-analysis by Swiss and American practitioners found 700 iu to 1000 iu reduced risk of falling by 19% to 26%
- Vitamin D less than 700 iu daily not effective

Bischoff-Ferari et al., 2009



## Recent genome research

- 'Vitamin D receptor binding sites were significantly enriched near autoimmune and cancer associated genes'

However, it is still not known whether a shortfall causes the diseases or the diseases cause a shortfall

Ramagopalan et al., 2010



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3000 iu of vitamin D

10 tins of sardines

150 egg yolks

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210 oz butter



5 to 10 minutes of arms and legs exposed, depending on season and latitude



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### Recommendations for Vitamin D

- Balanced diet containing oily fish
- Daily exposure to sunlight for 10 mins, April to September
- Wearing sunglasses when exposed to sunlight
- Medical advice re dietary supplementation, October to March

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### Implications for building design

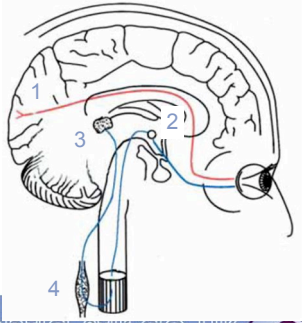


- Easy access to secure outdoor areas.

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### Non-visual pathway (blue)



- Visual cortex
- Suprachiasmatic nucleus
- Pineal gland
- Superior cervical ganglion

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## Detectors in the eye

- ~~Reeds~~
- ~~Cones~~
- ipRGCs

Intrinsically photosensitive Retinal Ganglion Cells



## Sleep patterns

- Elderly:
  - More frequent awakenings
  - Reduced REM sleep
- Alzheimer's Disease:
  - Changes greatly exceeded those of normal ageing

Swaab et al, 1985



## Regulation of circadian rhythm

- Alzheimer's Disease ▶
  - increased nocturnal activity\*
  - circadian rhythm of temperature is delayed\*
- High morning light levels ▶
  - improved sleep\*\*
  - reduced behavioural disturbance\*\*\*

\*Harper, Stopa et al, 2001    \*\* multiple reporters    \*\*\*Thorpe, Middleton et al, 2000



## Morning bright light exposure

- 6000 to 8000 lux for two hours
- 'substantial improvement in sleep among demented nursing home patients\*'
  - Waking time at night reduced by 2 hours
  - Sleep efficiency improved
  - Improvements in nursing staff ratings



## Melatonin

- Carries fundamental signals about circadian cycle
- 'extremely efficient radical scavenger' \*
  - (i.e. anti-oxidant)





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## Recommendations for regulation of circadian rhythm

- Darkness during sleeping hours
- External exposure to morning daylight, one hour, failing which
- Internal exposure to 5,000 lux for two hours.
- Wearing sunglasses when exposed to direct sunlight

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## Reduction of seasonal affective disorder

- Dependent on climate, genetic vulnerability and social-cultural context
- Cloudiness rather than latitude
- Light can help
- Curiously, fish can help

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## Recommendations for minimising SAD

- External exposure to morning daylight for 30 minutes, or
- Internal bright light of about 5000 lux on face for one hour

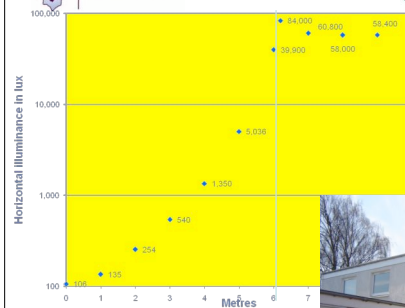
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Daylight; SE; 10.30 hrs; 24/8/09; 55.7°N; 4°W



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- Reduces stress
- Reduced analgesic intake
- Shortened hospital stays
- Improved patient satisfaction
- Improved staff satisfaction



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## Therapeutic views

<http://www.lemainairdetessy.com/>



<http://www.tessusainc.com/>





## Recommendations for therapeutic views

- Natural scenery, or
- A place where activity is likely.



## Additional benefits of being outdoors

- Fresh air
- More in touch with 'nature'
- Something to do
- Different noise and smells from inside
- Bright light



## Implications for building design

- Daylight penetration into communal rooms
- Easy access to secure outdoor areas.



## Implications for building design

- Therapeutic or 'activity' views.



## Implications for building design



- Daylight penetration and therapeutic view



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## Visual pathway (red)

1. Visual cortex
2. Suprachiasmatic nucleus
3. Pineal gland
4. Superior cervical ganglion

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## Human eye

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## Old age

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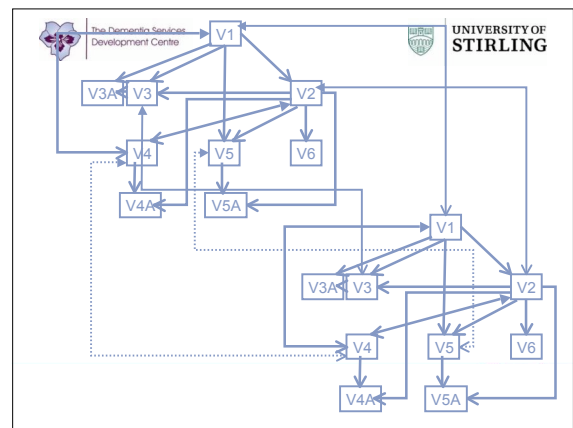
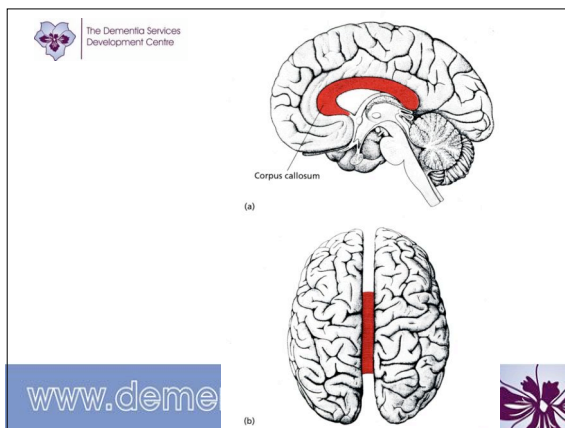
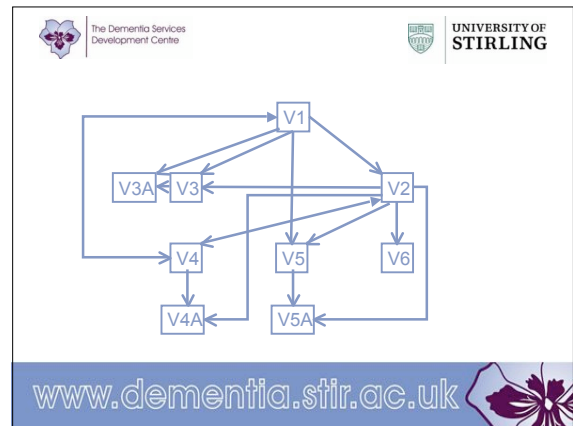
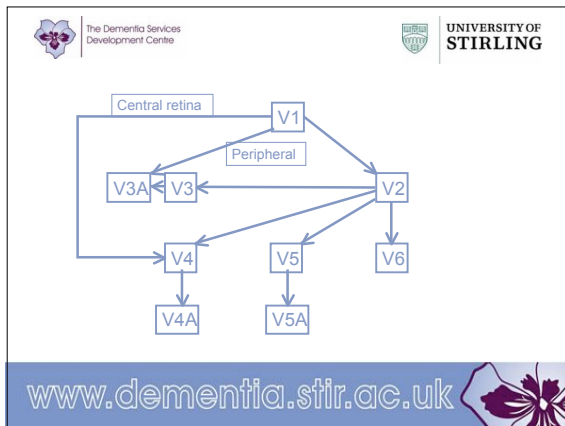
Zeki, 1993

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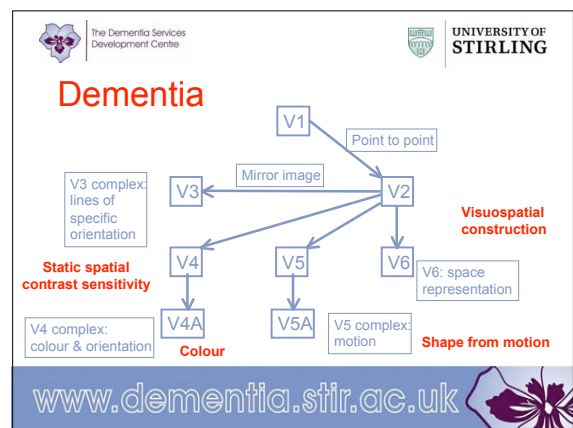
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## Dementia

- People with Alzheimer's Disease performed significantly worse on\*:
  - Static spatial contrast sensitivity
  - Shape from motion
  - Colour
  - Visuospatial construction
- 'Alzheimer's Disease affects multiple visual neural pathways and regions'

\*Rizzo et al, 2000

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## What we see depends on:

- (Emission)
- Reflection
- Contrast
- (Transmission)

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## Reflection

Luminous Flux (Lumen)

Luminous Intensity (Candela)

Illuminance (Lux)

Luminance (Candela per square metre)

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## Reflection and Contrast in turn depend on:

- Light
  - Quantity
  - Quality (colour)
- Surfaces
- Observer

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## Light - quantity

Relative visual performance

Illuminance

Contrast

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## Insufficient light/sufficient light

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## Colour rendition

- Furthermore, you need blue light in the environment

Lightcolour 830,  $R_a = 82$

$\phi_{\lambda}$  [W/(S\*nm)]

$\lambda$  [nm]

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## All lamps are equal, but some are more equal than others


PL-T (compact fluorescent, non integrated), Ra = 0.82

Spectral power distribution

Lightcolour 827

Lightcolour 830

Lightcolour 840



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## Colour



SOX Light



White Light

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## Surfaces



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## Position of observer



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## Contrast

- Free beer in bar after this presentation.
- Free beer in bar after this presentation.

- Free beer in bar after this presentation.

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## Signage



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## Dementia-friendly lighting: primary elements

- Light to twice 'normal' levels.
- Use sufficient 'domestic' style fittings.
- Use daylight wherever possible.
- Expose people to the 24-hour cycle of light and dark

This is the design challenge in lighting terms

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## Dementia-friendly lighting: other elements

- Think reflection and contrast
- Good uniformity & light on ceilings and walls
- Avoid sudden changes in light level
- Good colour rendition

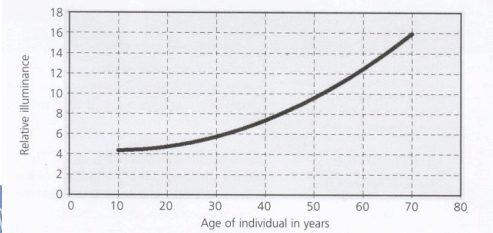


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## Light to twice 'normal' levels

- A typical 60 year-old person receives about one-third of the retinal illuminance of a 20 year old.



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## Light level

- What is the correct working plane illuminance in a bedroom?
- Peter Tregenza: 'This is a stupid question. Make the room look beautiful and provide plenty of plug sockets.'

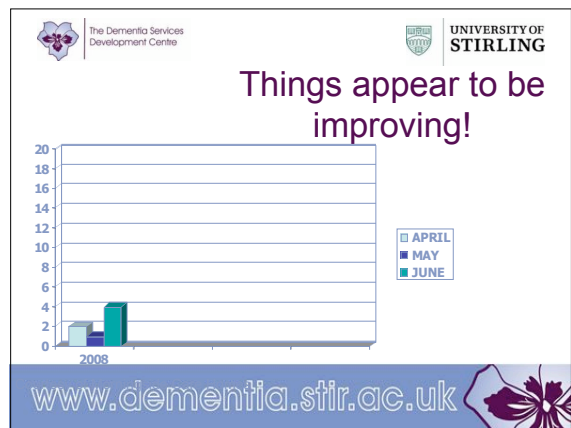
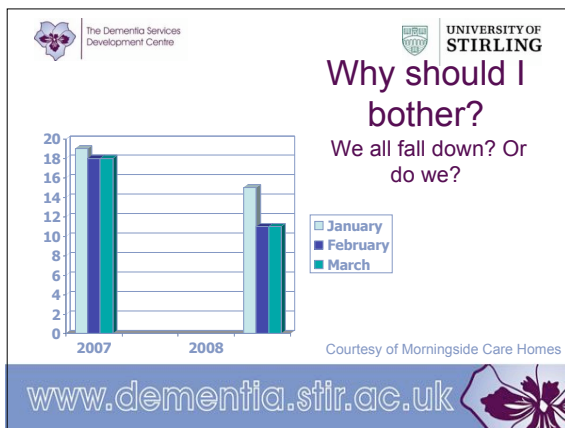
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Area	Average illuminance not less than	Overall colour rendering index (Ra)
Living rooms	600 lux	>85
Kitchens	600 lux	>85
Bathrooms & toilets	300 lux	>85
Bedrooms	200 lux	>85
Dining rooms	300 lux	>85

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- ## Controls and Circuits
- Daylight switching
  - Timers
  - Passive infra red
  - Microwave sensors
  - Multiple circuits
  - Some luminaires may have two lamps switched separately.
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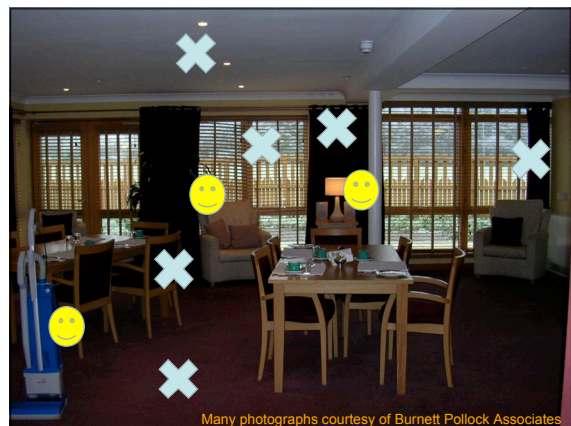



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### Making straightforward improvements

- Install rails that allow curtains to be opened fully beyond the edge of windows.
- Use lighter fabrics

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DEMENTIA DESIGN SERIES

Light and lighting design  
for people with dementia

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The end

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