CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
31230

Project Title
Testing a Nonlinear-Oscillator Neuron Model with Optical Illusions

Abstract

Objectives/Goals
A new physical framework of perception based on modeling neurons as nonlinear oscillators has recently been developed to explain the stroboscopic Wagon Wheel Illusion. This project tested the hypothesis that this model and framework could be extended to a second illusion, the Missing Fundamental Illusion, testing if the Missing Fundamental Illusion tends to support or contradict the theory that neurons are nonlinear oscillators.

Methods/Materials
Experiments involved both computer graphics presentations of four images (two based on the Wagon Wheel Image, and two based on the Missing Fundamental picture) as well as physical presentations using spinning wheels (optical choppers) and stroboscopic illumination (flashlight). The data from the latter presentation form was collected as the ratio of the stroboscopic period and the image repetition period was varied.

Results
The data from these experiments confirmed that, like the Wagon Wheel Illusion images, the Missing Fundamental images displayed the illusion over discrete ranges of the ratio of periods that fit the new framework of neurons as nonlinear oscillators. The Missing Fundamental Illusion itself was most clearly present at a small range surrounding and including the 1:4 and other even denominator ratios. However, the data at these ratios remained within the predicted zones of perception (locking zones), despite the presence of the Missing Fundamental Illusion.

Conclusions/Discussion
The strong agreement between the data and the predicted zones of perception shows again that the Wagon-Wheel Illusion supports the new model of perception, and also that the model can be extended to a second illusion with equal, if not stronger agreement with the data. It can therefore be concluded that the Missing Fundamental Illusion does support the theory that neurons are nonlinear oscillators, in agreement with the hypothesis. Insights about neuron behavior from this work may be applied in various fields of science.

Summary Statement
This project tests a model of perception, based on a theory that neurons in the brain function as nonlinear oscillators, with two optical illusions, and the experimental data indicates that both illusions support the theory and model.

Help Received
Sister helped with computer program, father supplied optical choppers and acted as 2nd observer