RETINAL BRIGHTNESS AS AN INDICATOR OF ACCOMMODATION UNDER VARIOUS VISUAL LOAD LEVELS

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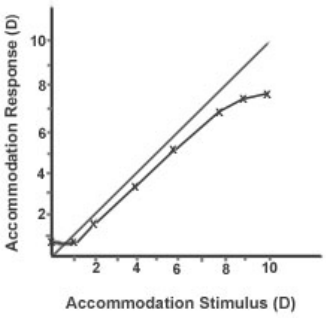
Introduction

- There are several methods used to measure the dynamic accommodative response in an eye. Examples include:
  - Free-view autorefractometery;
  - Wavefront aberrometery;
  - Infrared photorefractometry;
  - Nott dynamic retinoscopy;
  - MEM retinoscopy and others.

Accommodation mechanism

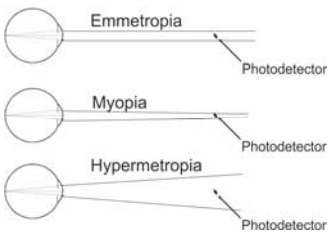
- The accommodation is mainly driven by the blur of the retinal image.
- The accommodative mechanism tries to adjust the crystalline lens power so as to keep the image formed onto the retina sharp.
- However, there is a deviation away from an ideal accommodative response curve.

Ideal and typical accommodative response

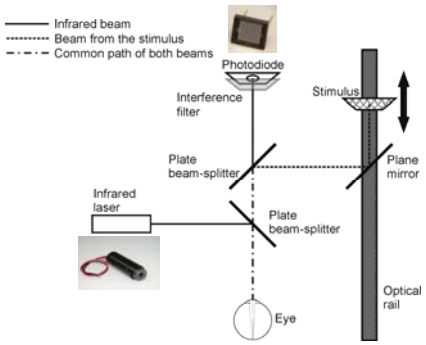


Purpose of the study

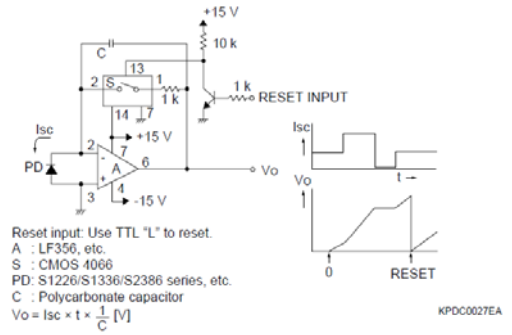
The purpose of the current study is to develop a method to measure the accommodative response using brightness of the retinal reflex.



The optical layout



Light integrator



Reset input: Use TTL "L" to reset.
A : LF356, etc.
S : CMOS 4066
PD: S1226/S1336/S2386 series, etc.
C : Polycarbonate capacitor
$Vo = Isc \times t \times \frac{1}{C}$ [V]

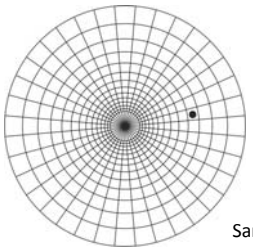
KPDC0027EA

Numerical simulation of the calibration curve

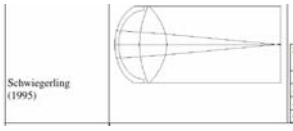
- Calibration curve shows what the voltage across the capacitor is for a given dioptric stimulus.
- The voltage appearing across the capacitor depends on many parameters:
  - Geometry and optical properties of an eye and the optical system;
  - Spectral power distribution;
  - Retinal reflectance;
  - Photosensitivity of the photodiode;
  - Integration time;
  - Filter transmittance and losses due to reflections.
  - and others.

LabVIEW

Numerical simulation of the calibration curve



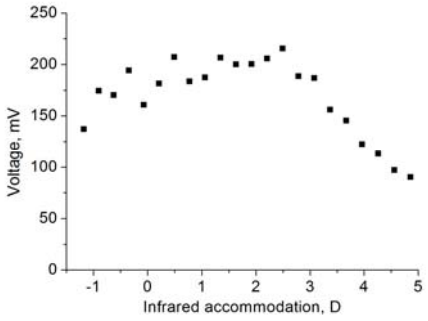
Sampling the spot on the retina



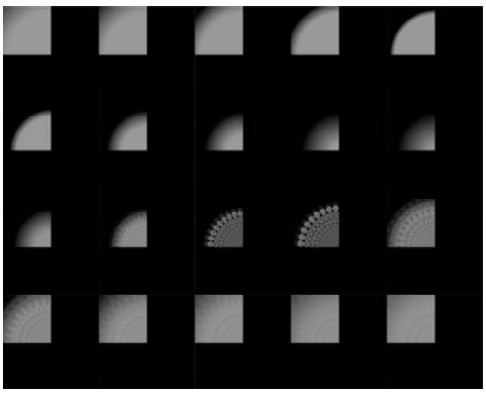
Schwiegerling (1995)

Surf.	Radius (mm)	Thick. (mm)	Asph.	Refraction index
1	7.8	0.55	0.75	1.3771
2	6.5	3.05	0.75	1.3374
3	11.03	4.0	-3.30	1.42
4	-5.72	16.60	-1.17	1.336

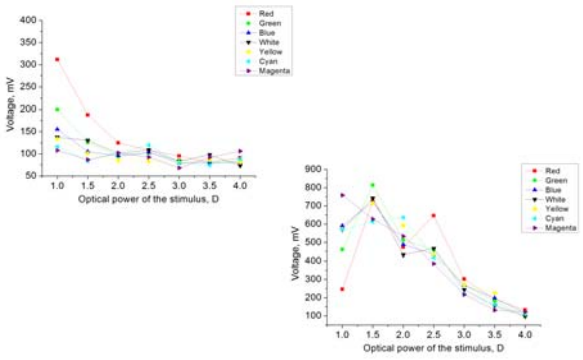
Calibration curve



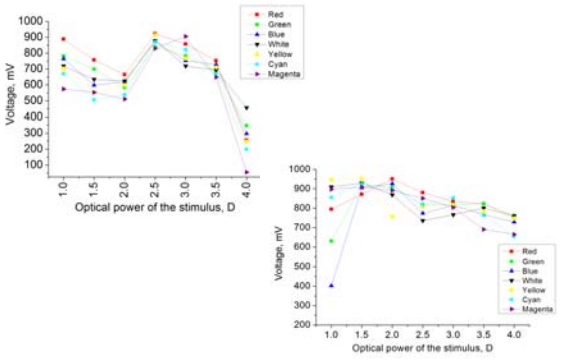
Simulated light intensity distribution



Voltage vs the accommodative stimulus



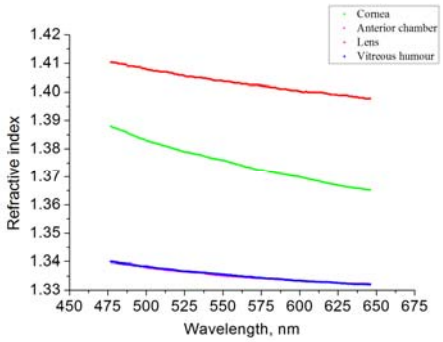
Voltage vs the accommodative stimulus (continued)



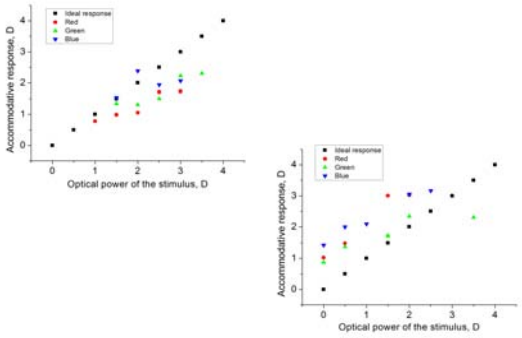
Calculating the accommodative response

- One must bear in mind that the stimulus is in the visible range but the measurement takes place in the infrared range. Conversion is necessary.
- Measurement and calibration curves must be aligned. Next, for a given voltage the accommodation in the infrared region can be calculated.
- Finally, back conversion gives the accommodation in the visible range.

Dispersion in ocular media



Accommodative response to various chromatic stimuli



Conclusions

- The method seems to be promising for objective assessment of the accommodative response.
- Minimal response from the subjects is required to measure the accommodative response. However, the subjects must be properly trained to keep stable fixation.
- Calibration curve must be precised and an analytical expression should be derived. Other factors should be included in simulation (e.g., degree of polarization of the radiation, saccades of an eye etc.).

Thank You for Your attention!

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