Low Image-Dataset Quality Strongly Contributes To DCNN Texture-Bias

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Origins of Texture-Bias

Deep Convolutional Neural Networks (DCNNs) trained on ImageNet have been shown to exhibit a texture-bias (*Geirhos et al. 2018*). The origin of this texture-bias has been debated widely (*e.g., Hermann et al. 2020*).

Here, we show that DCNNs trained on an **ultra-high-resolution dataset** exhibit a **more human-like shape-bias**.

Further, when tested on the ImageNet texture-bias benchmark, the texture-bias drastically decreases.

Open Amsterdam Data Set (OADS)

Ultra-high-resolution, labelled image dataset

5691 Images ⇔ **5496x3672** pixels

98534 Object Label annotations

Contributions

Introduction of ultra-high-resolution labelled image dataset OADS

Creation of high-resolution cue-conflict dataset

Texture-bias arises as a function of image quality

Texture-bias is reflected in representational geometry

Interaction between image resolution during training and testing and texture-bias

DCNN Training & Assessment

We train ResNet50 models with different image resolutions on a low-quality dataset (ImageNet) and a high-quality dataset (OADS) and assess DCNN texture-bias on both low-quality and high-quality cue-conflict benchmarks.

We created an **OADS** Cue-Conflict dataset using Neural Style Transfer[3] offering an alternative, high-resolution assessment of texture-bias in DCNNs to the ImageNet benchmark in *Geirhos et al., 2018*.

Schematic representation of model training, cross-finetuning and texture-bias assessment

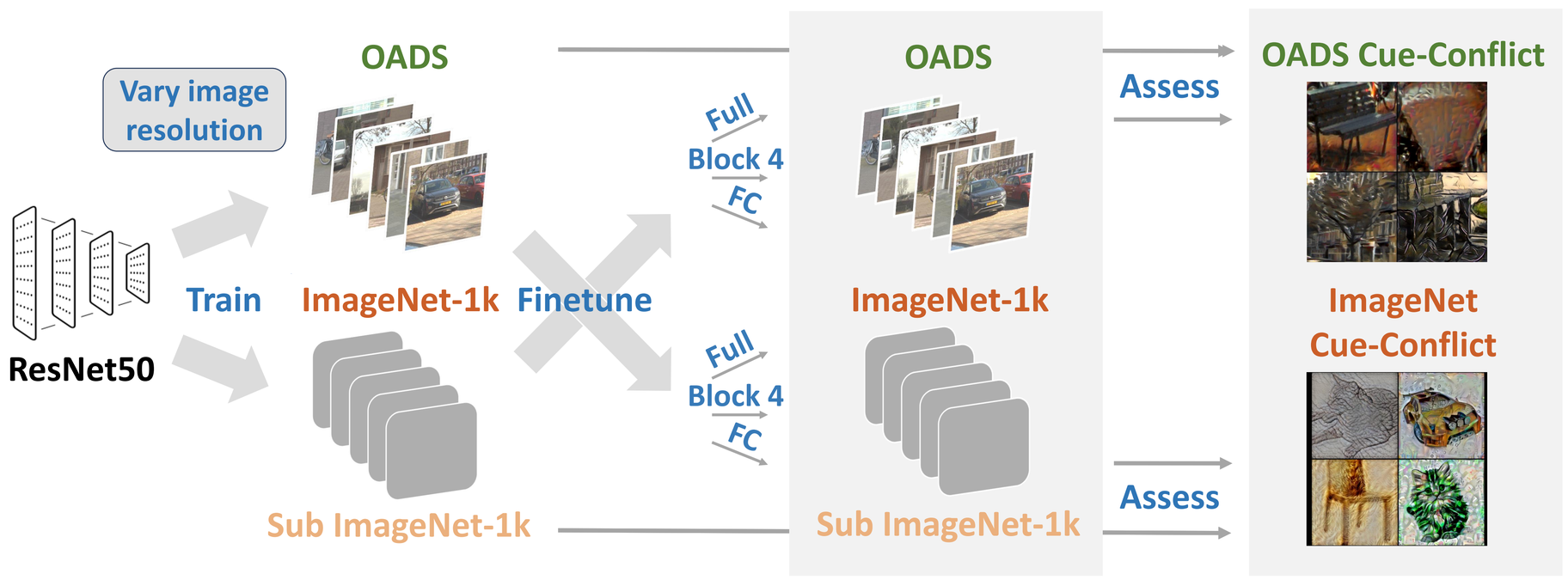
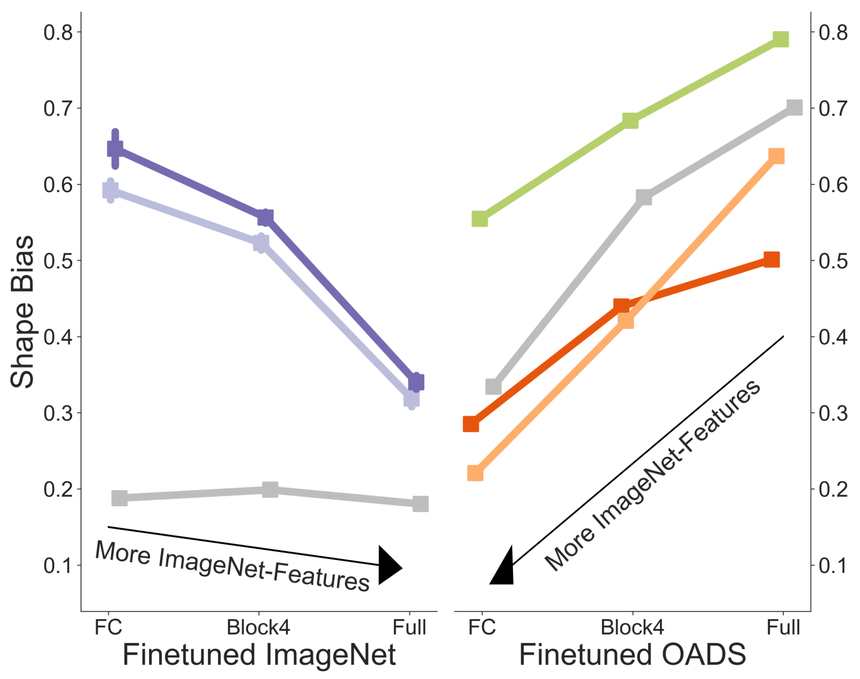


Image Quality vs. Texture-Bias

ImageNet-Features display low shape-bias



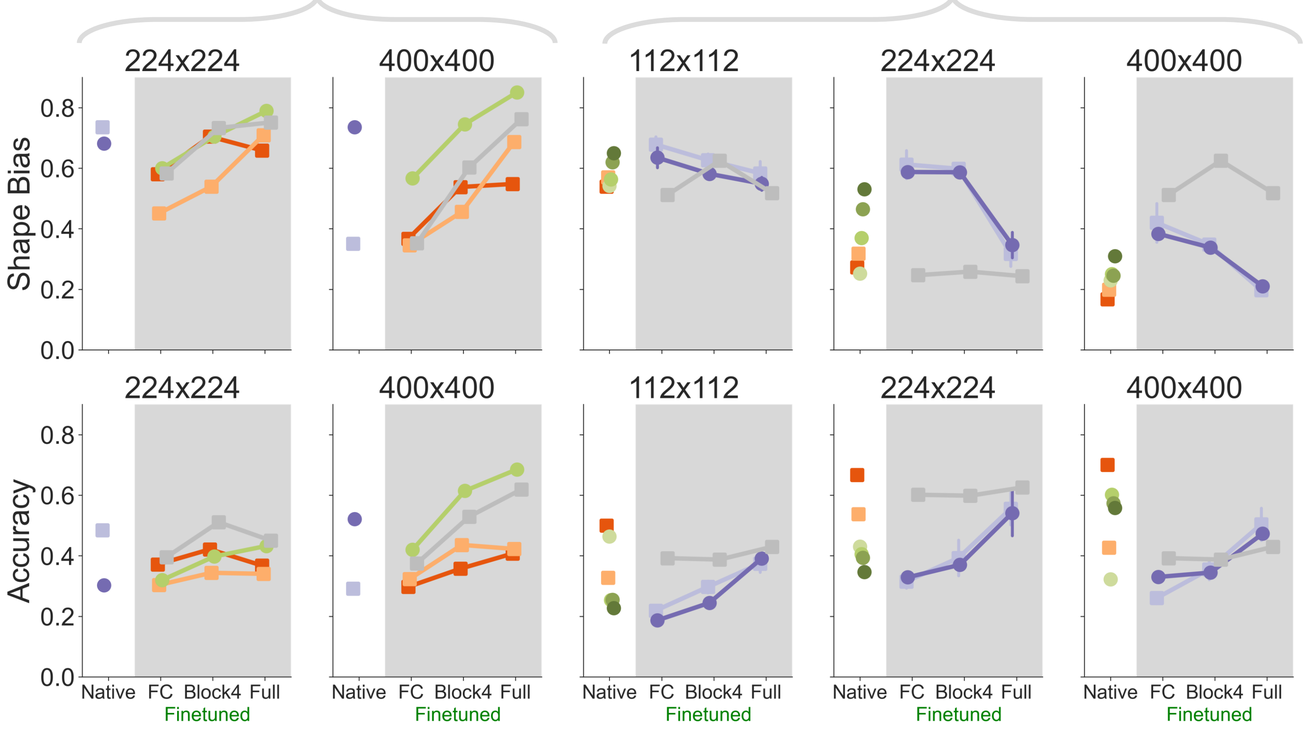
ResNet50 Pre-Training

- OADS 224x224
- OADS 400x400
- ImageNet JPEG 224x224
- Sub-ImageNet JPEG 224x224
- Sub-ImageNet JPEG 112x112
- Sub-ImageNet JPEG 400x400
- Sub-ImageNet JPEG 500x500
- Sub-ImageNet JPEG 600x600
- Places365 JPEG 224x224

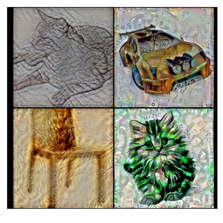
Shape-bias increases with image resolution

Dataset content influences shape-bias

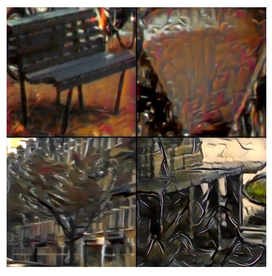
OADS Cue-Conflict | **ImageNet Cue-Conflict**

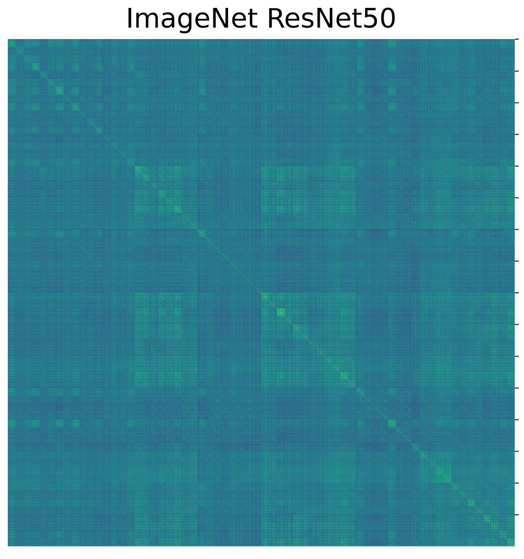


ImageNet Cue-Conflict

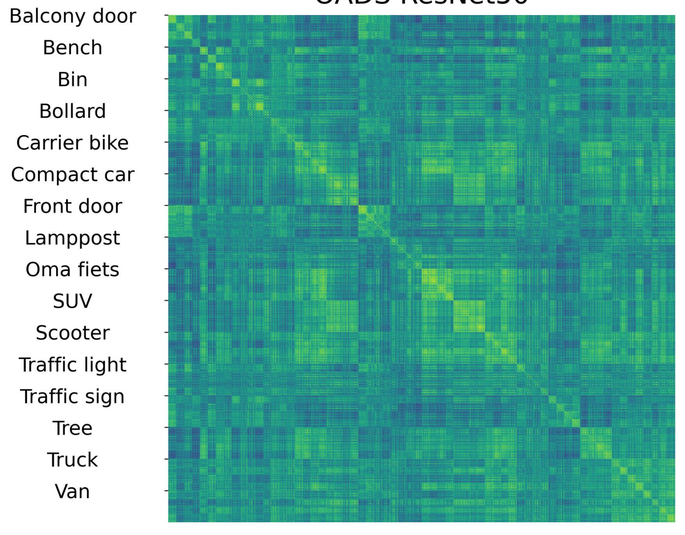


OADS Cue-Conflict

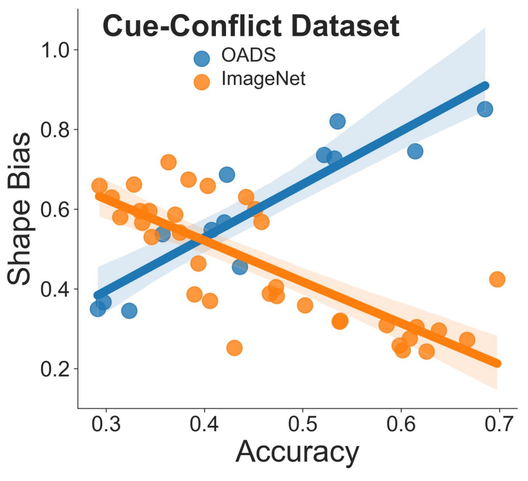




High Texture-Similarity



High Shape-Similarity



Accuracy determines estimation precision

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References | [1] Geirhos et al., *CVPR,* 2018; [2] Hermann et al., *NeurIPS,* 2020; [3] Gatys et al., *IEEE,* 2016.