Face Inversion Effect in DNNs

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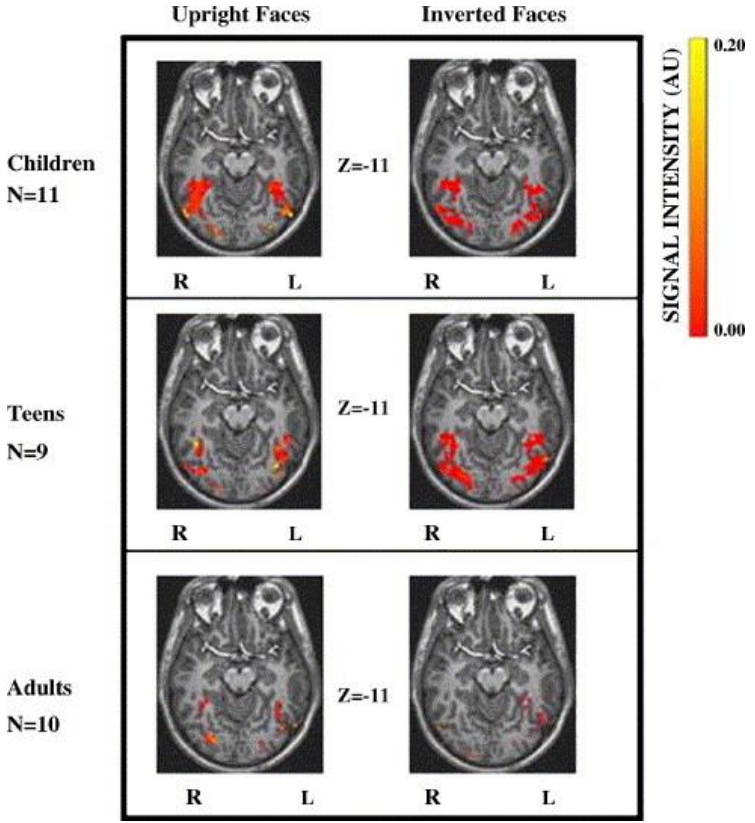
Psych 250

Motivation

- The Face Inversion Effect
  - 1-year-old's behavioral FIE approximates an adult's [4]
  - Neural FIE increases with age (even into adulthood) [1]
  - Upright & inverted face processing differ quantitatively, not qualitatively [5]



Neural correlate of FIE in children, teens, and adults [1]

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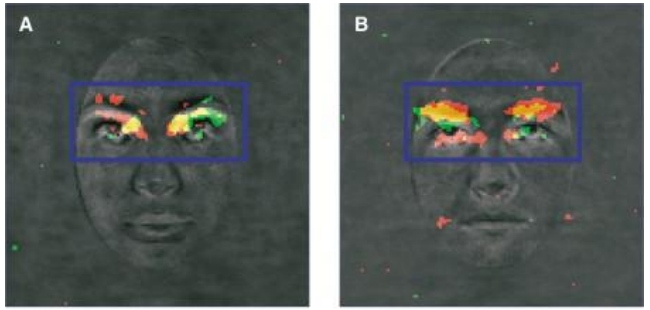


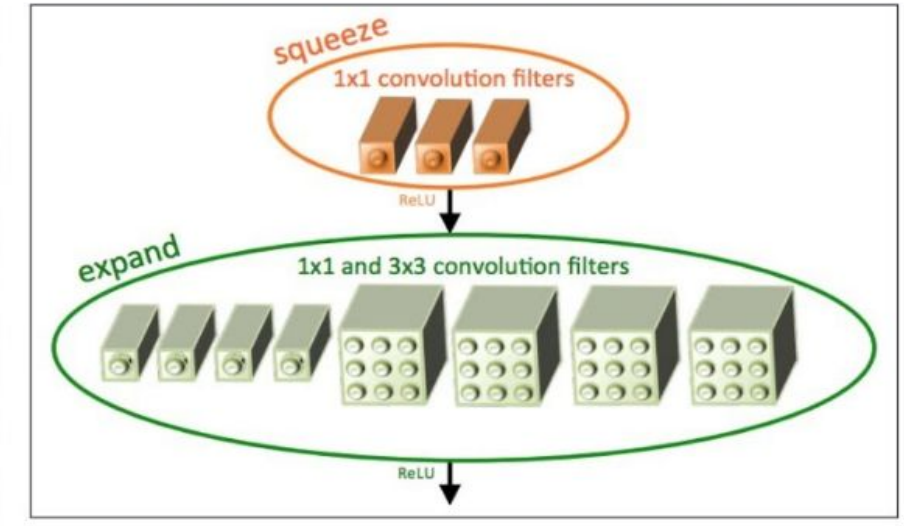
Upright and inverted facial recognition use the same low-level areas of the face [5]

Goals of this Project

1. Determine whether the Face Inversion Effect emerges early in DNNs, as it does in humans
2. Compare the DNN’s processing mechanisms for identifying upright and inverted faces

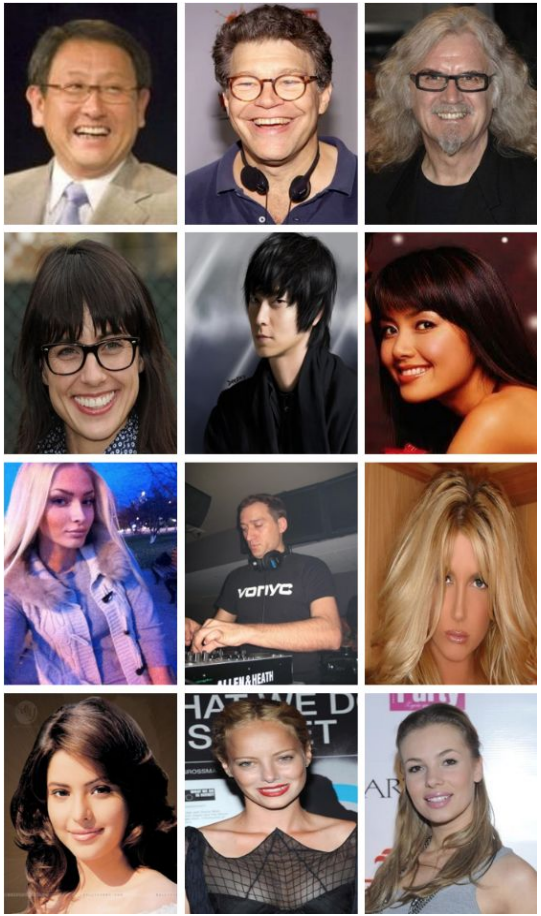
Methods: SqueezeNet

- Accuracy similar to AlexNet
  - 50x fewer parameters



SqueezeNet [2]

Methods: CelebA Dataset



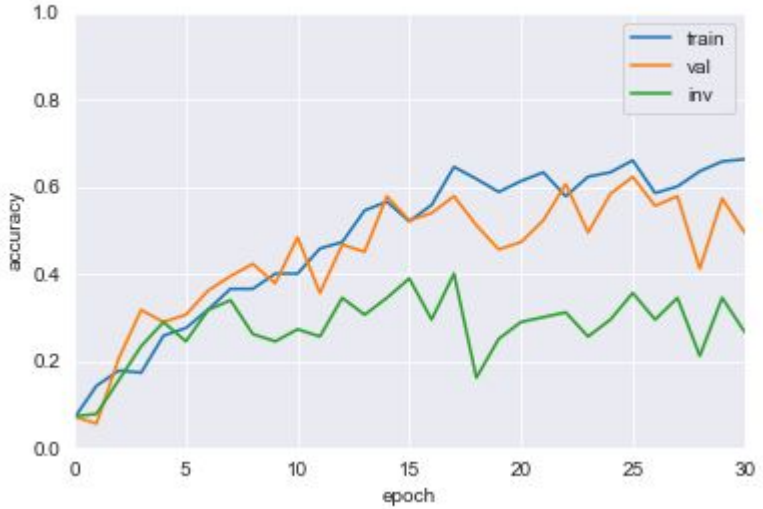
CelebA Dataset [3]

Methods: Procedure

- Trained SqueezeNet on subsets of upright faces from the CelebA dataset
- After training, with 20 different identities and with 100 different identities (20 and 100 classes), we:
  - Tested the network's ability to identify upright faces
  - Tested the network's ability to identify inverted faces
  - Quantified the difference between the network's accuracy in identifying inverted versus upright faces

Outcomes

Performance of our DNN on inverted and upright faces over time



20 classes

Outcomes

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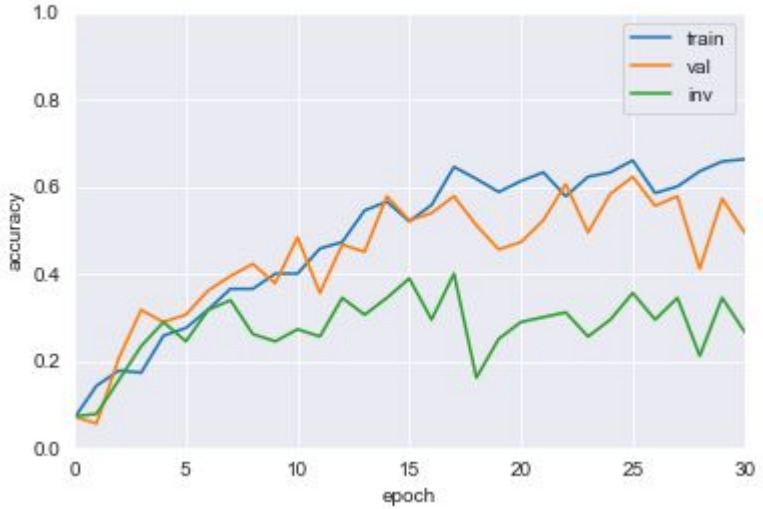
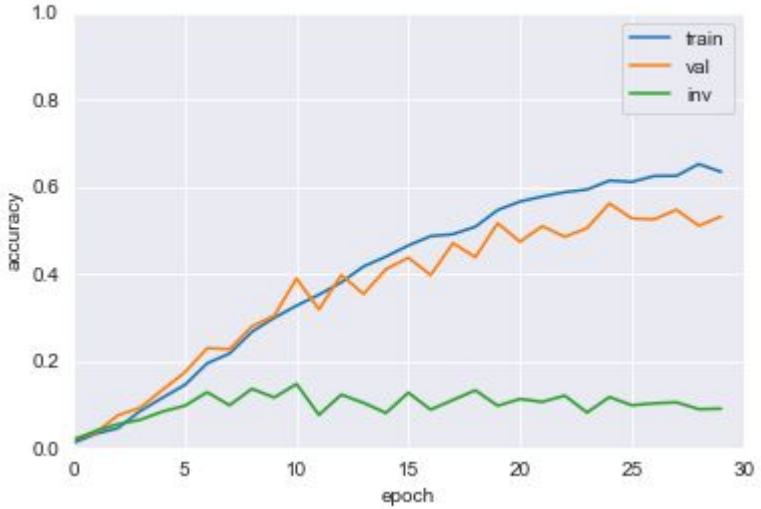


20 classes



100 classes

Conclusions

A face inversion effect emerged very early in our network, as it does in humans.

- Initially, accuracy increased at ~the same rate for both inverted and upright faces
  - This suggests similarities in data processing for inverted and upright faces, at least at first
    - Perhaps after the first few epochs, a new holistic processing pathway emerges for upright-face identification
  - Later differences between their performances are perhaps caused by experience only
- After a point, upright vs inverted face accuracies diverged
  - Behavioral differences increased with time
  - This parallels the development of the Face Inversion Effect in humans

Works Cited

[1] Cashon, Holt 2015. Developmental origins of the face inversion effect. Adv Child Dev Behav. 2015;48:117-50. Doi: 10.1016/bs.acdb.2014.11.008.

[2] Henry AI Labs: https://www.youtube.com/watch?v=ge_RT5wvHvY

[3] Liu, et al 2020. Large-scale CelebFaces Attributes (CelebA) Dataset. http://mmlab.ie.cuhk.edu.hk/projects/CelebA.html

[4] Passarotti, et al 2007. Developmental differences in the neural bases of the face inversion effect show progressive tuning of face-selective regions to the upright orientation. NeuroImage, vol. 34 (4):1708-1722. Doi: https://doi.org/10.1016/j.neuroimage.2006.07.045

[5] Sekular, et al 2004. Inversion Leads to Quantitative, Not Qualitative, Changes in Face Processing. Current Biology, vol. 14(5):391-396. Doi: https://doi.org/10.1016/j.cub.2004.02.028