



**CALIFORNIA STATE SCIENCE FAIR  
2005 PROJECT SUMMARY**

<b>Name(s)</b> <b>Christina G. Boardman</b>	<b>Project Number</b> <b>S0304</b>
<b>Project Title</b> <b>Lemon Aid: Can Lemon Scent Improve How Fast Your Brain Processes Information?</b>	
<b>Abstract</b> <b>Objectives/Goals</b> My objective was to determine if brain processing speed could be improved if pure lemon scent is administered to grade-school age students. I was also interested to see if there were any differences in improvement between learning disabled and general education students. <b>Methods/Materials</b> I administered to students ages 7 to 11 a test to measure brain processing speed. I gave a series of tests, first without and then with pure lemon scent; next without and then with a placebo; and finally, giving the lemon scent first and then removing it. I subjected the tests to statistical analyses. Materials were: multiple tests, pencils, a stopwatch, pure lemon essence, a placebo, and kleenex. <b>Results</b> For 100% of tests with lemon scent, in whichever sequence the lemon was given, the students' processing speed improved. In 20% of tests in which only a placebo was administered, students' processing speed declined. Improvement with lemon scent was always greater than improvement shown (if any) with a placebo or because of *learning the test* through repeat taking of the test sequence. Both learning disabled and general education students improved at comparable rates, on average; however, lemon scent brought learning disabled students into the processing speed range of the general education students <b>Conclusions/Discussion</b> The results supported my hypothesis, showing that brain processing speed can be significantly improved by administering pure lemon scent, beyond any improvement shown through *learning the test* or from a placebo effect. These results support the growing science of brain functions being explored through fMRIs (functional Magnetic Resonate Imaging); the expanding science of the olfactory function and its relationship to the brain, for which the 2004 Nobel Prize in medicine was awarded; and the important exploration of the brain and learning, especially as affects learning disabilities.	
<b>Summary Statement</b> Brain processing speed can be significantly improved in grade-school-age students when pure lemon scent is administered.	
<b>Help Received</b> Dr. Susan Bookheimer, UCLA Brain Mapping Institute, gave me e-mail advice on reversing test sequencing, and when I visited following completion of my tests, helped with statistical analysis and with information on the olfactory areas of the brain.	