



The University of Sydney
Faculties of Health Sciences and Architecture
**The Home Modification:
Information Clearinghouse Project**

**Lighting for Vision
Impairment
An Annotated Bibliography**

**Prepared by:
The Home Modification Information
Clearinghouse Project Team**

Authored by
Katrina Chaudhary

April 2007

Black, A., Lovie-Kitchin, J. E., Woods, R. L., Arnold, N., Byrnes, J., & Murrish, J. (1997). Mobility performance with retinitis pigmentosa. *Clinical and Experimental Optometry*, 80(1), 1-12.

In this study, the authors investigated the relationship between clinical vision measures and mobility performance under different illumination levels for subjects with retinitis pigmentosa. The study concluded that people with retinitis pigmentosa (RP) have worse mobility than people with normal vision, more so under reduced illumination levels. Visual field extent was the strongest predictor of mobility performance.

Boyce, P. R. (2004). Lighting research for interiors: The beginning of the end or the end of the beginning. *Lighting Research and Technology*, 36(4), 283-294.

Lighting research for interiors has been focused on the twin topics of visibility and visual comfort. The result of this effort has been the development of a validated model that allows the prediction of the effect of lighting and task conditions on visual performance, and an understanding of the conditions that cause visual discomfort. This paper considers whether any more research on lighting conditions for interiors is needed. The answer given is that more research is necessary if we are to fully understand all the impacts of lighting on the health, wealth and safety of people, but not more of the same. Rather, the future of lighting research in interiors lies in a move beyond visibility and visual discomfort to areas where lighting operates on mood and behaviour through the 'message' it sends and on health and task performance through the circadian system.

Bright, K., Cook, G. K., & Harris, J. (1997). Project rainbow - colour and contrast design guidance. *Access by Design* (72).

The authors outline their innovative research on colour contrast and luminance, which will assist construction professionals in selecting colours for use in new and existing buildings and help all potential building users, particularly visually impaired people, use buildings safely and effectively.

Brunnstrom, G., Sorensen, S., Alsterstad, K., & Sjostrand, J. (2004). Quality of light and quality of life - the effect of lighting adaptation among people with low vision. *Ophthalmology Physiology Optometry*, 24, 274-280.

The study investigated the effect of lighting on the daily activities of the visually impaired in their homes by comparison before and after light adjustments was made in the kitchen, hall and bathroom. It has also investigated the additional effects on the quality of life after providing task lighting in the living room.

Cook, G., & O'Neill, L. (2003). Lighting the homes of people with sight loss. Retrieved 6th December, 2005, from <http://www.fp.rdg.ac.uk/equal/Pocklington/Cook-PockEQUALPres231003.pdf>

This report summarizes the content and output of a one-year scoping study concerned with the artificial lighting requirements of visually impaired people in their own homes. The output from this project is the initial stage in the development of light guidance and recommendations for visually impaired people, community care professionals and designers.

Cook G., Yohannes, I., Le Scoullier, S., & Booy, d. (2005). Lighting the homes of people with visual impairment. Retrieved 5th December, 2005, from <http://www.hrc.rca.ac.uk/programmes/include/2005/proceedings/pdf/cookqgeoff2.pdf>

This study identifies important findings, including a range of areas and tasks within the home that visually impaired people find inadequately lit; the variability of luminance provided for task lighting and general lighting; and how effective visually impaired people find a selection of different lighting systems to those that they commonly use.

Cook, G. K., Wright, M. S., Webber, G. M. B., & Bright, K. T. (1999). Emergency lighting and wayfinding provision systems for visually impaired people: Phase II of a study. *Lighting Research and Technology*, 31(2), 43-49.

This article discusses whether significantly increasing the light output of the overhead emergency lighting system would significantly improve the visually impaired people's opinion of the traditionally high-mounted luminaries. The authors investigate different design attributes of powered wayfinding systems, to see how important some design details are to people's opinions.

Cornelissen, F. W., Bootsma, A., & Kooijman, A. C. (1994). Object perception by visually-impaired people at different light levels. *Vision Research*, 35(1), 161-168.

The authors investigated the relationship between the illumination level and the ability of visually impaired subjects to detect and recognize objects in a realistic visual environment. Subjects often continued to show substantial improvement at light levels where normal subjects have reached maximum performance. Integrated contrast sensitivity, a summary measure for the contrast sensitivity function, was better at predicting performance than either visual acuity or peak contrast sensitivity. However, when combined, the latter two predicted performance as well as the former, the authors concluded that when we try to find the best illumination for orientation and day-to-

day activities we should optimize it for both visual acuity and contrast sensitivity.

Cullinan, T. R., Silver, J. H., Gould, E. S., & Irvine, D. (1979). Visual disability and home lighting. *The Lancet*, 313(8117), 642-644.

In this study, 13 men and 43 women (average age 76) attending a low-vision clinic with visual acuity of 6/18 (Snellen) or less had acuity measurements made under standard (measured) hospital conditions, under normal home conditions, and under home conditions with augmented lighting. Median levels of ambient lighting in the home were 1/10 of those in hospital, while levels for reading were 1/7. Augmented lighting at home (a 60 watt bulb in a small adjustable lamp) improved visual acuity in 82% of subjects, restoring all but 11% to the levels achieved in hospital or above. Improvement was unrelated to disease. General levels of lighting are often so poor in the homes of elderly people that the number of people functioning as "blind" is twice what it need be. Simple improvements to lighting would reduce the prevalence of "visual disability" (less than 6/18 Snellen) from 520/100 000 home-based adults to about 300.

Debaughe, L. K. (1990). *Alzheimer's disease special care units: A comparative study of the retrofit design*. Unpublished Ph.D., Texas A&M University.

This research compared the retrofit design and lighting characteristics of ten Texas Alzheimer's Care Units to Alzheimer's disease patient wandering. A facility questionnaire, site observations, behavioural mapping, illumination readings, and field notes were used to gather and compare resident wandering and environmental characteristics. Illumination levels were measured and compared to the Texas Department of Health's minimum requirements for licensed nursing homes. A ranked, lighting evaluation was developed regarding code requirements, fixture type, placement, and safety.

Behavioural problems were exacerbated by design decisions to change, remove or maintain certain environmental features, particularly lighting. Seventy percent of the retrofitted facilities did not meet the minimum required light levels of 20 foot-candles in the corridors, all failed to meet the minimum levels in toilet areas, and 20% had improperly positioned luminaries. Resident exposure to direct or indirect sunlight was dependent on professional staff decisions; rarely did direct sunlight enter the ACU and if so, only in locations or times when residents could not access these areas. Specific ACU retrofit lighting and ideal retrofit guidelines were developed. Recommendations for further environmental research are discussed.

Figueiro, M. G. (2001). *Lighting the way: A key to independence*. Retrieved 10 December, 2003, from <http://www.lrc.rpi.edu/programs/lightHealth/AARP/pdf/AARPbook2.pdf>

The Lighting Research Centre at Rensselaer Polytechnic Institute developed principles for lighting for older adults and tested those principles in two assisted living facilities. The test results demonstrated that lighting helps older adults maintain their independence and improves their quality of life. Lighting can make the difference between seeing and not seeing for older adults with deteriorating vision. Home designers, architects, and builders can improve the quality of life of older adults by understanding how lighting compensates for the changes that commonly occur in aging eyes. This publication offers practical solutions for the residences of older people and answers frequently asked questions about how to use lighting to minimize some of the negative changes that occur with age.

Julian, W. G. (1983). *The design of the visual environment for the aged partially sighted*. Unpublished Ph.D, University of Sydney, Sydney.

This thesis examines the application of light to the partially sighted both as an aid and as a factor in the utilization of optical aids.

Kaufman, J. E. (Ed.). (1984). *ies lighting handbook: Reference volume*. New York: Illuminating Engineering Society of North America.

This handbook is a primary source of information on illumination. It contains technical and illustrative information and discusses theories and principles of light, optics, vision, colour, luminaries, and light sources. Definitions, lighting calculations and a detailed subject index are also included.

Kaufman, J. E. (Ed.). (1987). *ies lighting handbook: Application volume*. New York: Illuminating Engineering Society of North America.

This handbook is companion to the reference volume of IES *Lighting Handbook*. It covers design, economics and management; institutional, industrial and residential lighting; transportation and underwater lighting with illustrations and data. Also includes a detailed subject index.

Kuyk, T., & Elliott, J. L. (1999). *Visual factors and mobility in persons with age-related macular degeneration*. *Journal of Rehabilitation Research 7 Development*, **36(4), 303-311.**

This study determined the effects of reduced light level on mobility performance in persons with age-related macular degeneration (ARMD) and how performance relates to measures of visual sensory and perceptual function. Mobility performance was assessed under high and low illumination lighting conditions in a laboratory obstacle course and

two real-world courses, an indoor hallway and an outdoor residential route.

Long, R. G. (1995). Housing design and persons with visual impairment: Report of focus-group discussions. *Journal of visual impairment and blindness*, 89(1), 59-69.

This article talks about the little research that has been conducted on the extent to which persons who are visually impaired modify features of their homes or select new residences based on the availability of housing features or home modifications on independence and safety in performing routine activities.

Lovie-Kitchin, J. E., Woods, R. L., & Black, A. (1997). Effect of illuminance on the mobility performance of adults with retinitis pigmentosa. Retrieved 6th December, 2005, from http://www.eri.harvard.edu/faculty/pe/i/lab/woods/publications/IMC9_proc.pdf

This study investigated the use of residual vision by people with retinitis pigmentosa for mobility performance and how one environmental factor, illumination, affects their mobility performance.

Mulder, M., & Boyce, P. R. (2005). Spectral effects in escape route lighting. *Lighting Research and Technology*, 37(3), 199-218.

This experiment investigates how the ability to move over an obstructed escape route is affected by the spectral power distribution of the lighting. Measurements were made of the speed of movement, the number of collisions, and the perceived difficulty of moving over the escape route, immediately after the ambient lighting of the space was extinguished, for 15 different combinations of light level and spectral power distribution. The results show that all three types of measurement are much

more closely related to scotopic luminance than photopic luminance.

Pinto, M. R., De Medici, S., Zlotnicki, A., Bianchi, A., Van Sant, C., & Napoli, C. (1997). Reduced visual acuity in elderly people: The role of ergonomics and gerotechnology. *Age and Ageing*, 26(5), 339-344.

The discipline of gerotechnology studies the interactions between the aged and their architectural and technological living environments. It applies ergonomic principles to extend the independence of aged people, by adapting their surroundings to compensate for their declining faculties. The authors offer recommendations to aid those who are visually handicapped to maximize the power and arrangement of light sources to suit their reduced visual acuity. Additionally, choices for furniture, equipment and other technologies in their living environment are suggested to minimize the risk of accident and injury.

Spaulding, S. J., Patla, A. E., Elliott, D. B., Rietdyk, S., & Brown, K. S. (1995). Waterloo vision and mobility study: Normal gait characteristics during dark and light adaptation in individuals with age-related maculopathy. *Gait and Posture*, 3(4), 227-235.

The purpose of this study was to evaluate the gait responses of individuals with low vision compared to those of normal-vision individuals when their vision is challenged by extreme levels of light. Twenty subjects with age-related maculopathy (ARM) and 20 subjects with normal vision first walked along a flat, unobstructed path immediately after the ambient light level was changed from low (5 lux) to high (2500 lux). The procedure was repeated after the light was reduced from the high to the low level. Muscle activity, temporal and kinematics variables, and ground reaction forces were used to detect gait characteristics because of ambient light level changes. Data

suggested that ARM subjects walked slower and with more caution than normal subjects but that these differences were not related to ambient light level. Head angle, an estimate of gaze direction, was lower for ARM subjects during high light, but the gaze direction for both groups was low during low light. Among these ARM subjects, extreme levels of ambient light did not affect gait; subjects made adaptations that were reasonable to encourage safe ambulation, despite the direction of light change. Normal-vision individuals in this study experienced more difficulty in low light than high light situations.

The Society of light and lighting. (2004). Lighting for people who are visually impaired. *Factfile*, 8.

This information sheet provides some basic information about lighting for people with vision impairment.

Watson, G. C. (2002). *Emergency evacuation in aged care establishments with a particular emphasis on illumination*. Unpublished manuscript, Sydney.

The emphasis of this thesis is emergency evacuation lighting and the hypothesis tested is that Australia's minimum emergency evacuation horizontal luminance (0.2lux) is too low for aged people to safely evacuate aged care facilities.

Wright, M., Bright, K., & Cook, G. (1996). *Escape route lighting for people with poor vision*. Retrieved 14th December, 2005, from http://www.rics.org/Builtenvironment/Buildingstandards/escape_route_lighting_1996_0101.htm

This study looks at the range of different lighting systems and their suitability for people

with various visual impairments to determine which kinds of wayfinding lighting is easy for visually impaired people. A special facility at the Building Research Establishment was used to examine the performance of several types of emergency escape route Lighting and wayfinding provision. Five different lighting systems were tested and compared to normal lighting. Thirty visually impaired people passed through the test rig and answered questions about the different lighting systems they have experienced. Speeds of movement and an analysis of the answers to the questionnaire are also presented.

Wright, M. S., Cook, G. K., & Webber, G. M. B. (1999). *Emergency lighting and wayfinding provision systems for visually impaired people: Phase 1 of a study*. *Lighting Research and Technology*, 31(2), 35-42.

This study into the performance of visually impaired people under emergency lighting and wayfinding condition covers the influence of luminance, amount and distribution. The authors talk about the ability of visually impaired people to identify a mock exit door and to move through an unobstructed route.

Wright, M. S., Cook, G. K., & Webber, G. M. B. (2002). *The effects of smoke on people's walking speeds using overhead lighting and way guidance provision*. Retrieved 11th July, 2005, from http://www.rdg.ac.uk/ie/research/eewp/bstnsp_eedfin.pdf

The aim of this research was to compare human behaviour with different escape route lighting and way guidance systems in smoke logged conditions in order to contribute to the development of appropriate standards.