

Pretraining with random noise for fast and robust learning without weight transport

Jeonghwan Cheon, Sang Wang Lee & Se-Bum Paik

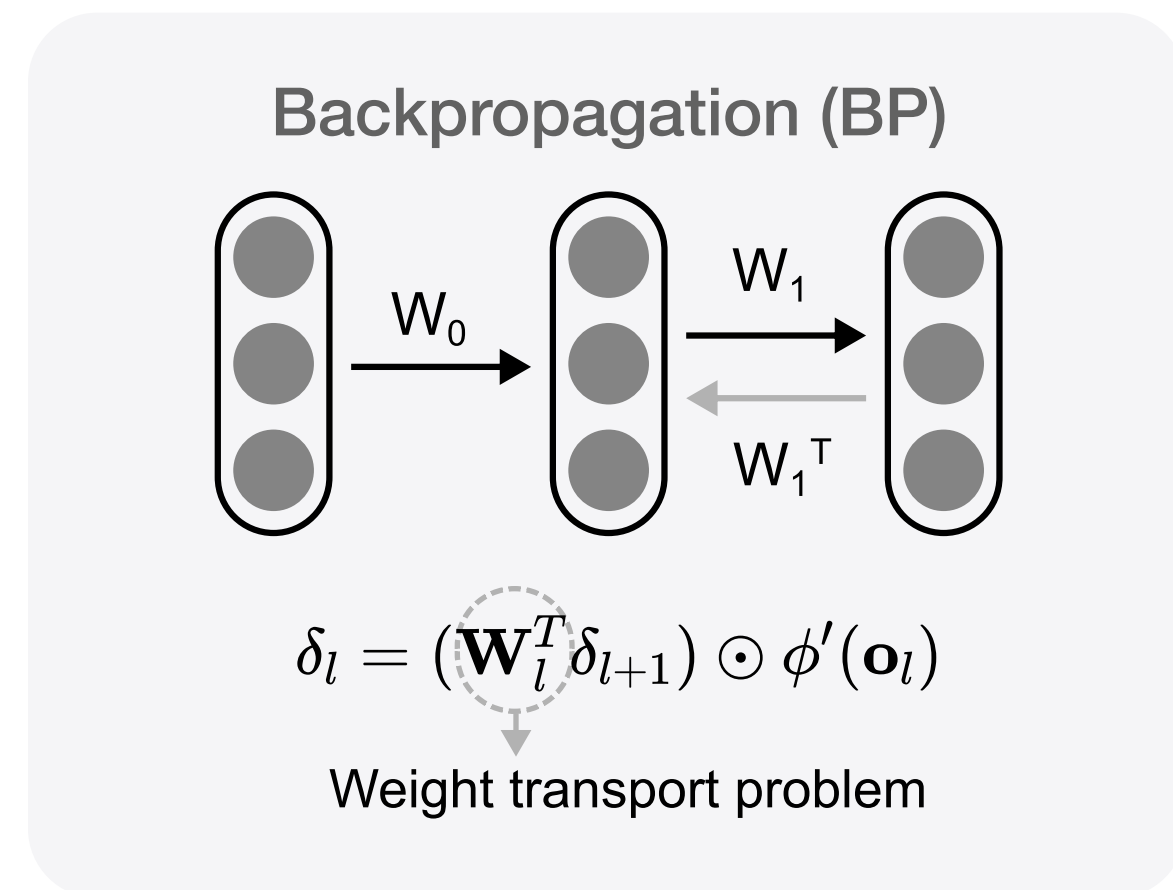
Department of Brain and Cognitive Sciences
Korea Advanced Institute of Science and Technology



Does the brain do backpropagation?

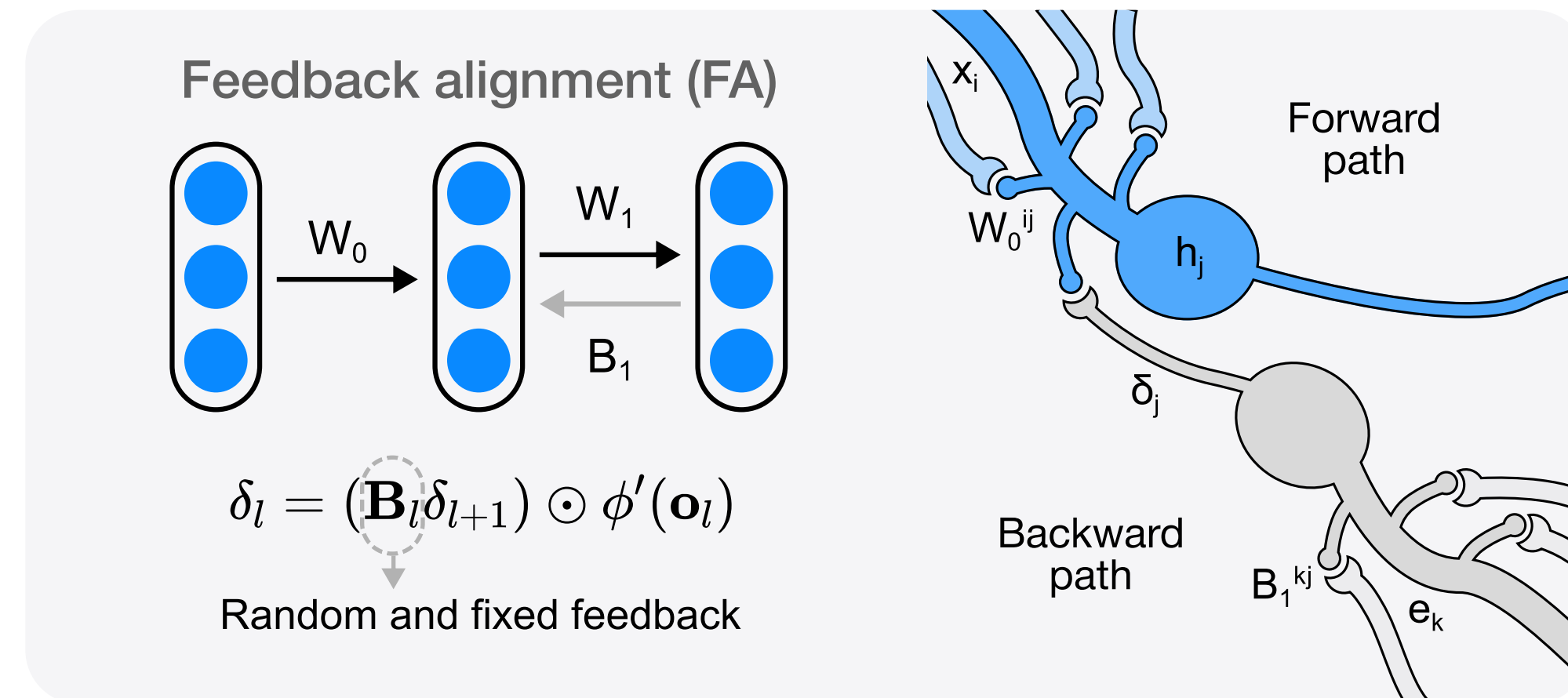
Weight transport problem

Weight transport problem of backpropagation



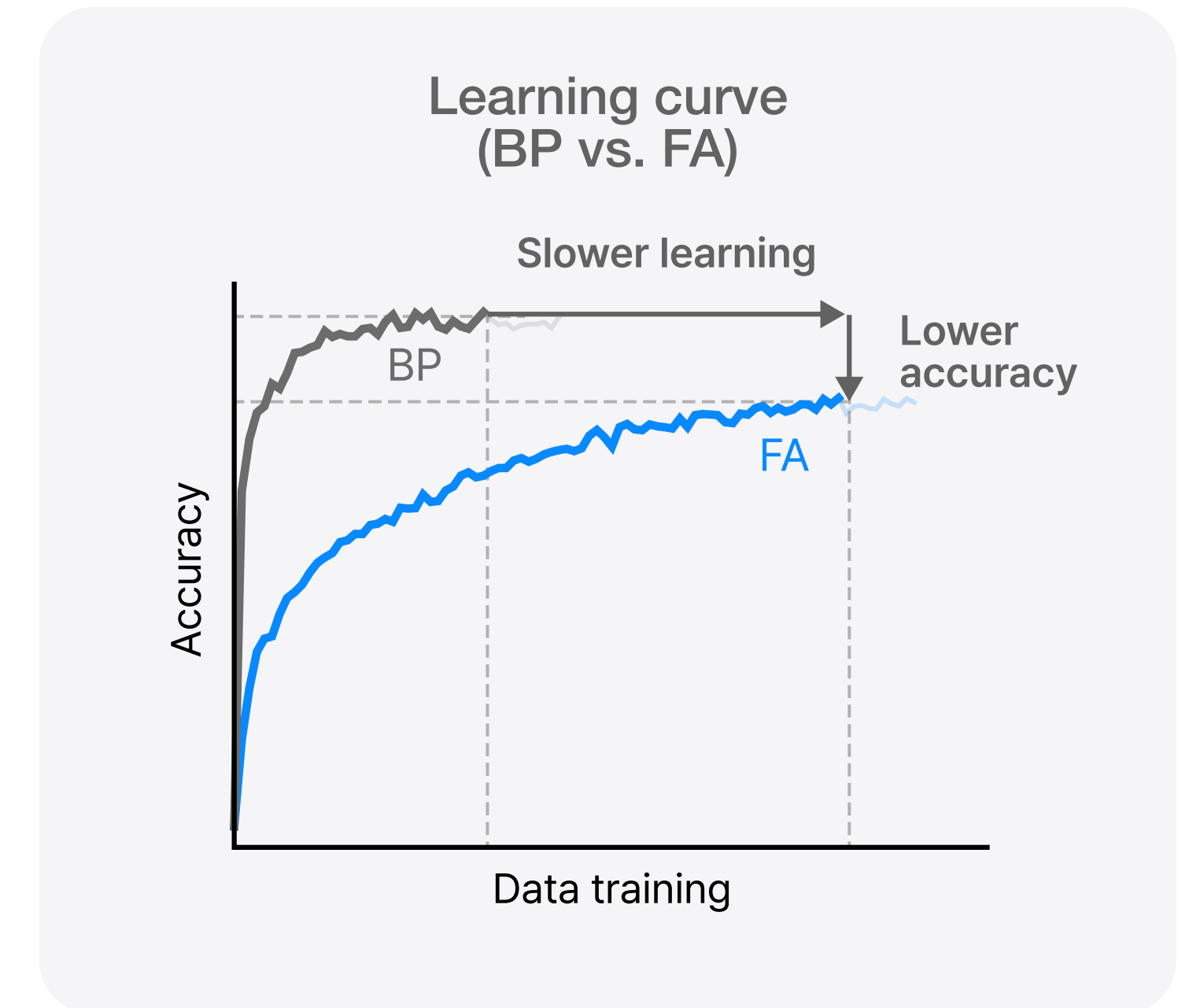
Rumelhart, 1986

Feedback alignment: A bio-plausible alternative



Lillicrap, 2016

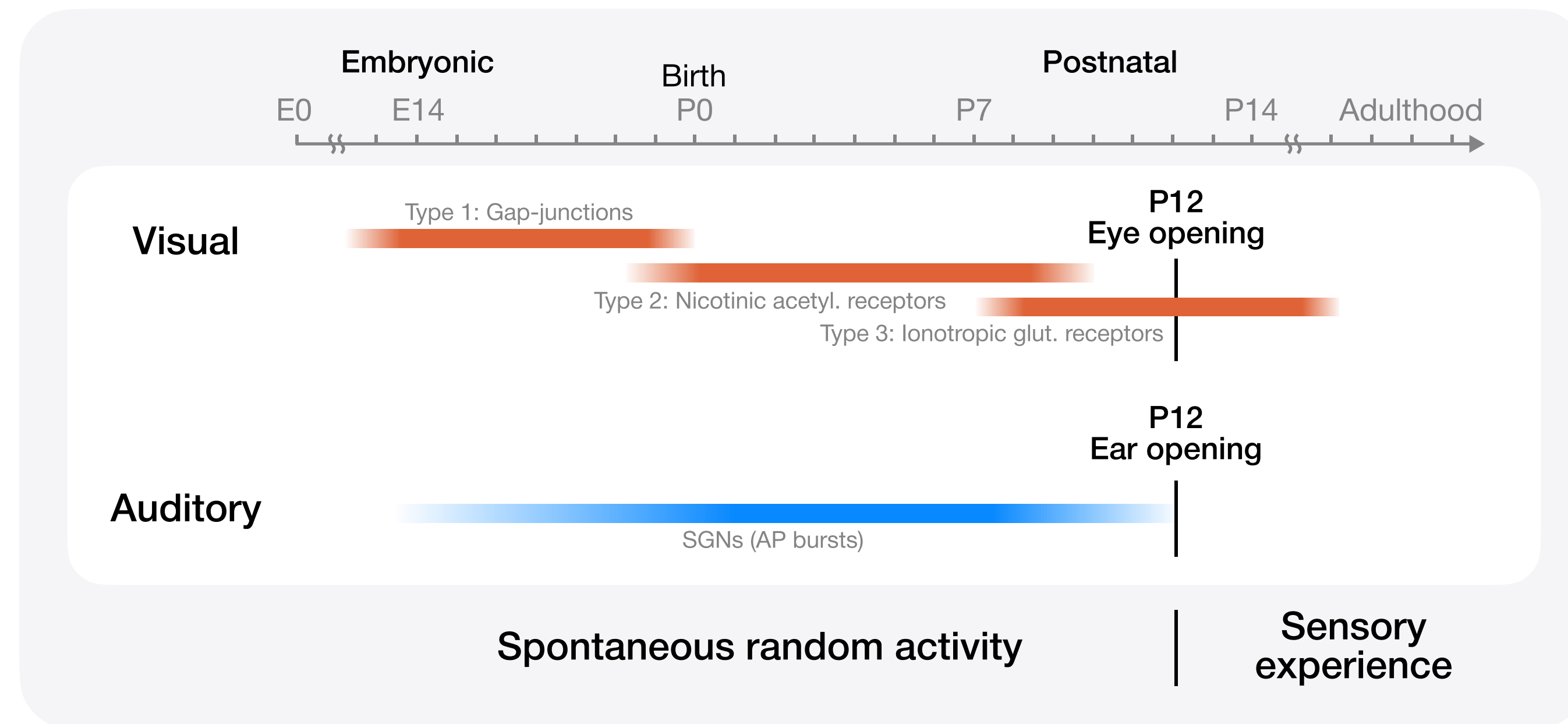
FA works, but its learning efficiency is poor



Spontaneous random activity before sensory experience

Insights from developmental neuroscience

Spontaneous neural activity is observed in brain before sensory experience



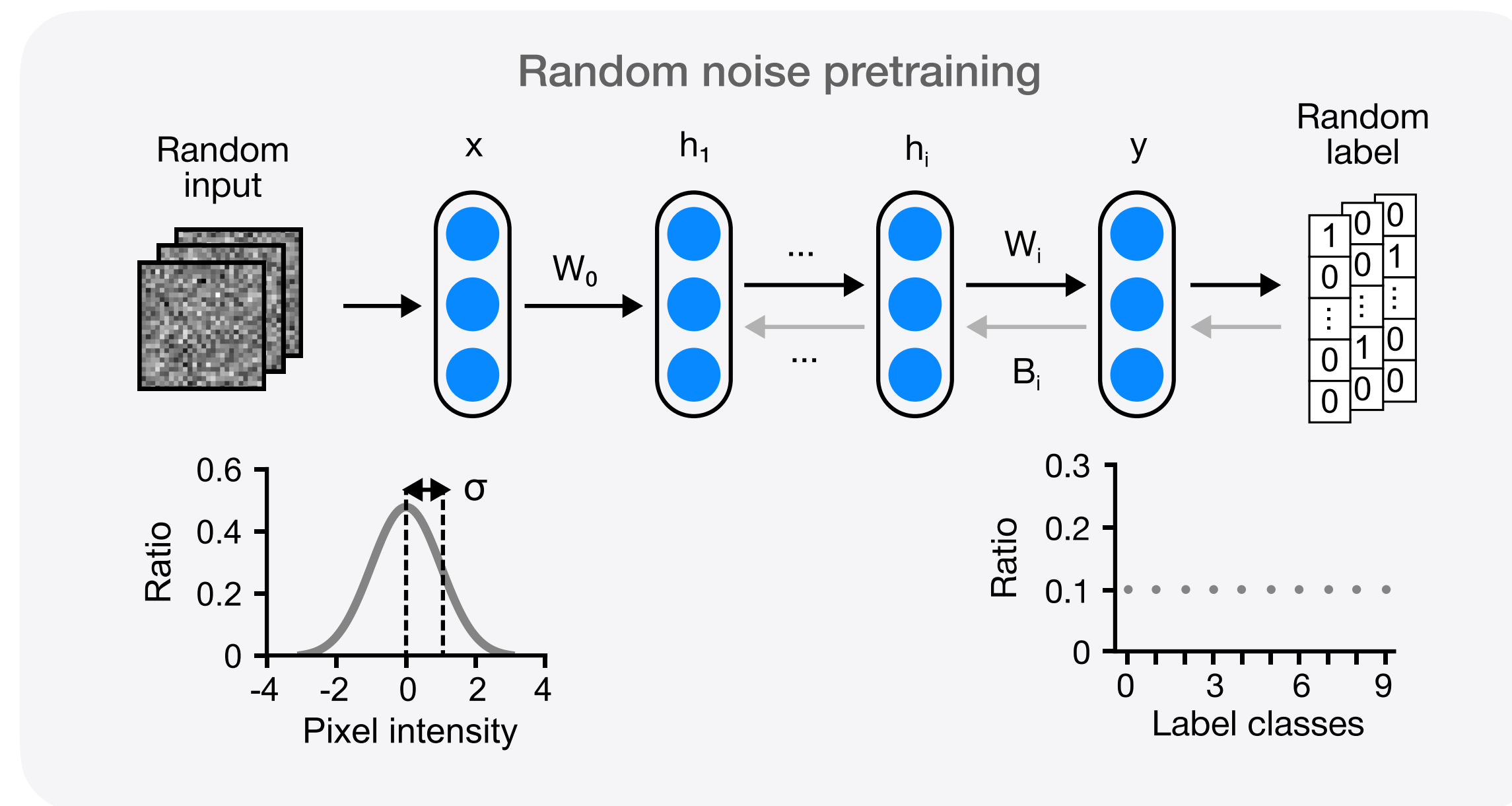
Martini et al., 2021

Can prenatal random activity enhance learning efficiency?

Pretraining with random noise

with feedback alignment without weight transport

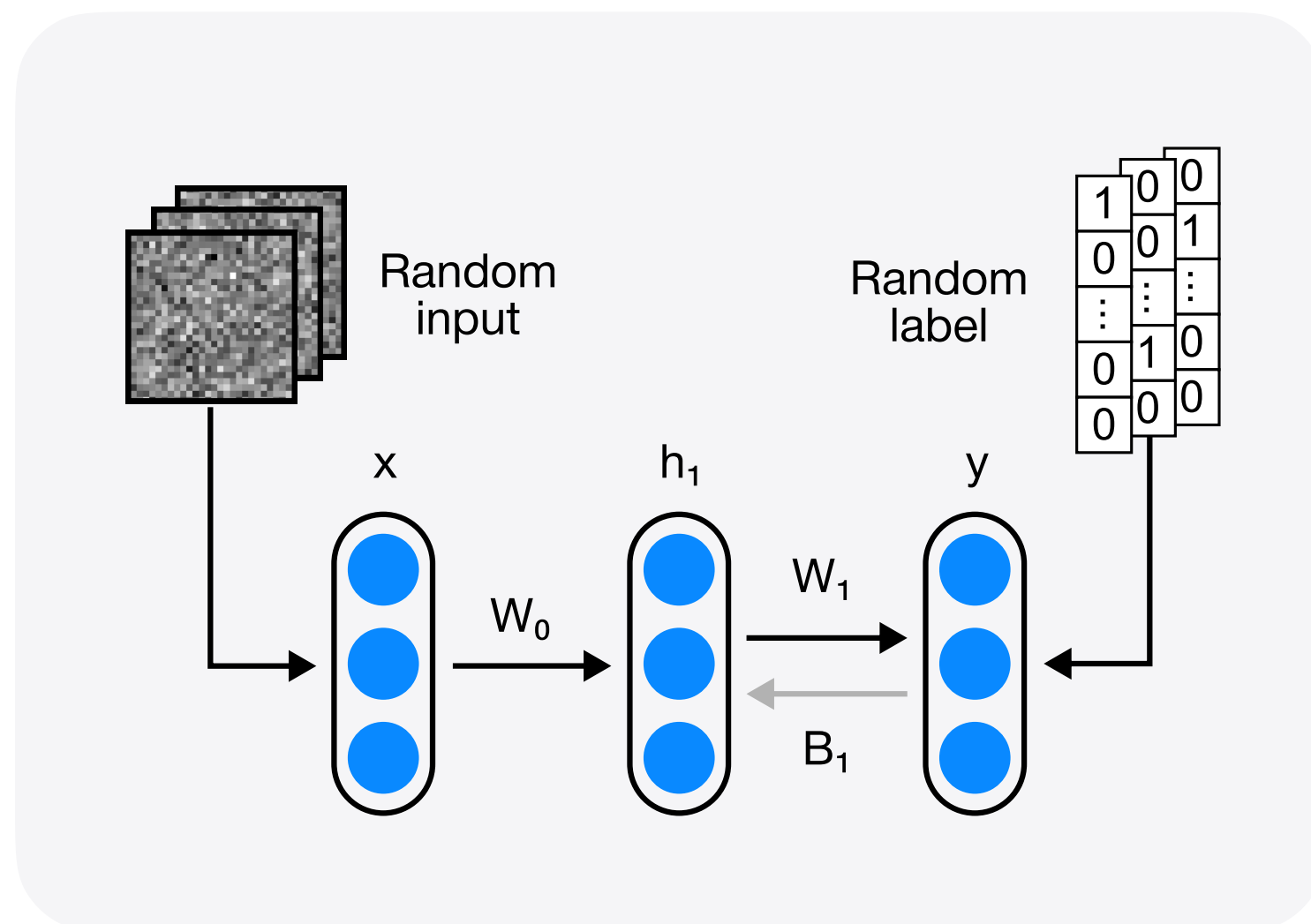
Training neural network with random input and label



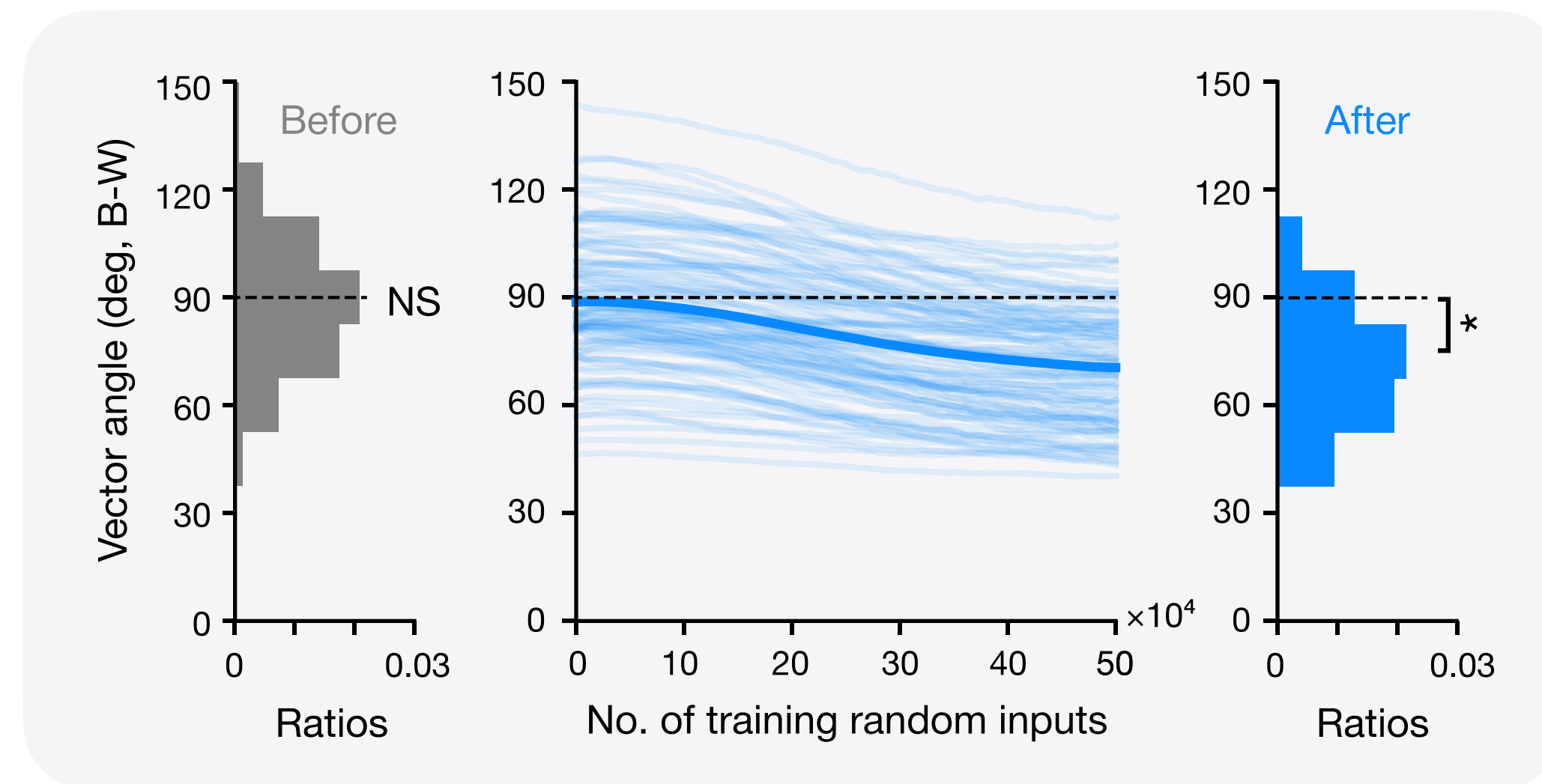
Result 1

Weight alignment to synaptic feedback

Random noise pretraining



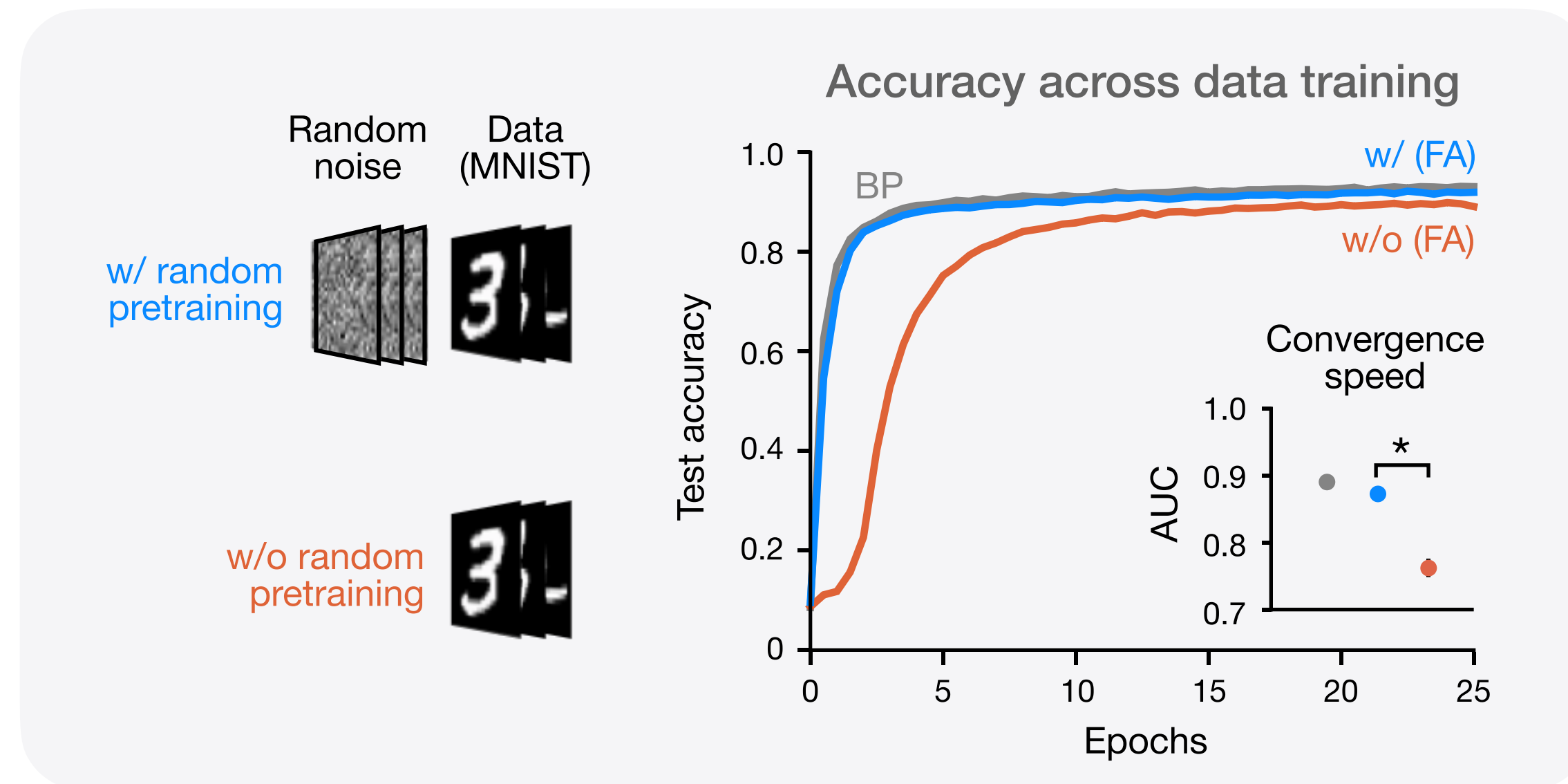
Alignment of forward and backward weights



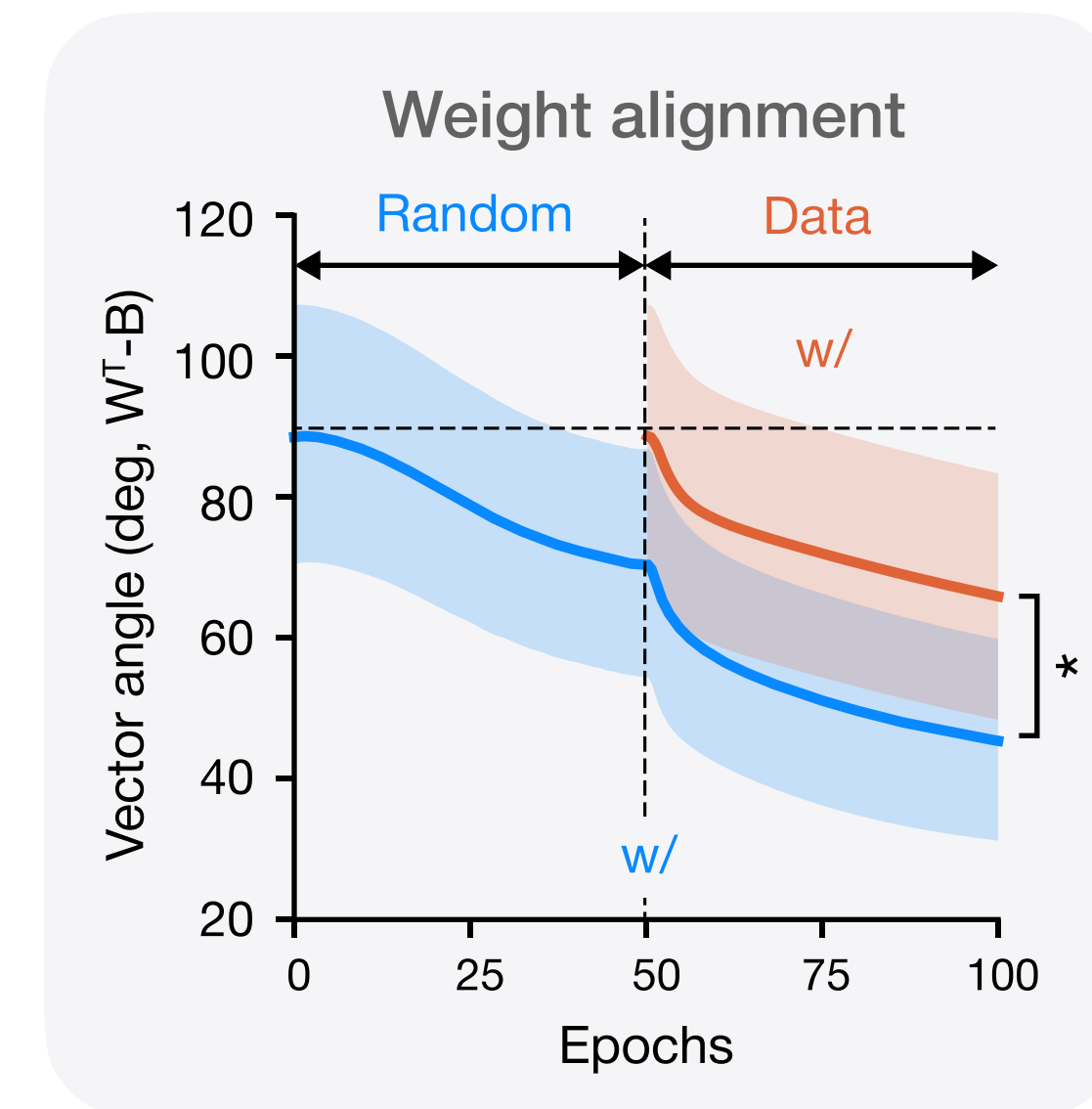
Result 2

Fast and accurate learning during subsequent data training

Fast and accurate learning of random pretrained network



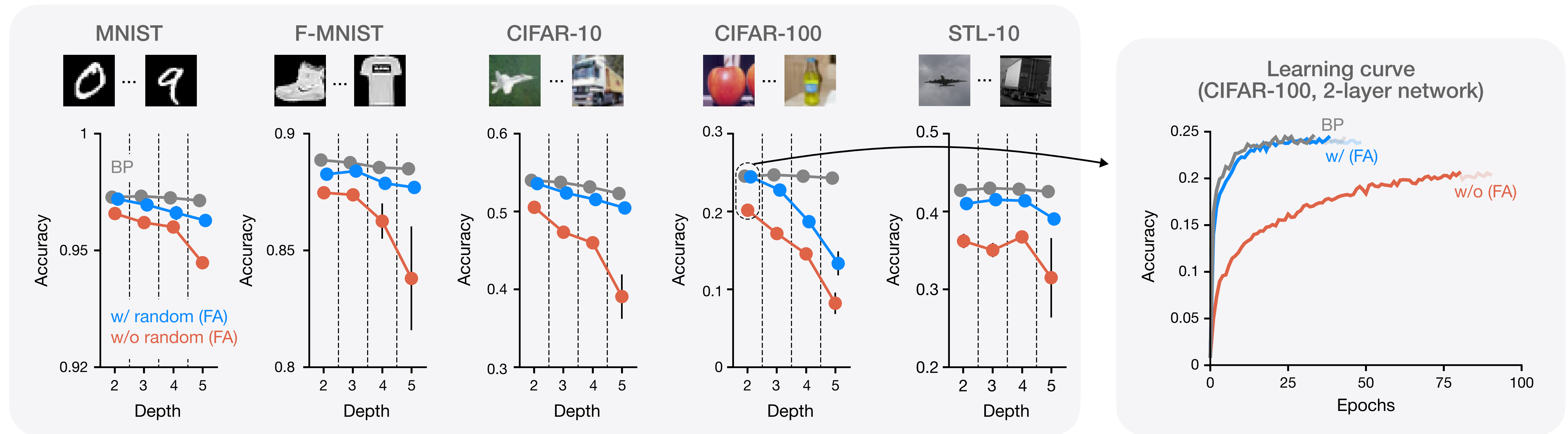
Enhanced weight alignment



Result 2

Fast and accurate learning during subsequent data training

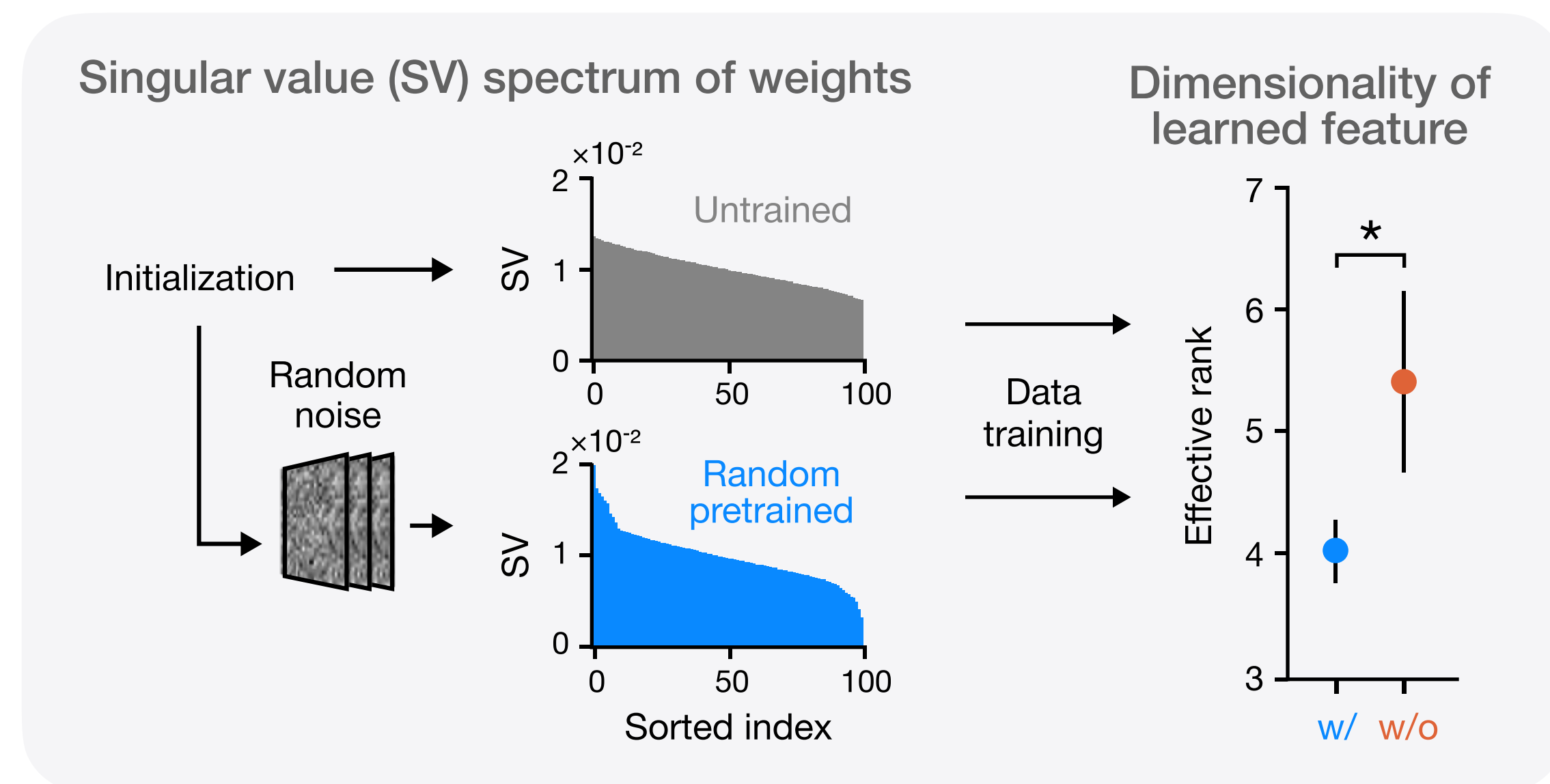
Enhanced model performance across different image datasets and network depths



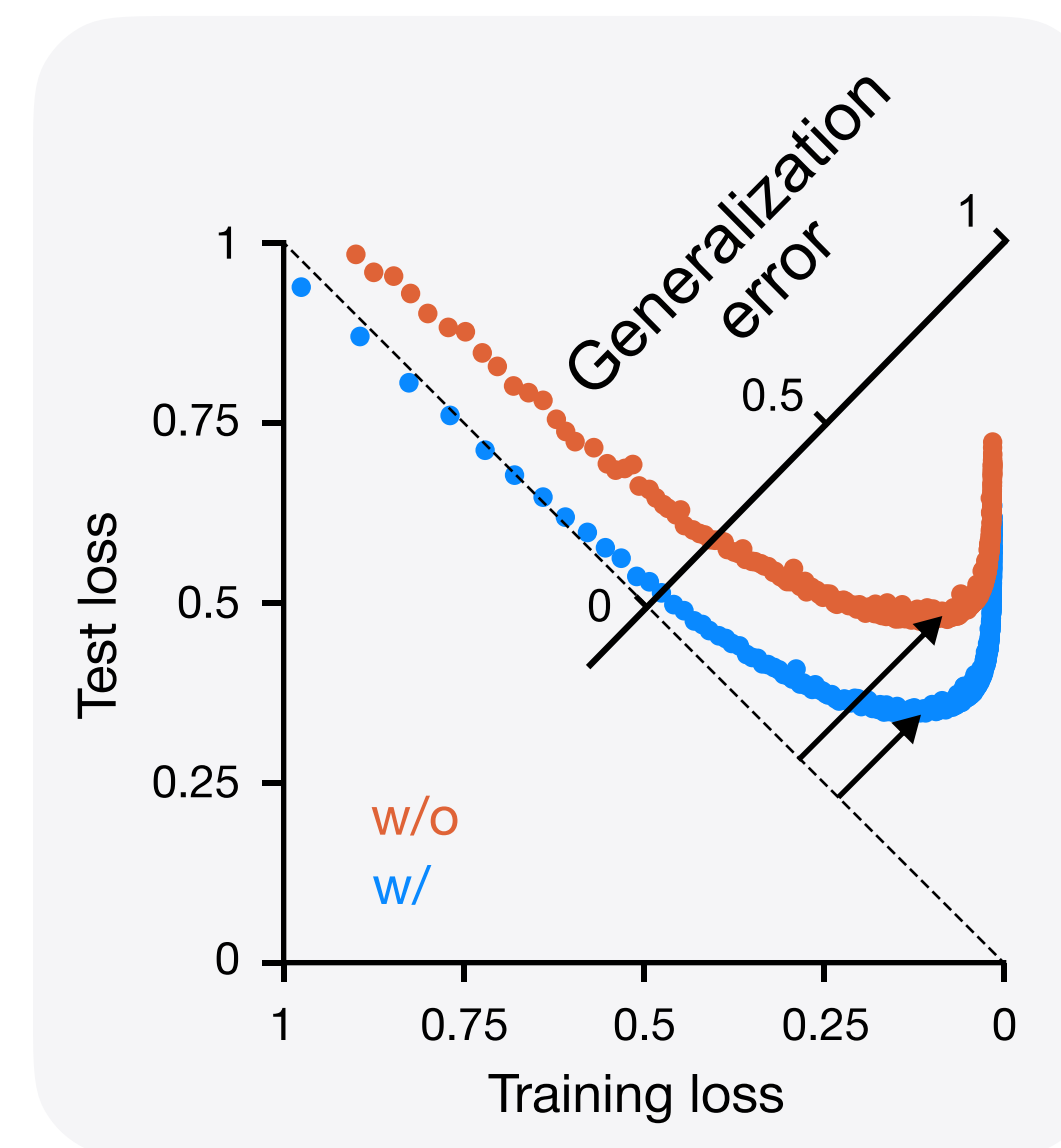
Result 3

Random pretraining as pre-regularization for robust generalization

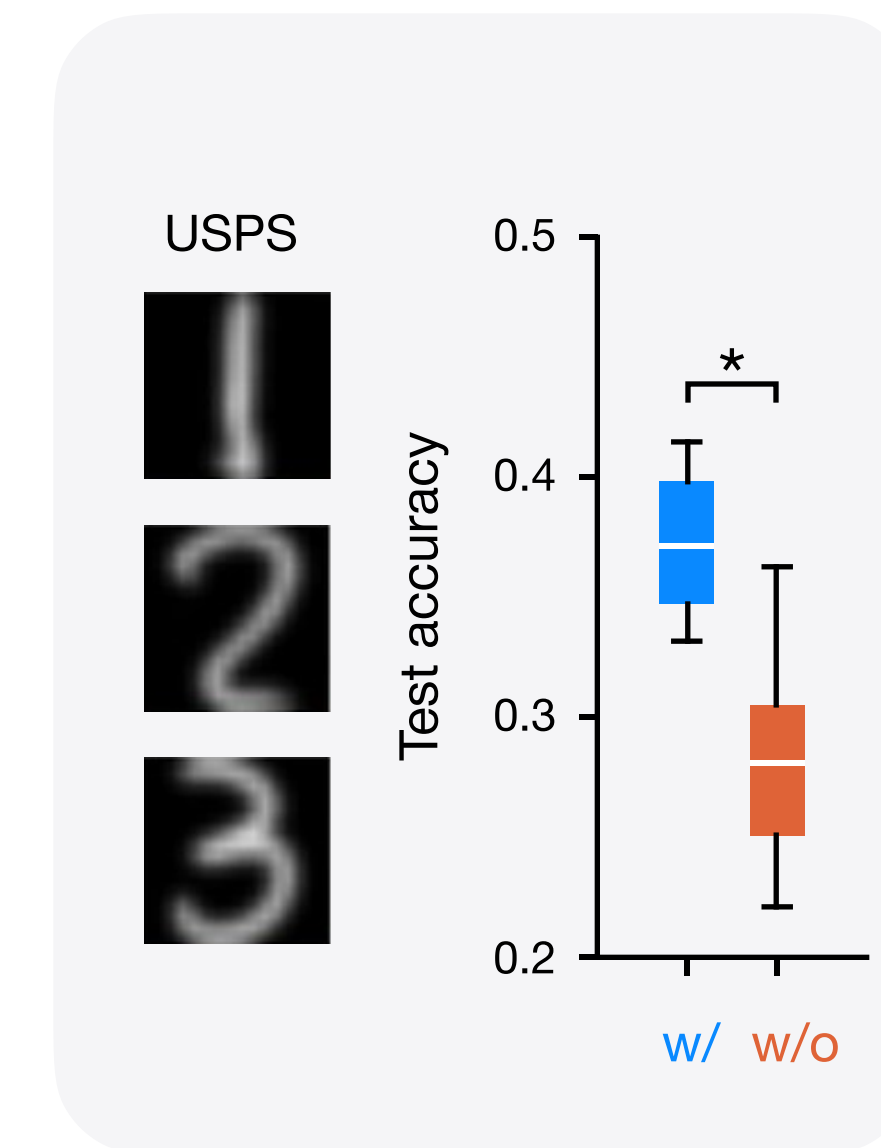
Pre-regularization for learning a low-rank solution



ID generalization



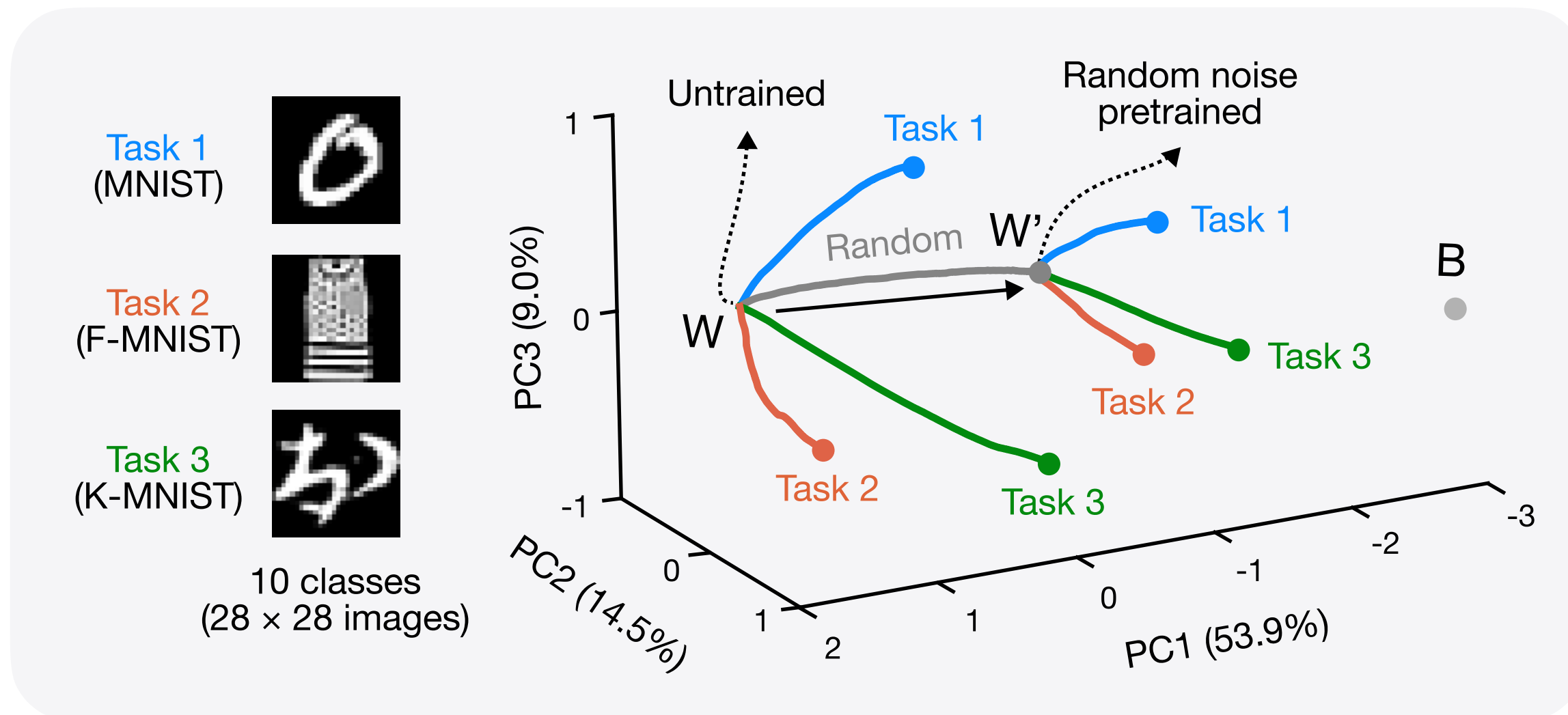
OOD generalization



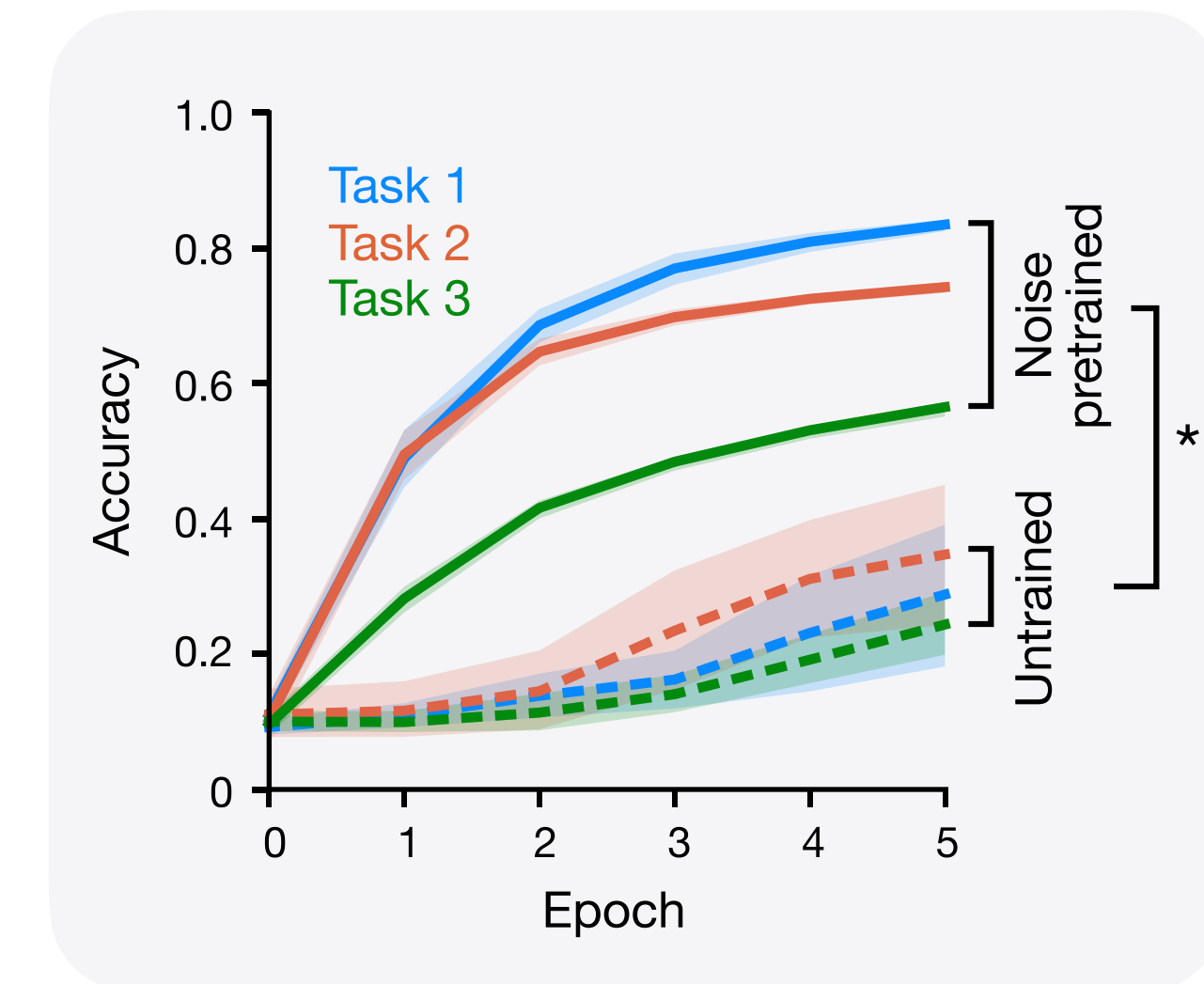
Result 4

Random pretraining as meta-learning for task-agnostic fast learning

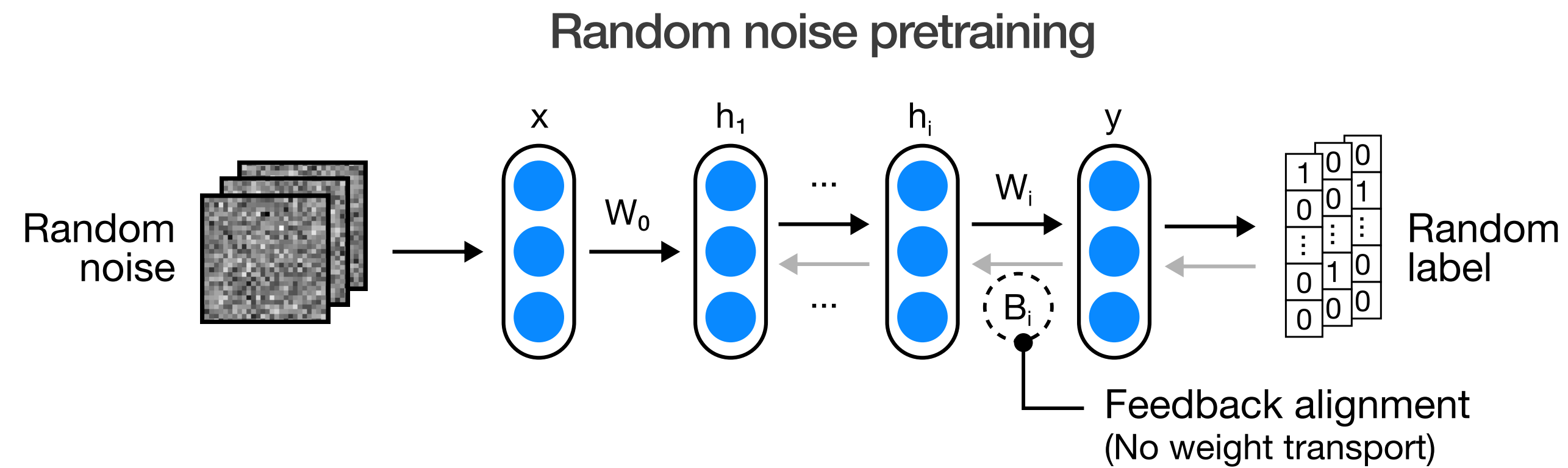
Random training enables meta-learning over tasks



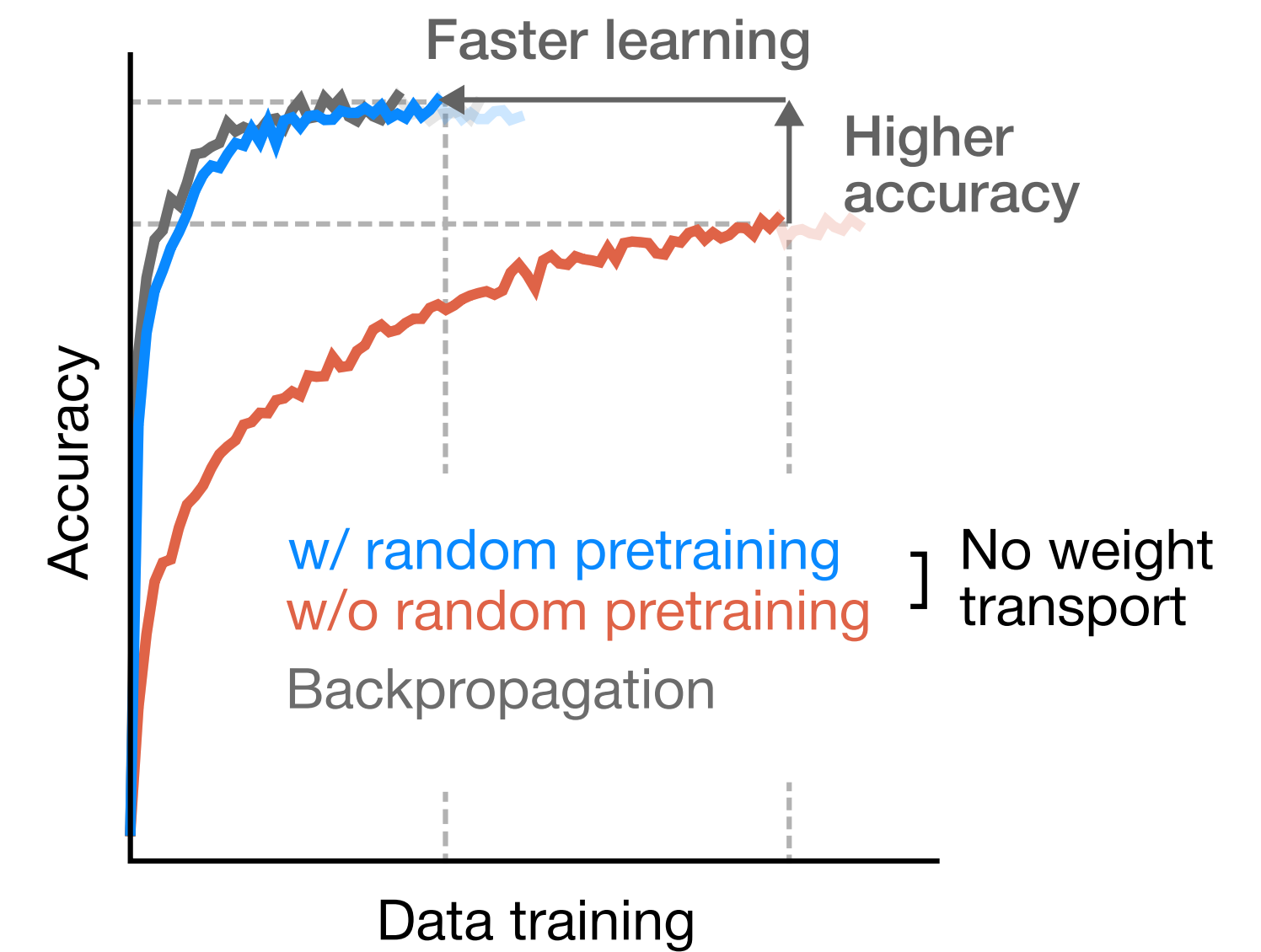
Task-agnostic fast learning



Summary



1. Weight alignment to synaptic feedback
2. Fast and accurate learning during subsequent data training
3. Pre-regularization for robust generalization
4. Meta-learning for task-agnostic fast learning



Acknowledgements

Presenter



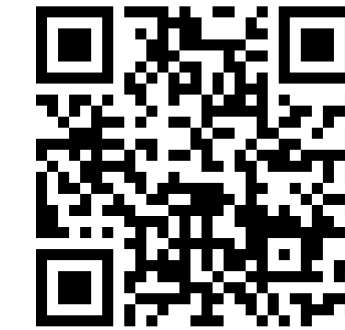
Jeonghwan Cheon
Master's students
Brain & Cognitive sciences
KAIST



Se-Bum Paik
Professor
Brain & Cognitive sciences
KAIST



Sang Wan Lee
Professor
Brain & Cognitive sciences
KAIST



arXiv
arxiv.org/abs/2405.16731



Code
github.com/cogilab/random



Lab
cogi.kaist.ac.kr