BACKGROUND

The pupil system

The pupil: more than just light adaptation

Dilation: sympathetic nervous system (fight or flight)

Constriction: parasympathetic nervous system (rest and digest)

Stark’s experiment (1962)

Dilation: sympathetic nervous system (fight or flight)

Stark's experiment (1962)

The pupil and cognition

Pupil pattern responses

Pupil grating response

Pupil color response

Melanopsin and ipRGC’s

Sustained pupil response in macaque retina activity of ipRGC's

Melanopsin action spectrum from sustained pupil response in human

Technical approach

In this work we seek to transform our understanding of the pupil system, which has traditionally been treated as a simple reflex by Stark. Here we use pupillometry by employing a real-time video pupillometer to control the intensity of a video display and to explore whether the pupil system is able to maintain visually mediated oscillations for a prolonged period. The data reveal that the pupil system can maintain oscillations for up to 10 seconds, and the amplitude of these oscillations is strongly correlated with the intensity of the stimulus. The results support the idea that the pupil system is able to maintain visually mediated oscillations for a prolonged period.

Technical challenges

Some related pupil designations are single and unrepeatable, and are linked to the pupil system's retinal illuminance and interpretation of the signals. As can be seen in the upper right figure in the panel to the left, the pupil grating response was recorded from a normal eye and has a peak amplitude of approximately half a millimeter.

More results: white noise analysis

Results: Oscillations produced by delayed feedback

Pupil oscillations were induced by stimulating the eye with a white intensity-modulated pupil area, with a variable delay. A simple neural model was developed to explain these oscillations, and the predictions of this model were confirmed experimentally. The data show that the oscillations can be produced even when the stimulus is not directly related to the pupil's function, and that they are not simply due to the pupil's response to the stimulus.

More results: white noise analysis

Conclusions

Our findings highlight the potential for the pupil system to mediate oscillations in response to complex visual inputs. These oscillations may provide a new method for studying the pupil system's role in visual processing, and may have implications for understanding the pupil system's role in other sensory systems.

References


