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Stable receptive fields in the early visual pathways enable robust continual learning

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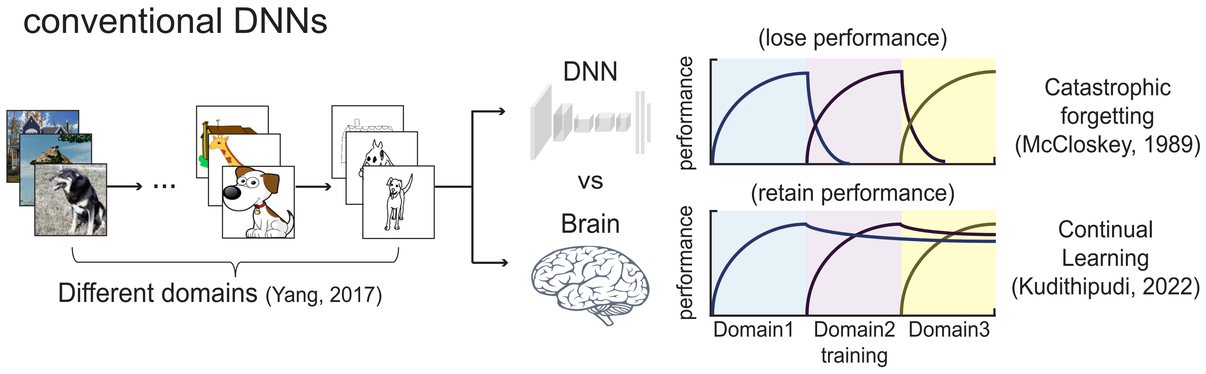
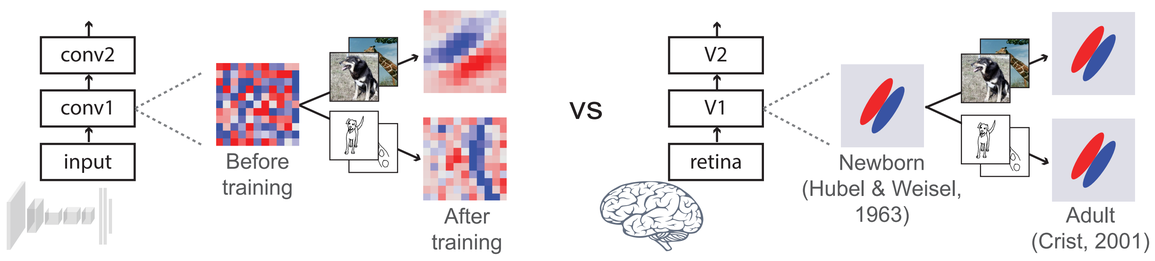
Introduction

- Continual learning is a key feature of animals but a challenging problem for conventional DNNs

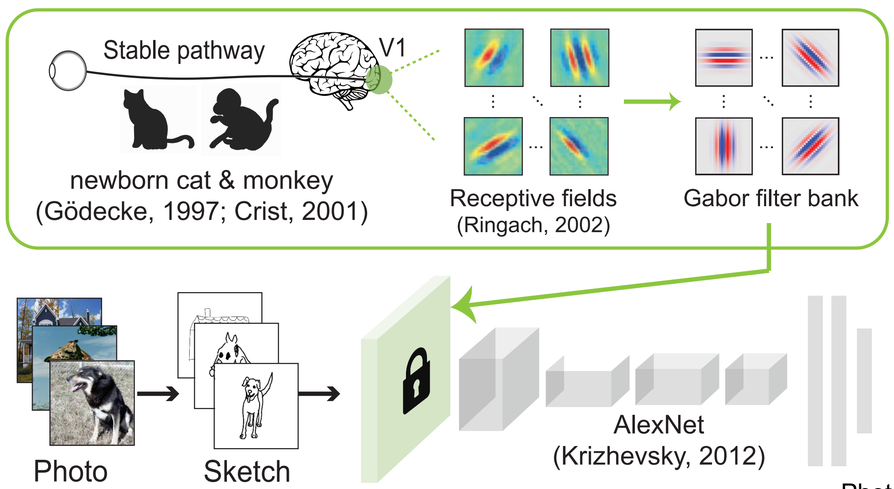


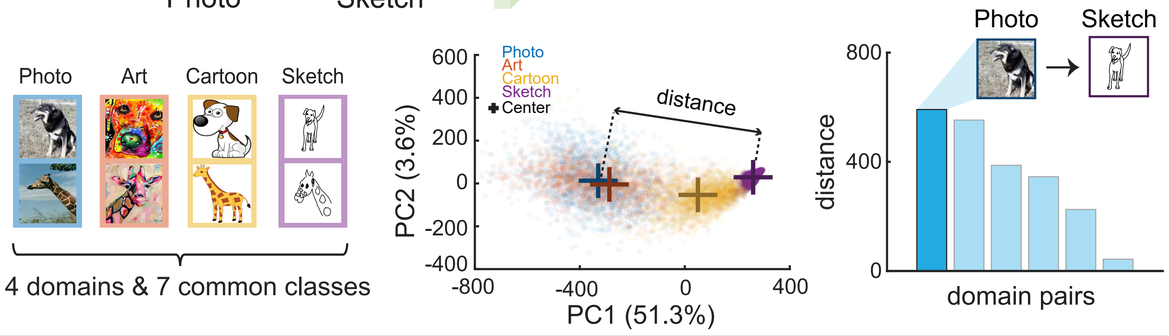
- Unlike DNNs, brain's early visual pathway has innate Gabor-like receptive fields that remain stable throughout visual experience



Q. Can stable receptive fields in the early layer enable continual learning under dynamic environments?

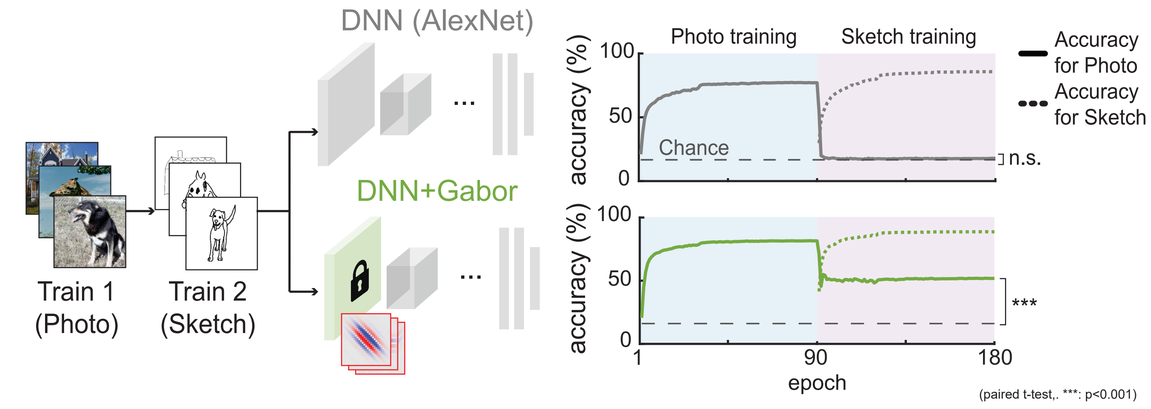
- **Our Model**: Fixed Gabor filters in the early layer (DNN+Gabor)

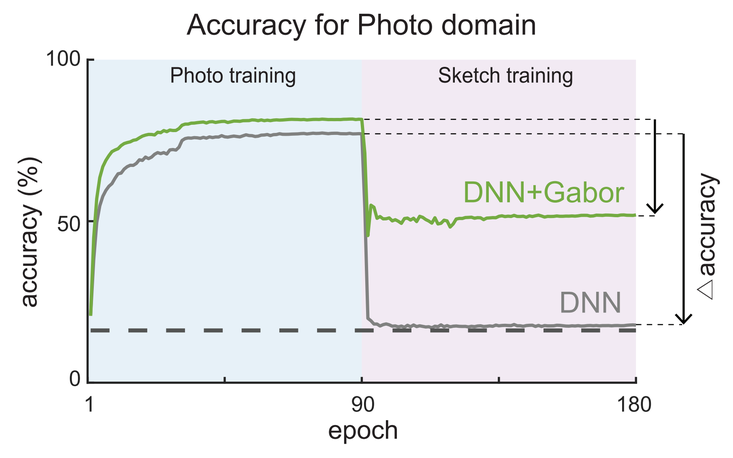


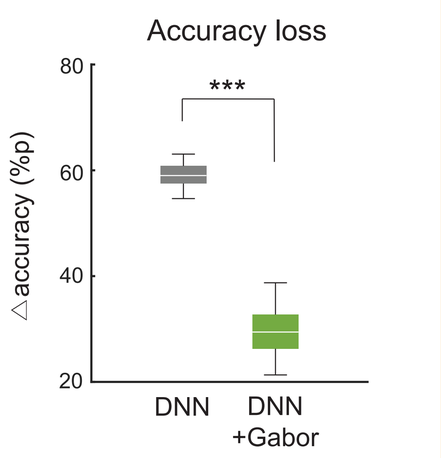


Results 1 (Key results)

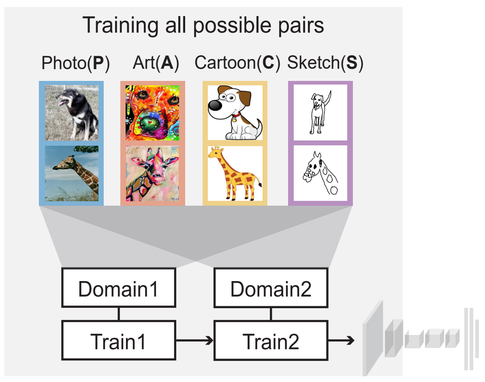
- DNN entirely lost performance, but DNN+Gabor maintained performance

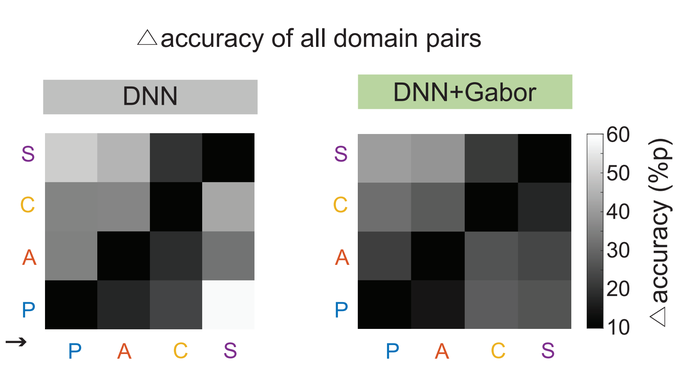




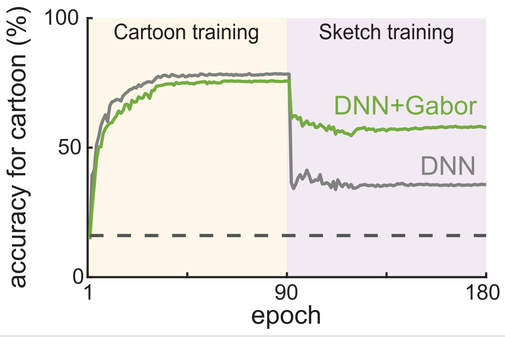


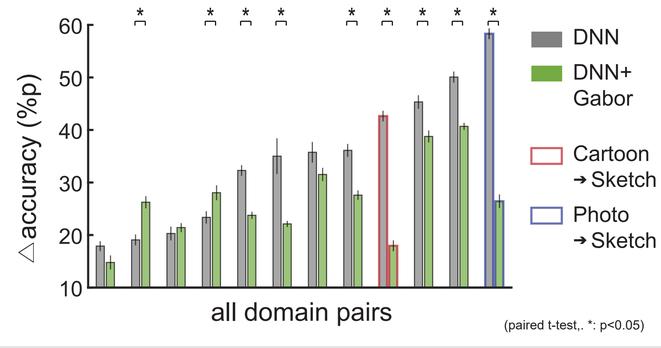
- DNN+Gabor maintained performance robustly for all domain changes





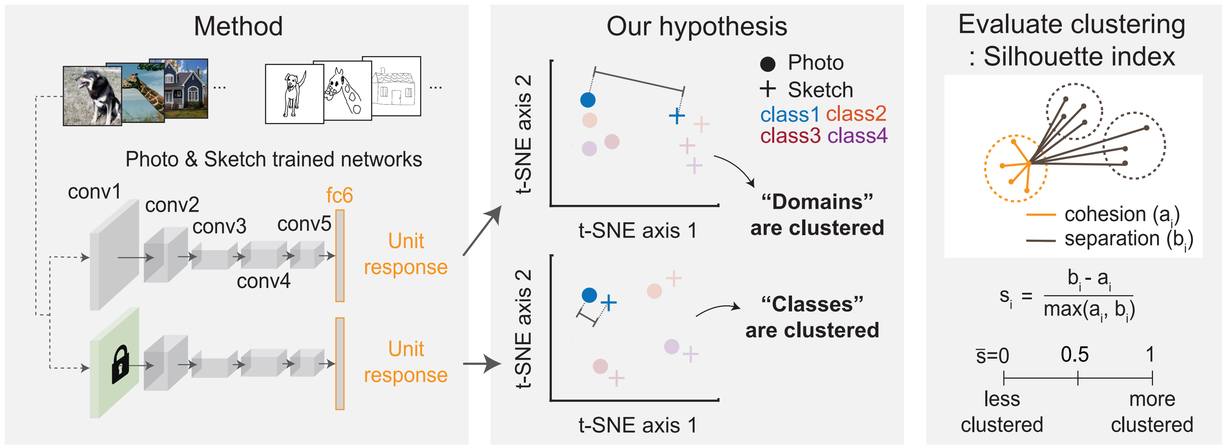
e.g. Cartoon ⟶ Sketch

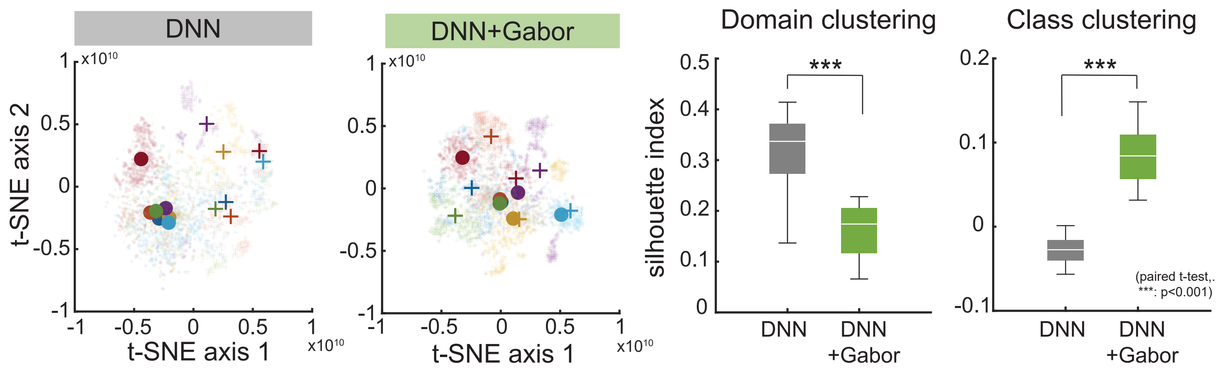




Results 2

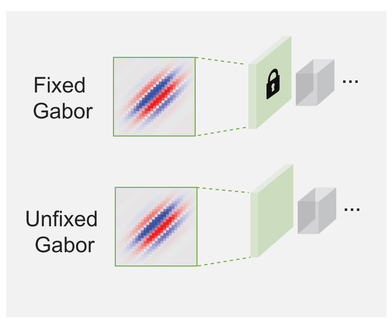
- Fixed Gabor filters enable networks to have similar representations across different domains

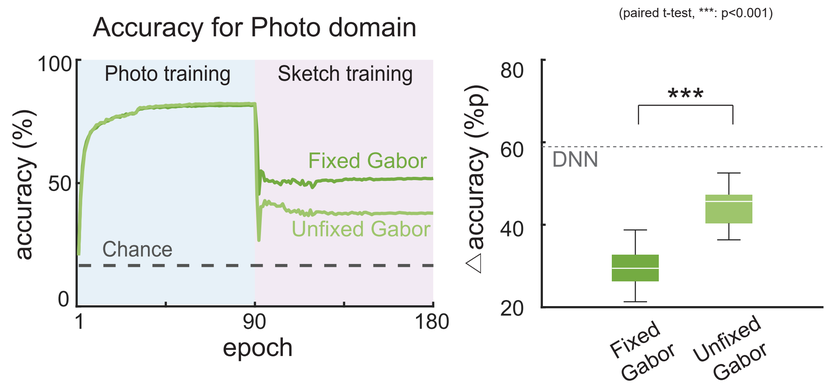




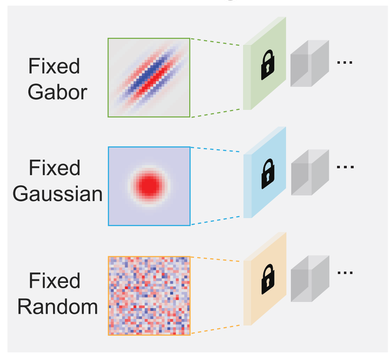
Results 3

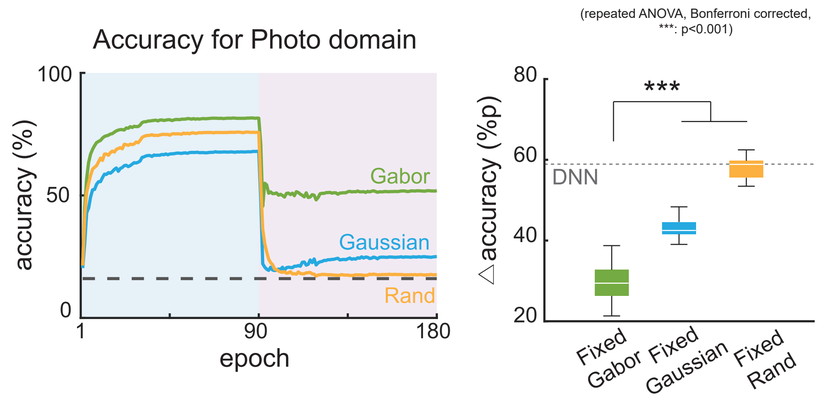
- Fixing filters is crucial for continual learning under domain change





- Gabor-like filter structure is also crucial for continual learning under domain change





Conclusion

- Networks with fixed Gabor filters, resembling stable early visual circuitry, maintained performance and representation under dynamic environments.
- Our results suggest that fixed Gabor filters in early layers could be key architectures for continual learning in dynamic environments.
- These may highlight the functional significance of innate, stable early visual pathways in the brain.

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