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Inherent receptive fields for environment-agnostic object recognition

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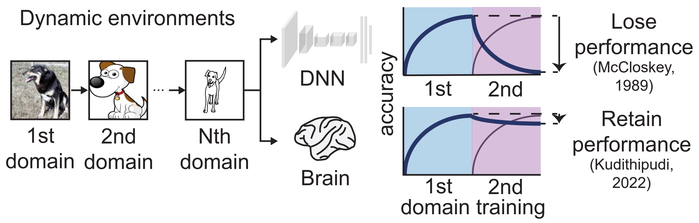
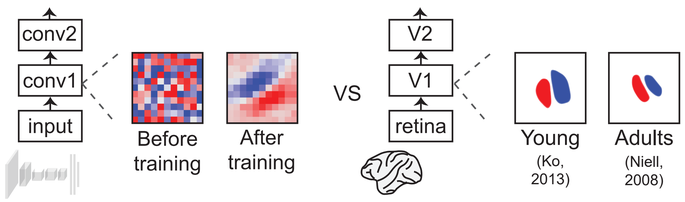
Introduction

- **Unlike brain, DNNs are vulnerable to environmental changes**

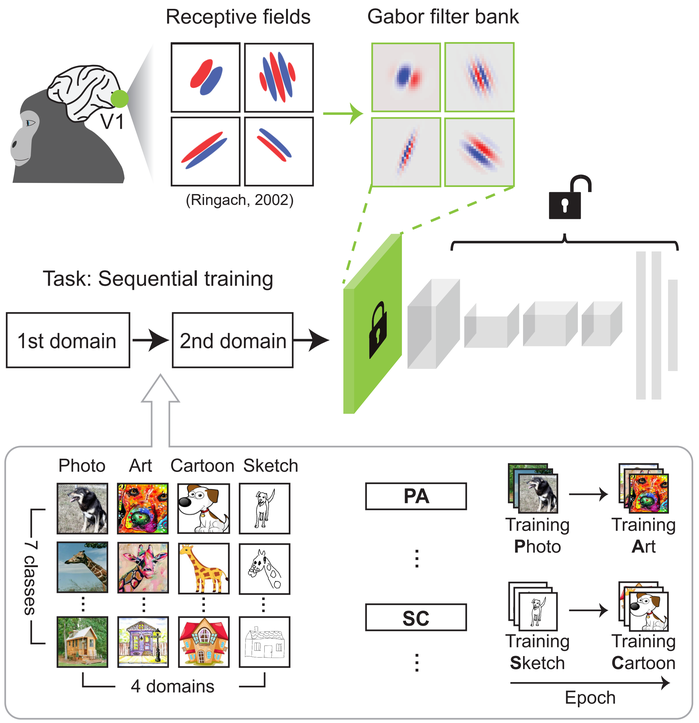


- **Brain's early visual pathway has innate Gabor-like receptive fields that remain stable throughout visual experience**



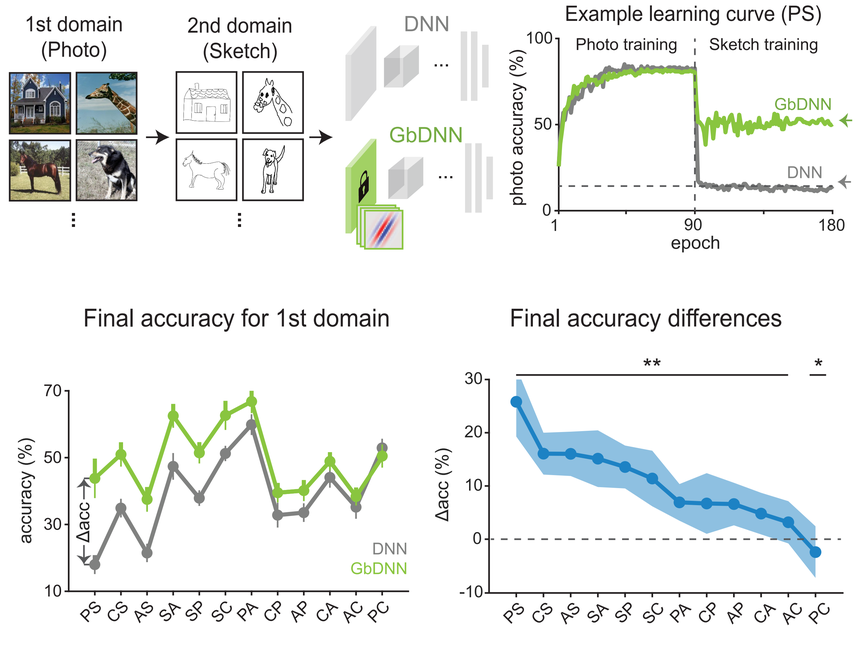
Q. Can Gabor-like receptive fields in the early layer enable domain-general object recognition?

- **Our model: Fixed Gabor filters in the early layer (GbDNN)**



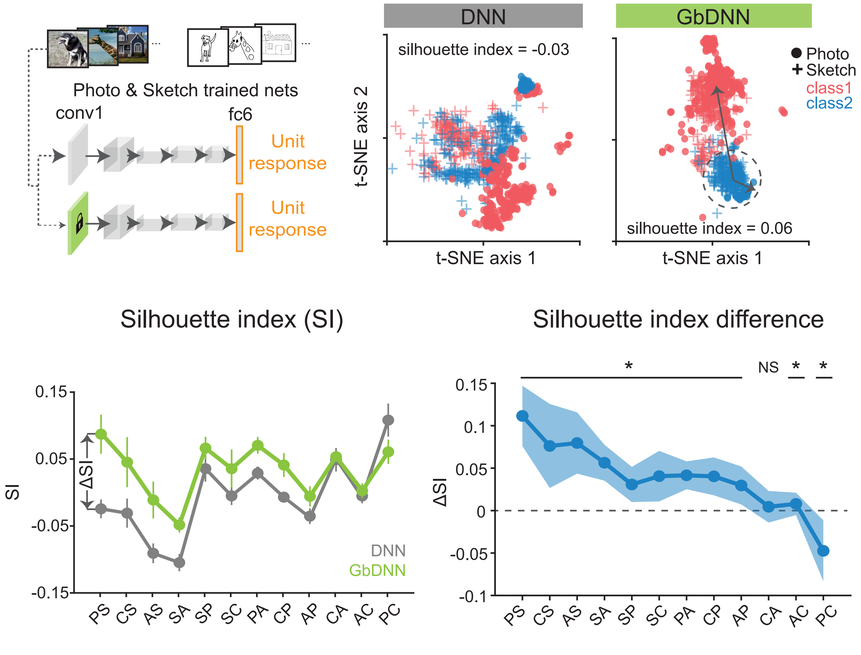
Key results

- **GbDNN robustly maintained performance under various domain changes**



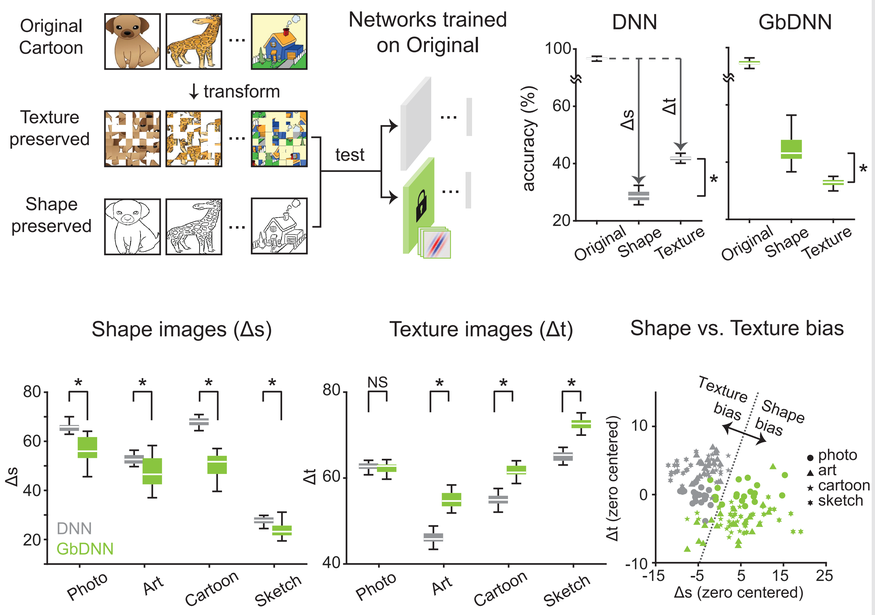
Results2

- **GbDNN produced invariant object representations irrespective of image domains**



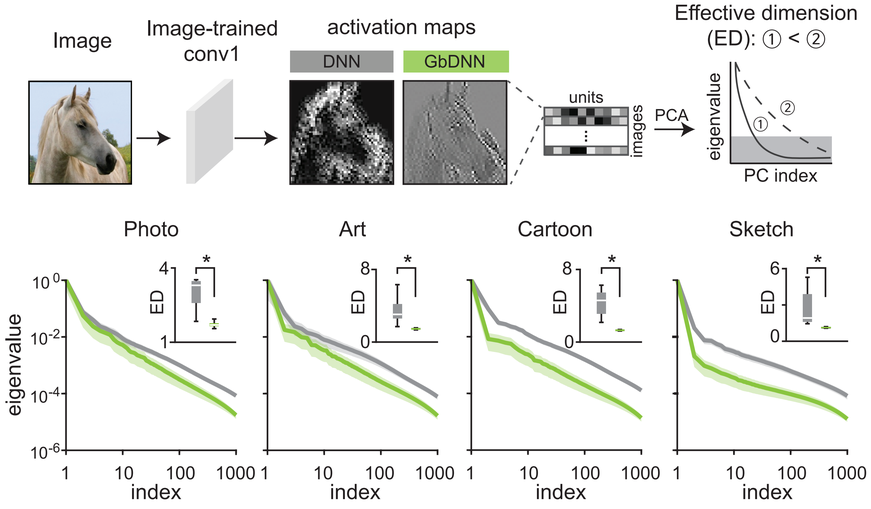
Results3

- **GbDNN showed shape-biased object classification**



Results4

- **Gabor filters directly reduced dimensionality of learned representations**



→ Gabor filters produce low-dimensional representations
= enhancing generalizability through less encoding redundant information

Conclusions

- Hard-wired Gabor filters, resembling the receptive fields of V1 neurons, enable environment-agnostic object recognition
- Unlike DNNs which cluster based on image domains, our model spontaneously clustered same objects across various domains in the latent space.
- Fixed Gabor filters allow shape-biased object classifications, suggesting that these filters highly prevented overfitting.

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