Introduction

- Individuals who suffer from psychosis, such as schizophrenia, may have visual hallucinations and distorted vision perceptions.
- Distorted vision in individuals with psychosis maybe explained by a weakened surround suppression (Butler, Silverstein, & Dakin, 2008; Dakin, Carlin, & Hemsley, 2005).
- Surround suppression can be demonstrated using sine-wave gratings in a two-alternative forced choice (2AFC) task (Fig. 1; Cavanaugh, Bair, & Movshon, 2002).
- Natural images are used to show that flexible gain control, one mechanism by which neurons receive surround suppression, is used in everyday settings (Coen-Cagli, Kohn, & Schwartz, 2015).

Why is this important?

- Surround suppression plays a role in our vision for everyday life.
- Understanding how surround suppression is altered in different real-world conditions can help us understand and better treat visual distortions in psychosis patients.

Objective

Determine the experimental conditions under which surround suppression occurs, and the degree to which it is produced using natural images.

Materials and Methods

Apparatus.
Stimuli were displayed on a monitor at a distance of 72 cm. The monitor’s background was set to mean grey. The stimulus program was administered and the data were collected using a laptop.

Images.
11 oriented natural texture images were selected from the Describable Textures Dataset (DTD) website. All natural texture images were grayscaled, and cropped. Pink noise images were generated by randomizing the phase of the natural texture images selected (Fig. 2).

Procedure.
Behavioral data were collected from 6 healthy participants. A two-alternative forced choice (2AFC) task was administered. Individuals would stare at a fixation point and would press a key to indicate which of the two images on the monitor they perceived as having a stronger contrast (Fig. 3). One of the center images was surrounded by another image that was either the same or different than the center image (Fig. 3). Based on whether the participant chose the surrounded image or not, the contrast difference between the surrounded and unsurrounded images, delta contrast, would increase or decrease.

18 different 2AFC tasks with 30 trials each were administered. These 2AFC displayed gratings, pink noise, or textures at parallel or orthogonal orientations (Fig.3). Lastly, there was a noise surround with a texture center task.

Hypothesis and Experimental Predictions

Surround suppression is a phenomenon that occurs in real world conditions:
- We expect both sine-wave gratings and the oriented texture conditions to show suppression.
- Parallel conditions should show more suppression than orthogonal conditions.
- We expect the noise and the texture noise conditions not to show suppression.

Discussion

- Surround suppression occurred in the sine-wave grating conditions as expected indicating that our experiment was administered correctly.
- Oriented noise showed a facilitation effect that we were not expecting and would have to further investigate.
- During the oriented texture task, subjects showed either stronger facilitation or suppression. This may indicate that not enough data was collected and that more trials are necessary.
- Additionally, we may have to control the parameters of the textures more rigorously such that the textures are more similar to each other.
- Oriented texture/noise did not show suppression or facilitation.
- One participant showed only facilitation in all tasks including the gratings control, indicating incorrect completion of tasks. The participant was excluded from data analysis.

Key Words

- Receptive field: a particular sensory location in which an individual neuron’s firing rate is activated.
- Surround suppression: when the firing rate of neurons in the primary visual cortex of the brain is decreased because of a surrounding stimulus outside of the neurons’ receptive fields.
- Facilitation: the increase in firing rate of vision neurons in response to surrounding stimulus outside of the vision neurons’ receptive fields.
- Natural texture images: images of everyday textures people are exposed to such as fuzzy carpet, and rough gravel.
- Spatial frequency: how many times a visual pattern repeats across the image (Fig. 1).
- Fourier transform: a mathematical operation that converts any signal into frequency components.
- 2D Fourier transform: a mathematical operation that convert images into spatial frequency.
- Pink noise: a type of noise, unstructured visual stimuli, with increased low spatial frequency content.

References


Figure 1. Example of low and high spatial frequencies. The human visual system does not respond with the same strength to all spatial frequencies. To the left of the image the spatial frequency is low and to the right of the image the spatial frequency is high.

Figure 2. Sample of images. Images from each category were used for the different tasks. The pink noise image is generated from the natural texture image.

Figure 3. Sample of 2AFC task. Task: oriented texture with the center orthogonal to the surround.