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Inherent receptive fields for reliable object recognition under dynamic environments

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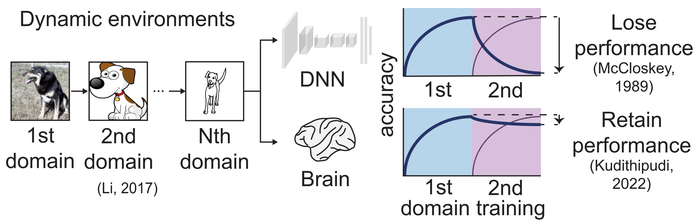
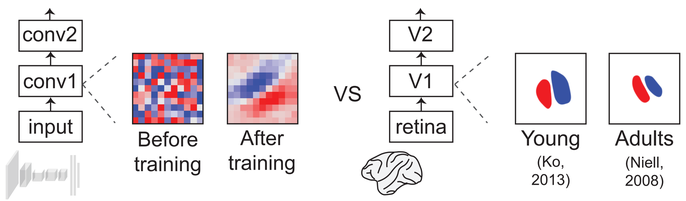
Introduction

•Unlike brain, DNNs are vulnerable to environmental changes

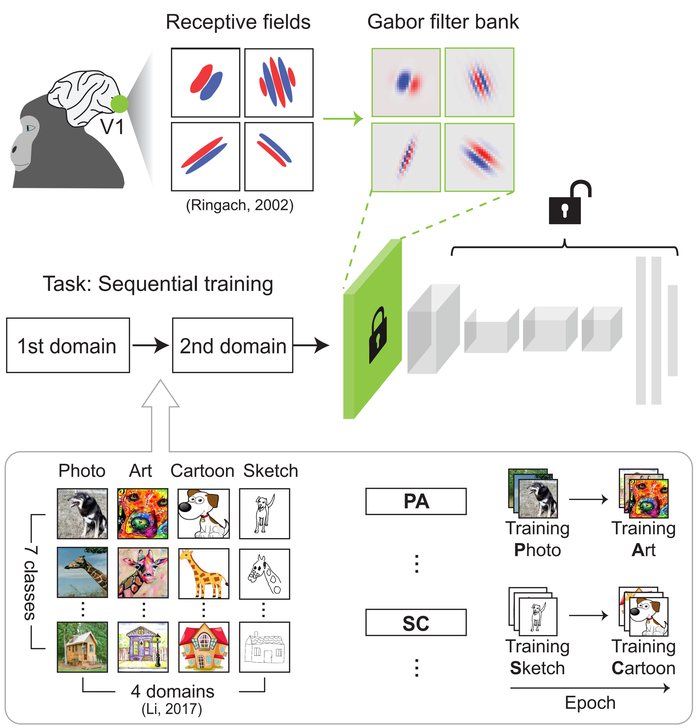


•Brain's early visual pathway has innate Gabor-like receptive fields that remain stable throughout visual experience



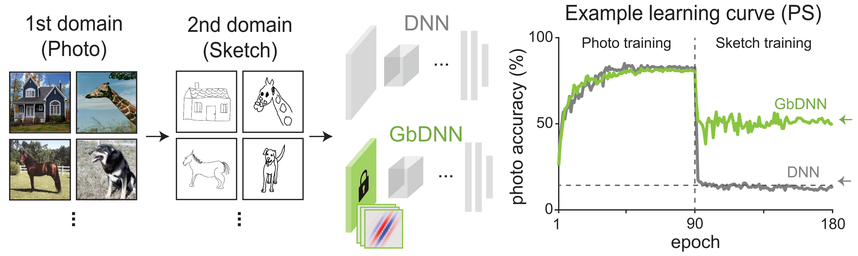
Q. Can Gabor-like receptive fields in the early layer enable domain-general object recognition?

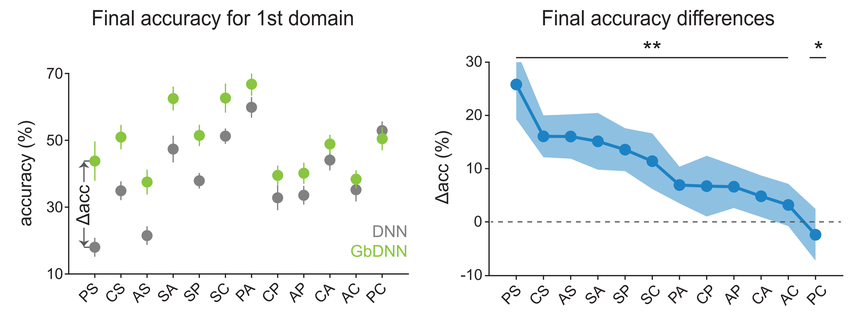
•Our model: Fixed Gabor filters in the early layer (GbDNN)



Key results

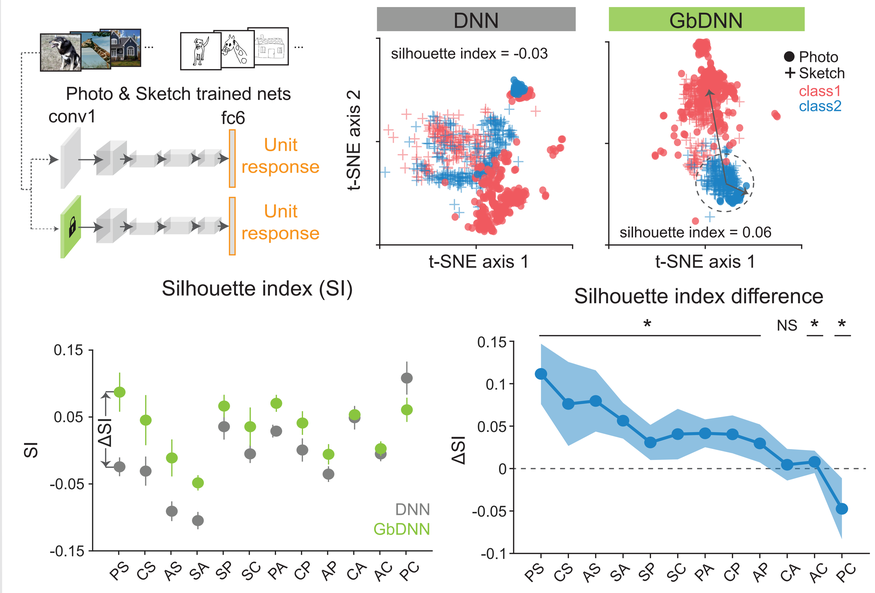
▪GbDNN robustly recognized objects under various domain changes





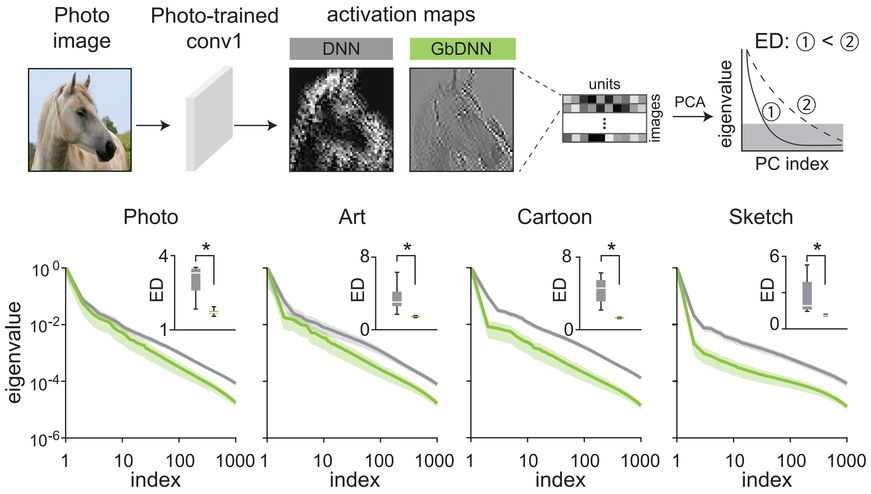
Results2

▪GbDNN produces invariant object representations across domains



Results3

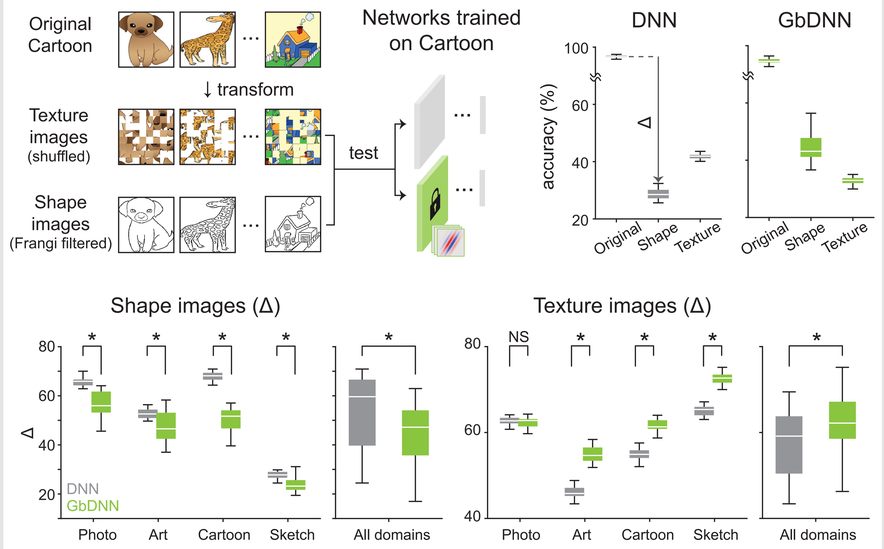
▪Gabor filters reduce dimensionality of learned representations



→ Gabor filters produce low-dimensional representations, enhancing generalizability

Results4

▪GbDNNs show shape-biased object classification



Conclusions

- Hard-wired Gabor filters, resembling the receptive fields of V1 neurons, enable consistent object recognition against dynamic environmental changes
- Our model inherently generate invariant object representations regardless of domains, leveraging global shape information
- Our results propose a biological strategy for environment-agnostic object recognition

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