INTRODUCTION

- Abnormal processing (lack of cortical response) in the primary visual cortex (V1) is associated with schizophrenia (Owen et al. 2016).
- Schizophrenia is a mental disorder that causes faulty perception, including hallucinations, delusions, and difficulty to distinguish reality from fantasy.
- V1 receives and processes input from the optic nerve through neurons in hypercolumns, each containing center and surround fields.
- Receptive field neurons vary activity based on angle of light grating. Surround cells maximally inhibit center cells in parallel angle contexts (Seymour et al. 2014).
- In schizophrenia, activity between inhibitory surround and excitatory center are the same no matter the orientation of light stimulus. How this lack of suppression from inhibitory surround cells happens may be better understood by computer models (Zenger-Landolt et al. 2003).

METHODS

- We used the model Simple Hyper Column in Matlab generated by using electrophysiological data of the V1 neurons of macaque monkeys while exposed to visual stimuli in their optical neuron’s surrounding and center fields (Shushruth et al. 2012).
- The neurons had their optimal, suboptimal, and orthogonal simulation values determined by electrophysiological recordings.
- This data was used to create a model of a hypercolumn containing excitatory, inhibitory, and basket cells, cells that can accept and receive excitatory or inhibitory impulses.
- We used this model to compare how changes in different parts of the surround pathways affect the center neuron and population activity.

RESULTS

- Subgraph A represents the activity of the center neuron at the orientation at which it produces the optimum results (blue) and at the orientation where it produces half of that response (pink/red) in response to the angle of the surrounding field gradients with the center field gradient.
- Subgraph B and C represent, respectively, the activity of the cell with a center field gradient at Opt and a center field gradient at Sub.
- The results of these graphs showed that weakening the connections between the hypercolumns produced a lack of suppression in response to the parallel gradients in the surround and center field.

DISCUSSION

- Changing the strength of the connections between the surrounding hypercolumns and excitatory or basket neurons created an activity pattern that mimicked the lack of suppression of the center neurons seen in schizophrenic patients.
- Weakening the feedforward connection heightened the difference between the orthogonal and parallel suppression of the cell rather than strengthening it, which was unexpected, as the connections from the feedforward are typically excitatory (Shushruth et al. 2013).
- The results of this simulation are limited since inputs from the surround were not modeled as part of a network that had connections to other parts of the brain.

CONCLUSION

- Our confirmation for the hypothesis that visual processing deficits in suppression and symptoms of schizophrenia originate at least partly in faulty connections and organization in the hypercolumn.
- Further clarifications on this theory can be applied in both treatment and prevention of schizophrenia and similar neurological diseases.
- Our model can be further developed through having the code altered to make it more realistic, such as adding a connection between the inhibitory neurons and the surround inputs, modeling the feedforward and feedback inputs in the model, or enter certain parameters to monitor the concentration of neurotransmitters that are involved in schizophrenia, such as GABA and dopamine.

REFERENCES


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