

A neuromimetic circuit demonstrating schizophrenic hallucinations

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Introduction

- The neural system in the human brain can identify regularities in received stimuli and, based on that, predict future stimuli. Neural prediction circuits reduce responses to predictable and thus redundant events.
- Failure in predictions and evoking erroneous responses may cause hallucinations in people who suffer from schizophrenia.
- Here, we have designed a bio-inspired electronic circuit that mimics this "prediction" in the human brain and its response to stimuli with a predictable pattern.
- Furthermore, the circuit shows how alteration in neural circuitry can cause the circuit to recognize stimuli that do not occur (hallucination).
- The synaptic layer is modeled with Carbon Nanotube transistors (CNT) and neurons are modeled with CMOS technology.

Typical and Atypical Responses

Typical responses:

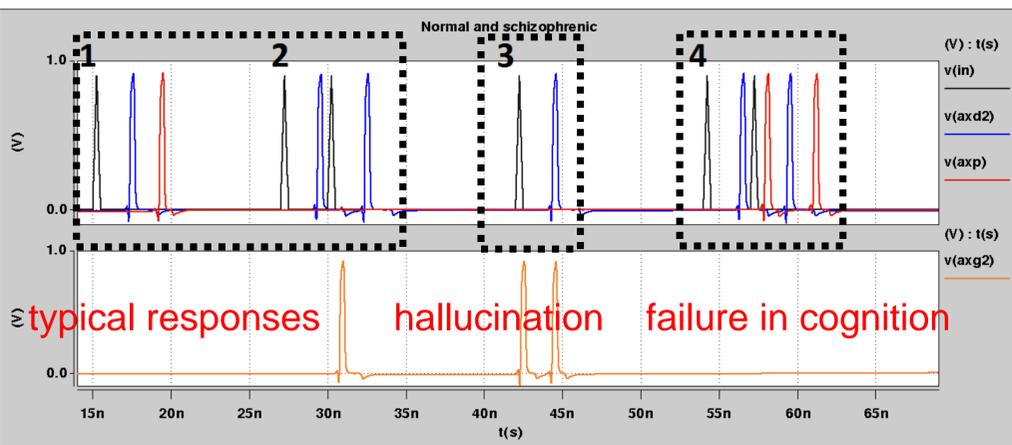
- Circuit is in normal condition and waiting for input of 2 spikes. Input is just 1 spike. P fires, analogous to the condition when a person hears something that he does not expect and he understands something is wrong.
- Circuit is still in normal condition. Input is 2 consequent spikes. Two interneurons G1 and G2 are inhibiting P from firing. At the end, P does not fire. This is analogues to condition when a person hears something that is consistent with his predication and therefore he stops responding to it.

hallucination:

- Circuit now is altered to schizophrenic condition. Noise can make G2 fire when input is only one spike or even when there is no input. It is analogous to hallucination and erroneous cognition.

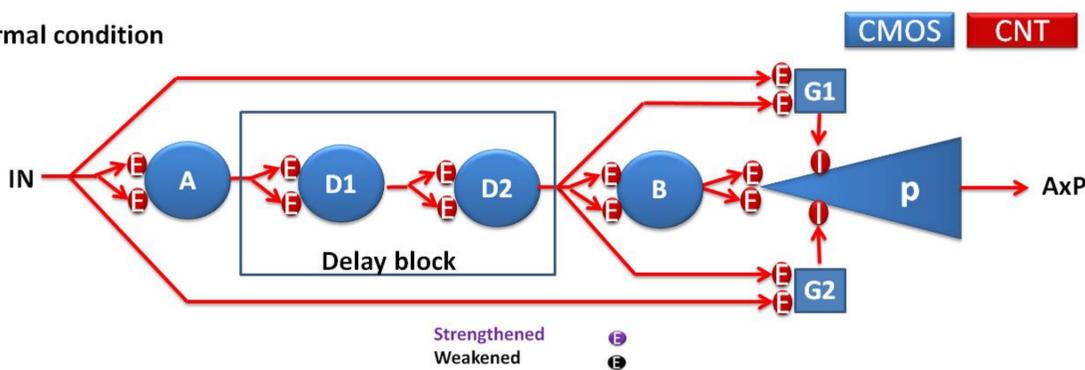
failure in cognition:

- Circuit is still altered to schizophrenic condition. Neuron P receives more excitation and less inhibition and fires even though input is expected pattern. Neural circuitry alteration causes circuit to fail in recognizing expected pattern.

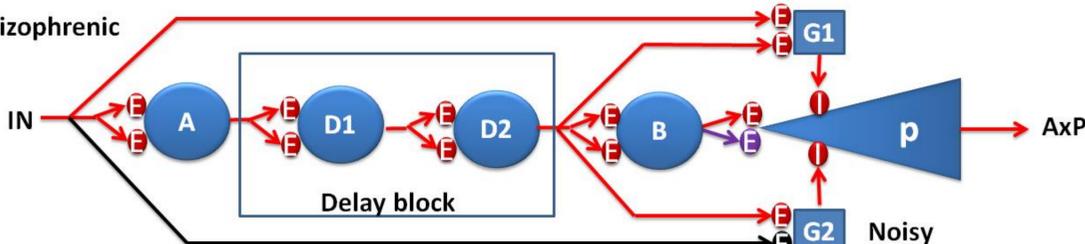


Hybrid structure

Normal condition



Schizophrenic



False firing due to noise

