

**GLARE AND NIGHTTIME
ROADWAY VISIBILITY:
HUMAN FACTORS**

Peter Boyce, Ph.D. , FIES

Lighting Research Center

Rensselaer Polytechnic Institute

FOUR QUESTIONS

- **Why does disability glare make objects less visible?**
- **What is the effect of disability glare on visibility in practice?**
- **Which groups are particularly vulnerable to disability glare?**
- **What about discomfort glare?**

Why does disability glare makes things less visible?

- Disability glare is caused by light scattered in the eye
- The scattered light in the eye lays a luminous veil over the retinal image. The effect of this luminous veil is to reduce the contrasts in the retinal image
- Mathematically:

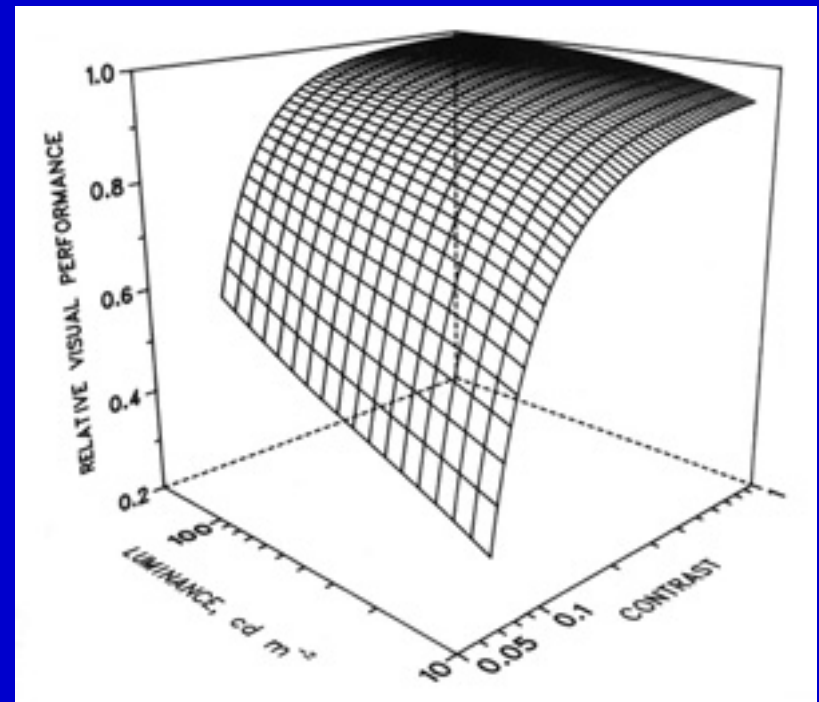
$$\text{Contrast} = (L_{\max} - L_{\min}) / (L_{\max} + L_{\min})$$

- Adding L_v = equivalent veiling luminance, to both L_{\max} and L_{\min} produces the following equation:

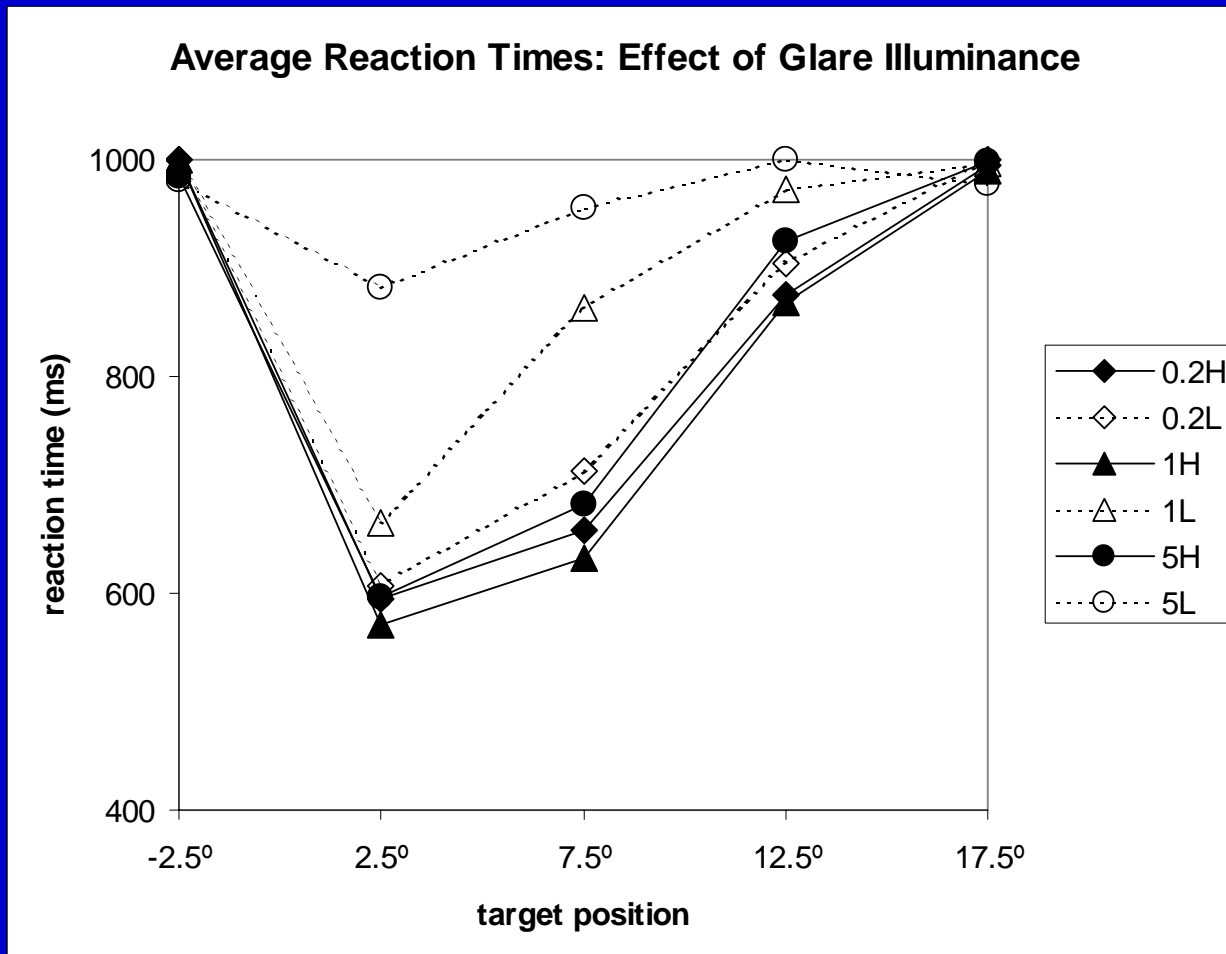
$$\text{Contrast} = (L_{\max} - L_{\min}) / (L_{\max} + L_{\min} + 2 L_v)$$

Equal reductions in luminance contrast do not affect performance equally

- Therefore, the effect of disability glare depends on the ambient lighting conditions and the nature of the object to be seen



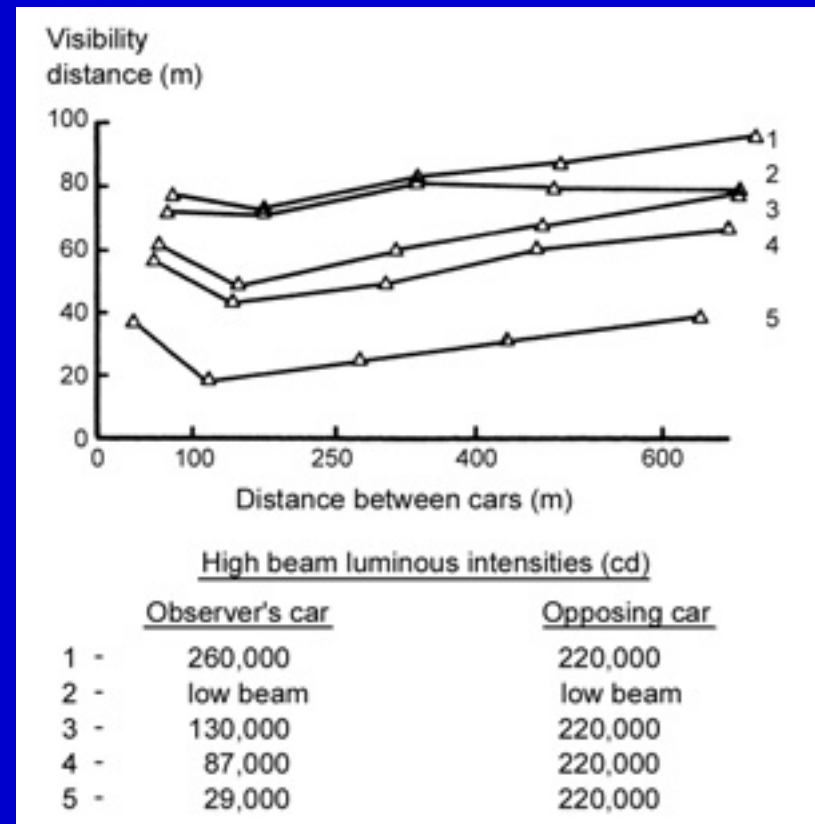
An example



What is the effect of disability glare on visibility, in practice?

Helmers and Becker (1975)

- For a small, dark-gray target, visibility distance without an opposing set of headlights is 220 m
- When an opposing set of headlights is present, visibility distance is reduced to about 40 to 80 m



What is the effect of disability glare on visibility, in practice?

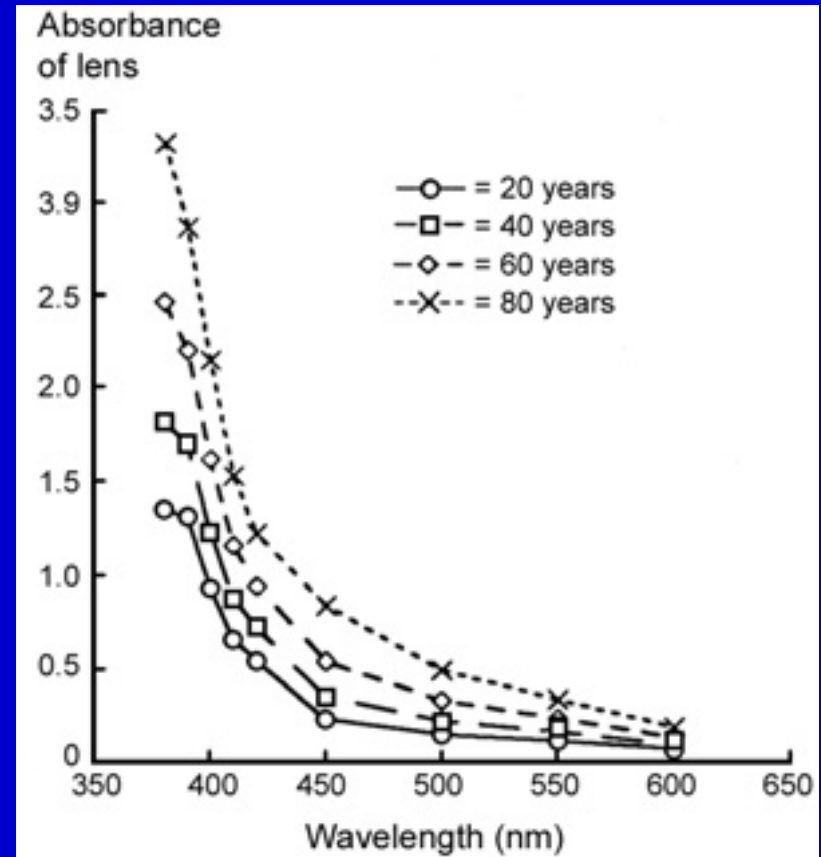
Theeuwes and Alferdinck (1996)

- People drove on roads at night with a glare source simulating the headlights of an approaching vehicle on the hood
- It was found that, with the glare source on:
 - ◆ People drove more slowly, particularly on dark, winding roads where lane-keeping was a problem
 - ◆ People missed more roadside targets
- These effects were largest for older drivers

Which groups are particularly vulnerable to disability glare?

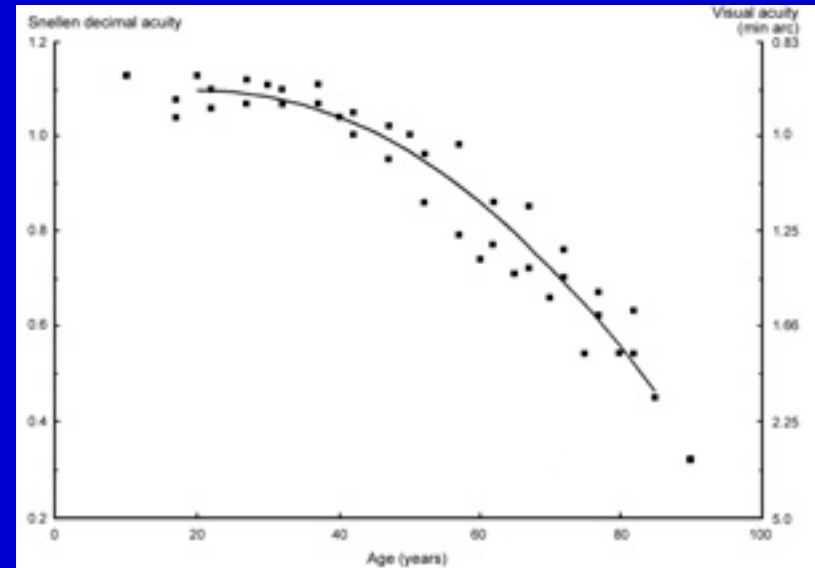
The elderly, for four reasons

1. Older people are working at lower light levels, because of greater absorption of light on passage through the eye



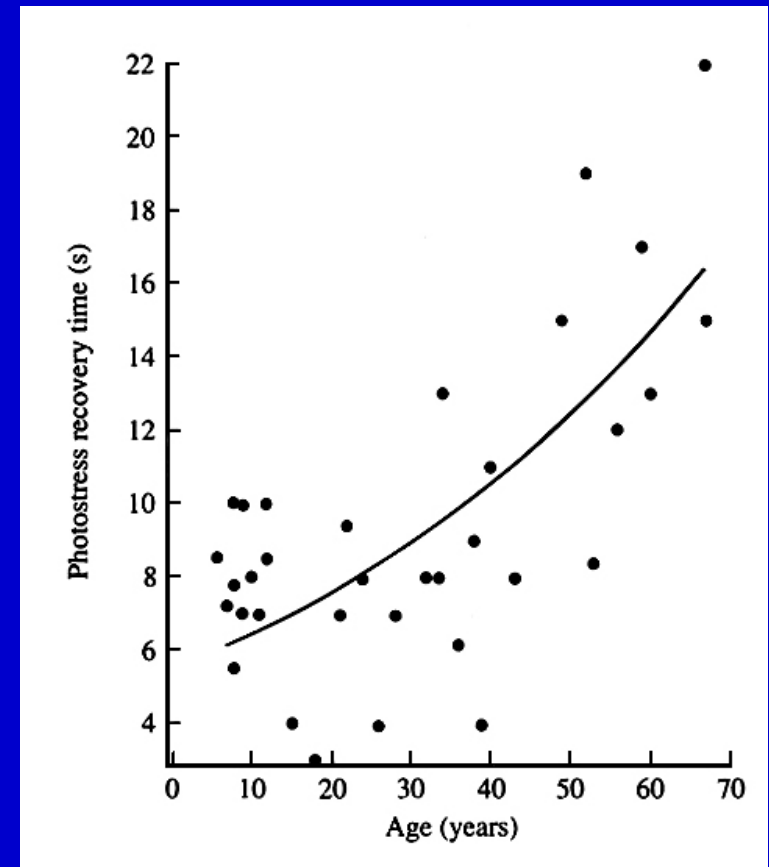
Which groups are particularly vulnerable to disability glare?

2. The amount of light scatter is greater, so the equivalent veiling luminance is higher. Therefore visual acuity is reduced.



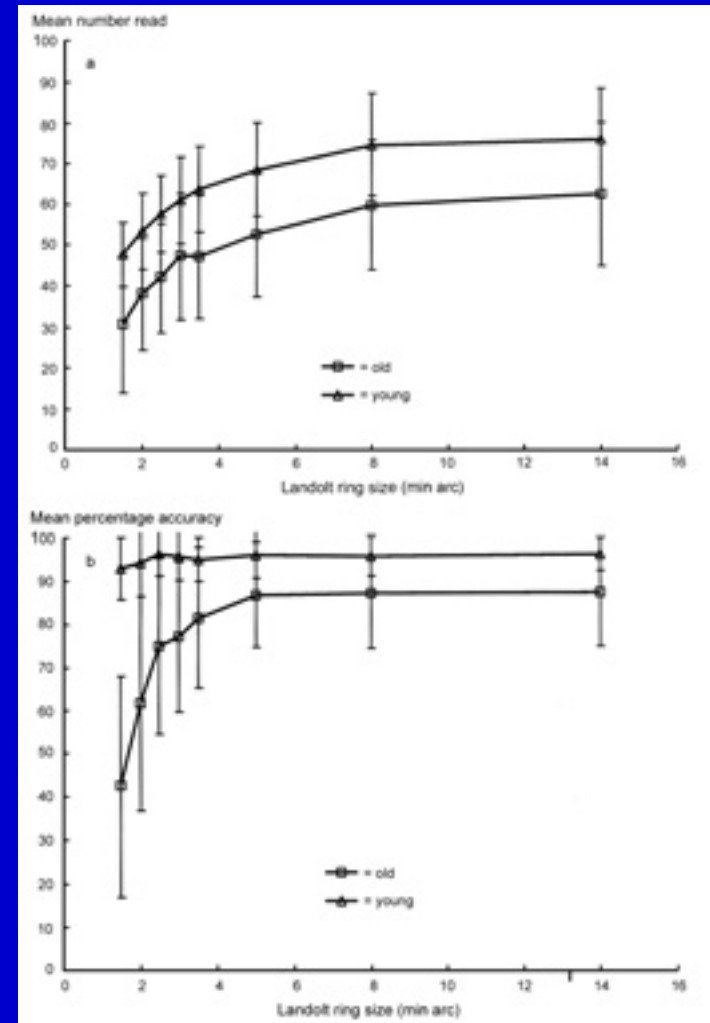
Which groups are particularly vulnerable to disability glare?

3. Older people take longer to recover from exposure to glare



Which groups are particularly vulnerable to disability glare?

4. Older people generally have a slower cognitive response



What about discomfort glare?

- Taken literally, discomfort glare does not affect visual performance because if it did, it would be disability glare.
- Such semantics are not helpful. The difference between disability glare and discomfort glare is really a matter of measurement.
- Disability glare measures what you can do. Discomfort glare measures how you feel.

Disability glare is always possible because

- All light sources produce some scattered light in the eye. Whether this affects the visibility of a target depends the ambient conditions and how close that target is to threshold. When it does, disability glare can be said to have occurred.

Discomfort glare is always possible because

- Any light source that makes what needs to be seen more difficult to see will be considered uncomfortable.

Discomfort glare can occur without disability glare because

- **The visual system can only deal with a limited luminance range at one instant in time**
- **How much discomfort is experienced will depend on both the stimulus conditions and on people's experience and expectations**

Will a glare source that produces only discomfort cause changes in visual performance?

- **Not by reducing the luminance contrast of what needs to be seen**
- **But maybe by acting as a distraction**