Your eyes give you away: pupillary responses, EEG dynamics, and applications for BCI
(Conference Presentation)

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ABSTRACT

As we move through an environment, we are constantly making assessments, judgments, and decisions about the things we encounter. Some are acted upon immediately, but many more become mental notes or fleeting impressions -- our implicit "labeling" of the world. In this talk I will describe our work using physiological correlates of this labeling to construct a hybrid brain-computer interface (hBCI) system for efficient navigation of a 3-D environment.

Specifically, we record electroencephalographic (EEG), saccadic, and pupillary data from subjects as they move through a small part of a 3-D virtual city under free-viewing conditions. Using machine learning, we integrate the neural and ocular signals evoked by the objects they encounter to infer which ones are of subjective interest. These inferred labels are propagated through a large computer vision graph of objects in the city, using semi-supervised learning to identify other, unseen objects that are visually similar to those that are labelled. Finally, the system plots an efficient route so that subjects visit similar objects of interest.

We show that by exploiting the subjects' implicit labeling, the median search precision is increased from 25% to 97%, and the median subject need only travel 40% of the distance to see 84% of the objects of interest. We also find that the neural and ocular signals contribute in a complementary fashion to the classifiers' inference of subjects' implicit labeling. In summary, we show that neural and ocular signals reflecting subjective assessment of objects in a 3-D environment can be used to inform a graph-based learning model of that environment, resulting in an hBCI system that improves navigation and information delivery specific to the user's interests.

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