Validation of a simulation of visual impairments as applied to visually impaired people

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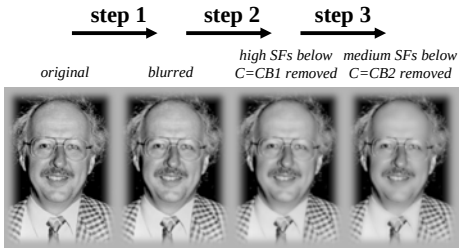
GOALS:

Evaluation of an image transformation method that gives insight in the visual limitations of people with the most common visual impairments: i) macula degeneration, ii) cataract, iii) glaucoma, iv) (diabetic) retinopathy, v) myopia.

Establishing the link between simulation parameters and contrast sensitivity (of LandoltC test patterns).

METHOD:

- Removes elements that are invisible to the visually impaired person
- Based on work by Peli (e.g. Peli *et al.* JOSA, '96)
- Uses a local band-limited contrast model (pyramid)
- Image degraded more and more (in 3 steps):
  - step 1: blur = remove high SFs
  - step 2: removing SFs in highest remaining SF band with local contrast below some threshold contrast
  - step 3: removing SFs in medium SF band with local contrast below some threshold contrast



EXPERIMENT:

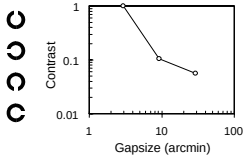
creating a simulation in 3 steps

- 2AFC (transformed left or right?)
- adaptive staircase procedure
- => ***sigma*** (blur) and contrast levels ***CB1***, ***CB2***

CONTRAST SENSITIVITY CURVE:

Characterized by:

- ***acuity***
- contrast thresholds at
  - 3x acuity (***CT1***)
  - 10x acuity (***CT2***)



HYPOTHESES:

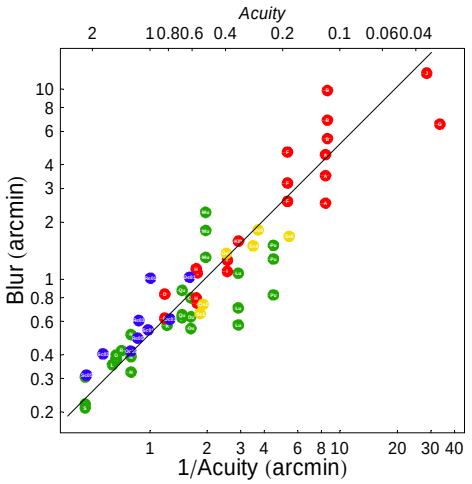
- ***sigma*** (blur) related to ***acuity***
- contrast levels (***CB1*** and ***CB2***) related to contrast thresholds (LandoltC: ***CT1*** and ***CT2***)

DIFFERENT SUBJECTS

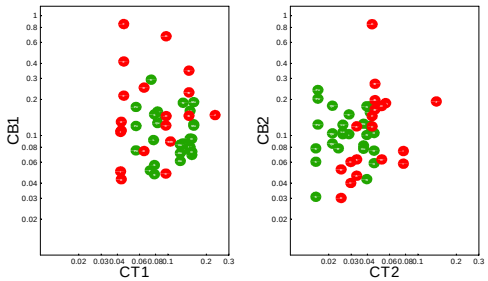
- visually impaired (macula degeneration, glaucoma, cataract, diabetic retinopathy)
- unimpaired and myopic (uncorrected) subjects (see Hogervorst *et al.* ECVP03)
- unimpaired: reduced contrast (by 50%, 25%, 12.5%)
- unimpaired: periphery (2, 4, 8 deg eccentric)

RESULTS

- sigma (blur) = 2.0 x (1/acuity)
- independent of cause of reduced acuity:
  - visual impairment
  - no correction (myopia)
  - reduced contrast
  - eccentric viewing



CONTRAST THRESHOLDS



Correlation Coeffients, *R*

	CT1	CT2
CB1	0.27	0.63**
CB2	0.16	0.64**

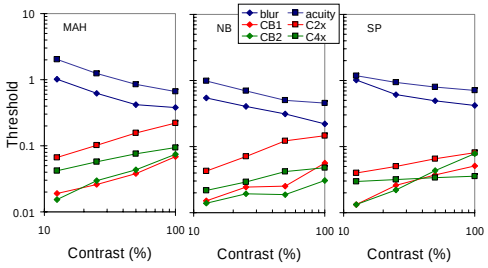
RESULTS

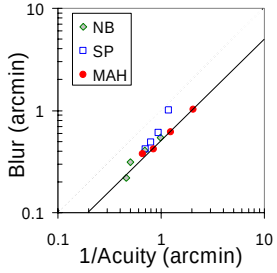
- *weak* link between contrast levels (simulation) and contrast thresholds (LandoltCs)

Possibly due to i) difficult task (steps 2 and 3), ii) small variation in contrast thresholds (LandoltCs: CT1 and CT2)

REDUCED CONTRAST

- ***Acuity*** threshold, CT at 2x and 4x acuity (***C2x*** and ***C4x***) derived from curve fit (contrast sensitivity curve)



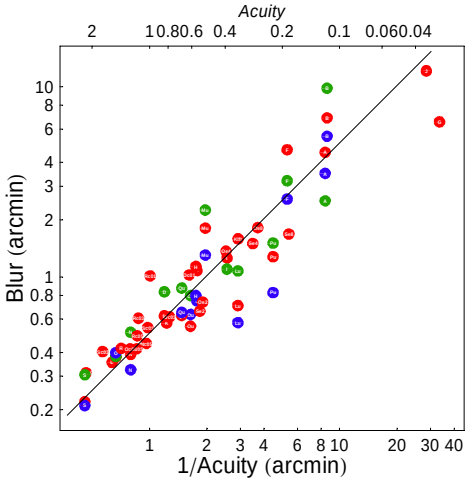


RESULTS

- contrast thresholds (simulation: CB1 and CB2) decrease with decreasing contrast thresholds (LandoltCs: C2x and C4x)
- sigma (blur) = 2 x (1/Acuity)

⇒ indicates a direct link between (local) blur and (local) contrast

DIFFERENT IMAGES



RESULTS

- relationship between blur and acuity largely independent of image content

CONCLUSION: The relationship between simulation parameters and contrast sensitivity is the same for visual impairments as for other causes.