



**CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY**

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Project Title Pupillometry Made Easy: Measuring How Hard You Think	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Everyone knows that your eye constricts and dilates when exposed to different light levels. However almost 100 years ago scientists observed that other things can cause your pupils to change size, such as non-visual stimulation, mental load, or increased attention (eg, thinking about a multiplication problem). This technique can be used to diagnose diseases of the brain. In the past, however, this is done with complex and expensive equipment. The purpose of our project is to engineer a cheap but effective way to measure the size of a person's pupil in response to attention effort.</p> <p>Methods/Materials To capture the eye's response to a mental load we used a Logitech webcam disassembled and mounted to a plastic glasses frame and took a series of pictures of the eye while the subject was completing a multiplication problem (eg, 23 x 13). The dilation of the pupil is miniscule during a mental task compared to one based from light, so we had to write an image analysis algorithm to that allowed us to accurately quantify the size of pupillary response.</p> <p>Results To test our experimental setup and image analysis program we measured the size of a user's pupil while a bright light was shone in their eyes. We observed the pupil quickly and dramatically constricted, which could be quantified with our program. Having established that our system was working we repeated the experiment with a mental task instead of a light source. We were able to detect a small but significant pupillary dilation associated with our test subject performing mental effort. When presented with a memorized multiplication problem the test subject's pupils did not dilate.</p> <p>Conclusions/Discussion We were successfully able to create a pair of glasses to measure the size of the users pupil when they are under a heavy mental load, such as a difficult multiplication problem. With this cheap and accessible system anyone can perform a cognitive test at home to could be used for monitoring diseases of the brain such as Alzheimer's or ADHD.</p>	
Summary Statement We engineered an inexpensive device to measure pupil dilation that, when combined with our image analyzing algorithm, was able to show pupillary responses to complex cognitive tasks, such as advanced multiplication.	
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