MODELING EFFECTS OF BLURRED VISION ON CATEGORY LEARNING

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Background

Visual acuity develops substantially in the first few months of life (Hugelberg 1992). This increase in acuity occurs in tandem with broader visual category learning. Studies show this visual learning period is critical to perceptual tasks including peripheral vision and global motion, along with facial recognition (Lewis et al. 2005, Roder et al. 2013). Convolutional neural networks (CNNs) are computer vision models partially inspired by the human visual processing system. They are not very robust to image degradation and are particularly susceptible to blur, noise, and occlusion (Kaheman et al. 2016). Building on Vogelsang et al. (2013), we investigate training CNNs with blurry training images to mimic human visual development.

Does including blurry images during computational model learning lead to more robust vision? Are there specialized learning effects based on classification task difficulty or model complexity?

Methods – Network Training

- **Single-blur training**: Round of single-blur training and testing consists of training network with images at each blur level, then testing each network on all blur levels.
- **Sequential-blur training**: Train network on sequences of images with different blur levels: Seq 1: (1, 3, 5, 11), Seq 2: (1, 2, 3, 11), Seq 3: (1, 3, 11), Seq 4: (1, 3, 11), Seq 5: (1, 3, 11).
- **Long** and **Short** training: Each blur level uses 100 epochs to train.
- All methods use 5-fold cross validation

Results – Single Blur Training

Across both networks and datasets:
- Top accuracies when test images have same blur as training images.
- Imbalanced benefit of training blur: Learning from high blur images allows somewhat strong recognition for low blur images; learning from low blur images does not equally benefit high blur image recognition.
- Imagenette vs Imagewoof: Higher accuracies for Imagenette than Imagewoof.
- More pronounced blur effects on learning for Imagewoof than for Imagewoof.

Discussion

- Training CNNs with blurry images improves classification accuracy for clear images, but disappointingly improves accuracy identifying lower resolution images.
- Average classification accuracy across blur levels is greater when some level of blurry images is included in training, and sequential blur training was more effective than single blur.
- Posters of blurry images show greater testing benefit, even without using more training time.
- High blur benefits are less pronounced - longer training time had partial effect on accuracy.

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References


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