Analogue Computer Model of Progressive Myopia—Refraction Stability Response to Reading Glasses
Peter R. Greene* and Antonio Medina
B.G.K.T. Consulting Ltd., Bioengineering, Huntington, NY, USA
MultiVision Research, Milpitas, CA, USA

Brief Communication
A tendency of the eye to become myopic with long hours focusing at a near distance has been reported often [1-8]. Myopia development, as any refractive development, is described by a first order feedback system. A first order feedback system is defined by its transfer function

\[ F(s) = \frac{1}{(1+ks)} \]  

This function anticipates an exponential development of refractive state and the effect of lenses. Near work is myopizing, as it is equivalent to wearing a negative lens.

Using a digital computer, first-order equations have been solved previously to describe and predict myopia progression [1,3]. An analogue circuit can simulate myopia progression vs. time \( R(t) \) because the response of the feedback system is the same as the capacitor voltage in a R-C (Resistor-Capacitor) circuit, as shown in Figure 1. When near work is involved a negative square-wave represents the daily accommodative demand as represented in the inset in Figure 1[3]. The R-C circuit solves the problem without any computations.

The system exhibits an exponential progression of myopia [1,3],

\[ R(t) = -5.00 -3 \left[ 1 - \exp\left(-\frac{t}{\tau}\right) \right] \]  

where \( t \) is time, \( \tau \) is the time constant and \( R \) is either refraction or voltage. This equation applies initially when the square wave is at -3, and then exponentials alternating with the square wave apply as described in [3].

This electrical circuit simulates myopia progression vs. time as the voltage at the capacitor, where Volts (V) represent Diopters (D), when we initialize the subject’s myopia to -5 D and a negative square-wave representing the daily accommodative demand due to near work is applied. The switch selects the subject’s myopia. We use -5 and -2 as a typical example.

Reading glasses will cancel the -3 diopter demand. Any type of reading glasses have the capability to optically shift a book or computer screen from a typical reading distance of 1/3 meter (14-inches) to infinity, reducing accommodative demand on the visual system. Plus-add glasses, bifocals, and progressive addition lenses (PALs) have therefore the potential to stabilize-myopia [4-8]. The use of electrical circuits as models of myopia may enlighten the understanding of this condition and its progression among those literate in the engineering field.

Conflict of Interest Statement
The authors have no proprietary or financial conflicts of interest.

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References

*Corresponding author: Peter R Greene, BGKT Consulting Ltd., Bioengineering, Huntington, NY, USA, Tel: +16319355686; E-mail: prgreeneBGKT@gmail.com

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