Comparing human and deep convolutional neural network face-matching performance on disguised face images

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Introduction

- **By 2013**, identity matching accuracy comparable for humans and machines for:
  - high resolution, frontal views, (reasonably) consistent illumination, expression & appearance (Phillips & O'Toole, 2014)
  - These algorithms fail with pose changes and large changes in illumination, etc.
- **2014-present ->** Deep Convolutional Neural Networks (DCNNs) (Krizhevsky et al., 2012)
  - Succeed on *very* challenging images.

Research Questions:
1.) How do DCNNs perform on images of people who are disguised?
2.) How do they compare to human performance?

- **Approach**—test face-matching performance of a DCNN (Chen, 2016) on disguised faces with FAÇADE image database (Noyes & Jenkins, 2016).
- Compare Results to human data from Noyes and Jenkins (2016).
- **Contribution**—Further understanding of DCNN representations. Additional forensic implications.

Stimuli

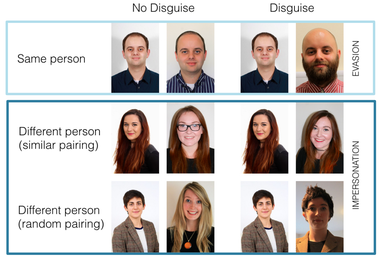
- FAÇADE image dataset
- 26 models—disguised and non-disguised.
- 3 disguise conditions for each model
- disguised relative to a specific reference image

Evasion: model photographed to look unlike self

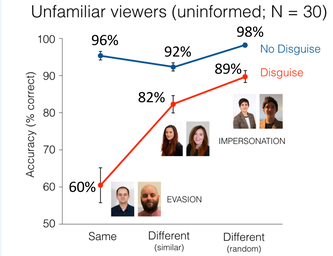
Impersonation Similar: model photographed to look like a 'similar' person

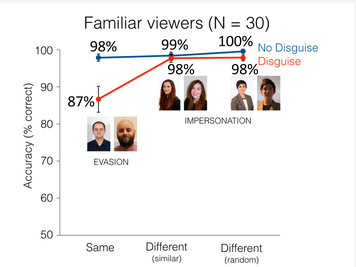
Impersonation Random: model photographed to look like a 'random' person

Image pair conditions:
Same and Different identity pairings,
Disguise and No Disguise image conditions.

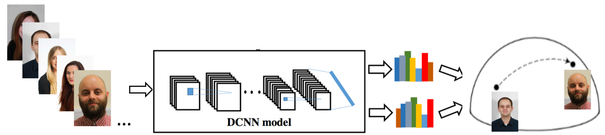


Human Results (Noyes & Jenkins, 2016)





Algorithm Methods



1. Façade images input to DCNN
2. Processed …
3. Feature vectors generated for each image
4. Similarity scores computed between pairs of images

Algorithm Exploratory Analyses

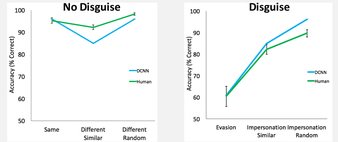
t-SNE Visualization (Van Der Maaten & Hinton, 2008)

Clustering

- Hierarchical clustering function
- Height—cluster number best matched true number of identities

Analysis

Same identity pairs—correct if placed in same cluster.
Different identity pairs—correct if placed in two different clusters.

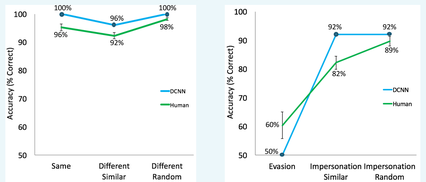


- Similarities with human card sorting tasks (e.g. Jenkins et al., 2011)

Algorithm Identity Matching Simulation

Analysis

Similarity scores of each image pair compared against criteria point to determine same/different identity response. (chance accuracy = 50%)



Conclusions

- DCNN outperformed 'unfamiliar' humans at matching images of people who are not disguised.
- DCNN performance on disguised faces comparable to unfamiliar humans.
- DCNN show same pattern of results–higher accuracy for impersonation than evasion.
- In comparisons to Noyes and Jenkins (2016), 'familiar' humans still better than machines on disguised pairs.

Next Steps

- Model DCNN as a 'familiar' viewer.

References

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Acknowledgements

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