



## **Analysis of Dynamic Pupil with Generalized Linear Mixed Models**

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### **Abstract**

Pupil size is one of the adaptation mechanisms used by the visual system when the perceived luminance changes occur. The study of the effects of multiple glares in the visual system during night driving route has been of interest in our environment. This prompted researchers from the Institute of Lighting of the National University of Tucumán, Argentina, to study the dynamics of pupil diameter under certain conditions. In the study the measurements of pupil diameter (Dpmax), were carried out on 10 young subjects and 10 older adults, considering three levels of luminance. At each level of luminance, the same subject was evaluated 30 times. Generalized linear mixed model (GLMM) was used, since Dpmax follows an Exponential distribution and it is longitudinal study. The GLMM provide a tool to model data where assumptions about the response such as independence, linearity, constant variance, and normality are questionable. They have attracted considerable attention, with the development of routines such as lme4 R and SAS macro GLIMMIX during the last ten years. These models combine the features of generalized linear models and mixed models. The descriptive analysis of the data was performed using STATA 11 software; and inferential analysis with the software R. The estimates were made by maximum likelihood with Laplace approximations. The fit indicates that both age and luminance levels are significant. The average value of Dpmax is 27% lower in adults for a given luminance and time and decreases approximately 4% from a low level to high level of luminance, for a given age and time. Besides, the average value of Dpmax is lower when the number of glare grows. The GLMM models allow answering the research question, taking into account the within-subject dependence of the observed values. They allow quantifying the contribution of the explanatory variables and do not require the response observed to follow a Normal distribution. In addition, not less important, is that the mixed models in the area of lighting technology were introduced. This may be an improvement in future designs of experiments, since the mixed models allow experiments with fewer subjects, ensuring reliable estimations

**Keywords:** pupil diameter; luminance; correlation within subject, random effect.