CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S1719

Project Title

Ethanol's Effect on Synaptic GABA-Mediated Paired-Pulse Inhibition: A Novel Mechanism behind Alcoholic Intoxication

Abstract

Objectives/Goals

To identify a novel molecular mechanism behind ethanol and its interactions with the central nervous system in order to better understand ethanol's actions at the neuronal level and to develop potential drug therapies and biomarkers for human alcoholism.

Methods/Materials

Experiments were run at different low concentrations of ethanol mixed with ACSF (0.10%, 0.25%, 0.50%, and 2.50%). Paired-pulse inhibition (PPI) amplitudes were measured before, during, and after the ethanol solutions were added, and the experimental PPI values with ethanol were compared against control PPI values to determine the percent increase in PPI amplitudes. A 105% increase or higher in PPI when ethanol was added was defined as a significant increase in PPI. The percentage of experiments carried out that illustrated a significant increase in PPI, defined as the percentage of responders, is also measured to examine the degree of effectiveness of each ethanol concentration. The number of spikes discharged per second was also measured when ethanol was added to control ACSF solutions, and the number of spikes was shown to increase in the ethanol solutions versus in regular ACSF solutions. Lastly, in each #wash-out# stage, in which ACSF solution was re-added to the hippocampal slices, the average PPI of each responder was shown to return to control levels.

Results

I mapped ethanol's actions at the low concentrations associated with human intoxication directly onto GABA-A-slow, and also developed a theoretical GABA pathway in the central nervous system that illustrates how GABA-A-slow may selectively inhibit GABA-A-fast. I also pinpointed the interactions of ethanol with GABA-A-slow to specifically within synapses, and proved how increases in the concentration of ethanol create much more dramatic effects on paired-pulse inhibition and on the percentage of responders.

Conclusions/Discussion

My experiment concluded that ethanol interacts directly with phasic, synaptic GABA-A-slow receptors at the low concentrations associated with alcoholic intoxication. By mapping ethanol#s effects onto these synaptic GABA-A receptors, a novel molecular mechanism of ethanol#s actions on the central nervous system was identified, and this mechanism is an area for future research and analysis on how to counter the effects of intoxication and genetic alcoholism.

Summary Statement

Electrophysiological experiments were conducted to identify a novel mechanism behind alcohol's interaction's with the central nervous system via GABA-mediated paired-pulse inhibition, which may lead to future therapies for alcoholism.

Help Received

I conducted this project at the Stanford University Medical Center under the invaluable mentorship of Dr. M. Bruce MacIver at the MacIver Lab. Mr. Tim Smay provided suggestions and feedback on the original draft of my research report.