Stimulus dependency of surround modulation in V1 allows for unbiased orientation decoding

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Introduction

Phenomenological model

Population response: In the center independent model all neurons are modulated differently, leading to a shifted population response. But in the center dependent model all neurons are modulated identically.

Population Response

Phenomenological Model Bias

Population Response and Illusion

Conclusion

Vector Decoding

Phenomenological model

Population response: Due to the shifted population response, the center independent model has a strong bias. While the center dependent model has zero bias.

Population Response and Illusion

Conclusion

Modulation shifts with center

• Classically neurons experience suppression with a surround, which is strongest at the preferred orientation.
• However, a number of studies have shown that it is strongest when center and surround are aligned (e.g. Shushruth et al. 2012)
• What are the functional implications?

Vector Decoding

• Given a population of neurons:
  • Weigh the preferred vector of every neuron by its activity
  • The sum of these vectors

• The estimated θ₀ = arctan(∑ᵣᵢ rᵢ)

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Phenomenological model

Population response: We consider a simple model with subtractive suppression from the surround:

\[ r_{\text{sur}} = \frac{g(v_{\text{sur}} - v_{\text{opt}})}{g(v_{\text{sur}} - v_{\text{opt}}) + g(0 - v_{\text{opt}})} \]

• We study two version of this model, only differing in their surround modulation, either center independent or center dependent:

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