Human Versus Biometric Perception of Iris Texture

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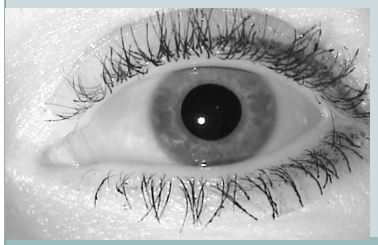
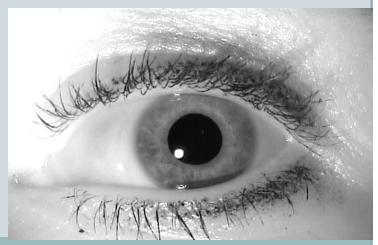




Acknowledgments

This work is supported by the FBI, CIA, IARPA and TSWG under US Army contract W91CRB-08-C-0093.

Opinions and conclusions expressed do not necessarily represent those of our sponsors.

Acknowledgments

This work was done with:

undergrads Sam Fenker, Steve Lagree,

PhD grad (!) Karen Hollingsworth,

co-PI Patrick Flynn.

Biometrics Research @ ND

We do *lots* of biometrics research other than what I will talk about today:

- Iris: "fragile bits" in the iris code, averaging of frames in video, pupil dilation, template aging, …
- Face: 3D, IR, multi-modal, video

…

(See http://www.cse.nd.edu/~kwb/publications.htm for details.)

The Main Point

In biometrics, each iris is independent of all others, even same or related persons.

Humans readily perceive iris texture similarity that biometrics do not – ***Monozygotic irises look a lot alike*****.**

This suggests new possibilities for iris texture analysis.

Outline

- Biometrics & monozygotic irises
- Human perception of L,R irises
- Human perception of twins irises
- Conclusions & future research

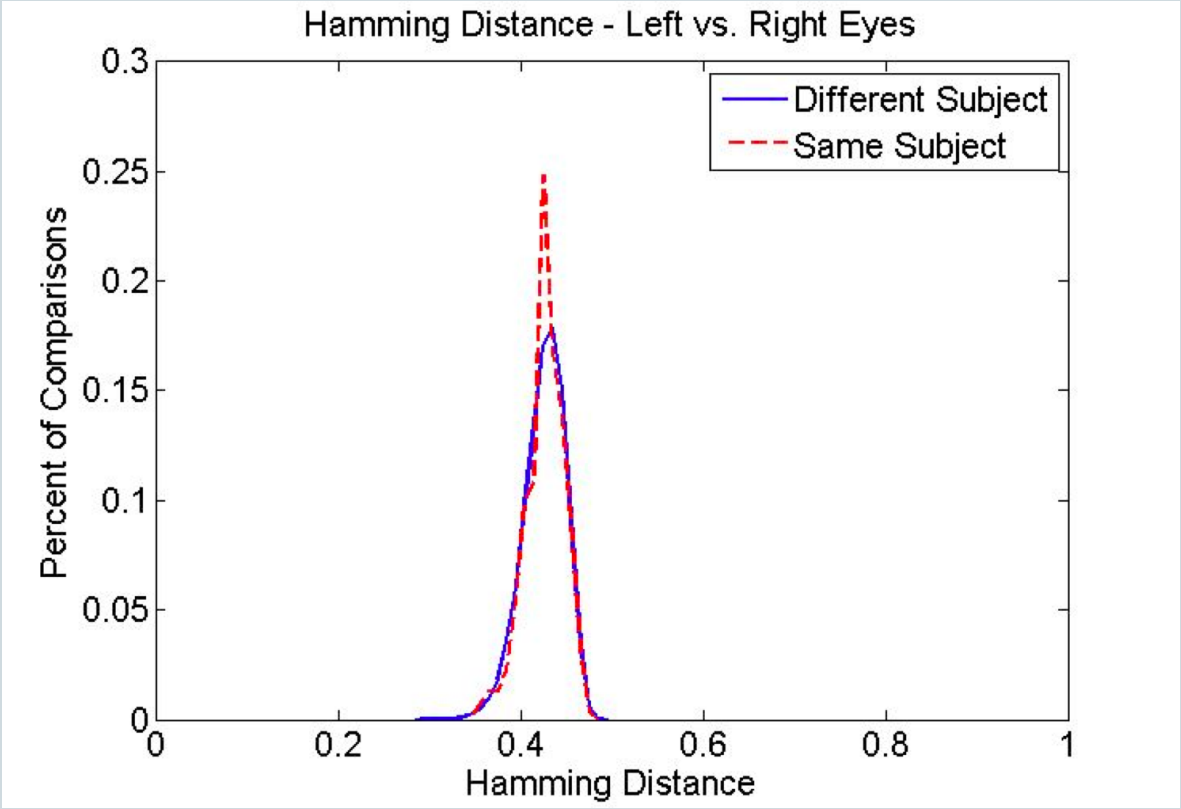
Monozygotic: Left-Right

Conventional wisdom –

"Iris Images of left and right eyes are known to be different."

"Combining face and iris for identity verification," Wang, Tan & Jain, *AVBPA*, 2003.

Monozygotic: Left-Right



Imposter distributions obtained with our data support that left and right irises are different.

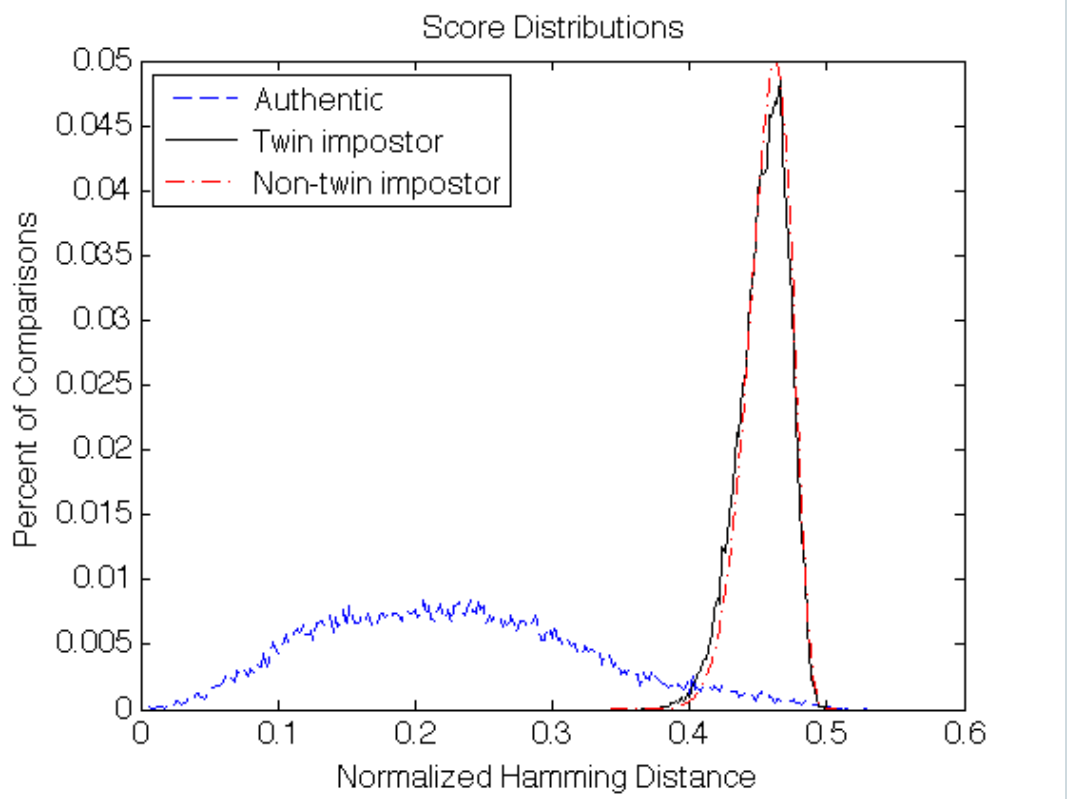
Monozygotic: Twins

Conventional wisdom –

"… comparisons among the eyes of actual monozygotic twins also yielded a result expected for unrelated eyes ..."

"How iris recognition works," Daugman, *IEEE Trans CVST*, 2004.

Monozygotic: Twins



Identical twins and unrelated persons give very similar imposter distributions.

Monozygotic Iris Texture

Our iris biometric results on left and right irises, and on identical twins, agree with results reported by Daugman and others.

But there is more to iris texture!

Monozygotic Iris Texture

From viewing large numbers of iris images, we became convinced that there is a similarity in left-right iris texture, and then also in twins.

Basically, there is no related work.

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L-R Iris Similarity

Experimental materials:

- Left and right irises for 327 persons, from ND_Iris_0405 dataset[+]
- Custom software to control observer experiment

[+] ICE; 60K+ LG 2200 images; available to research community.

L-R Iris Texture Similarity

Same person or different persons?

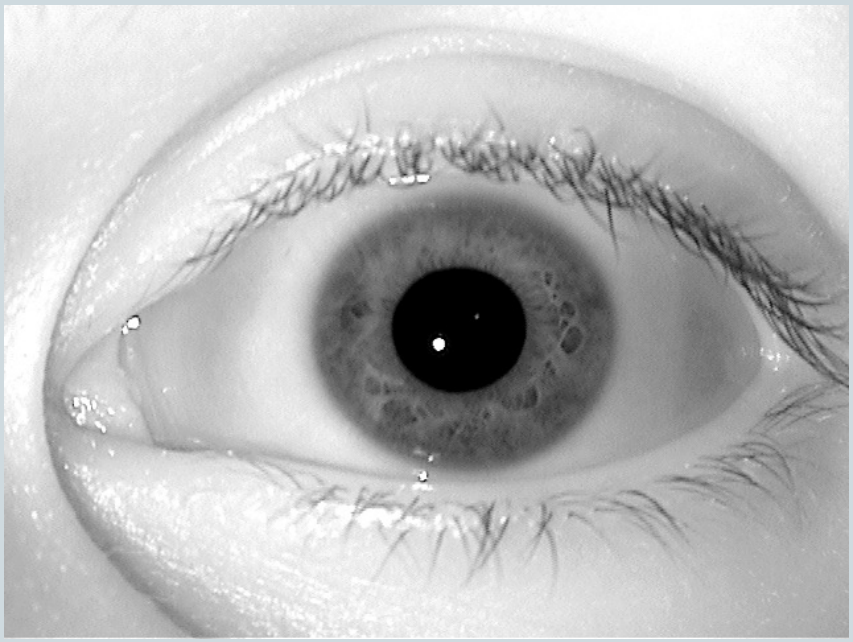
L-R Iris Texture Similarity

- Certain it was matched pair
- Likely it was matched pair
- Can’t tell
- Likely it was NOT matched pair
- Certain it was NOT matched pair

L-R Iris Texture Similarity

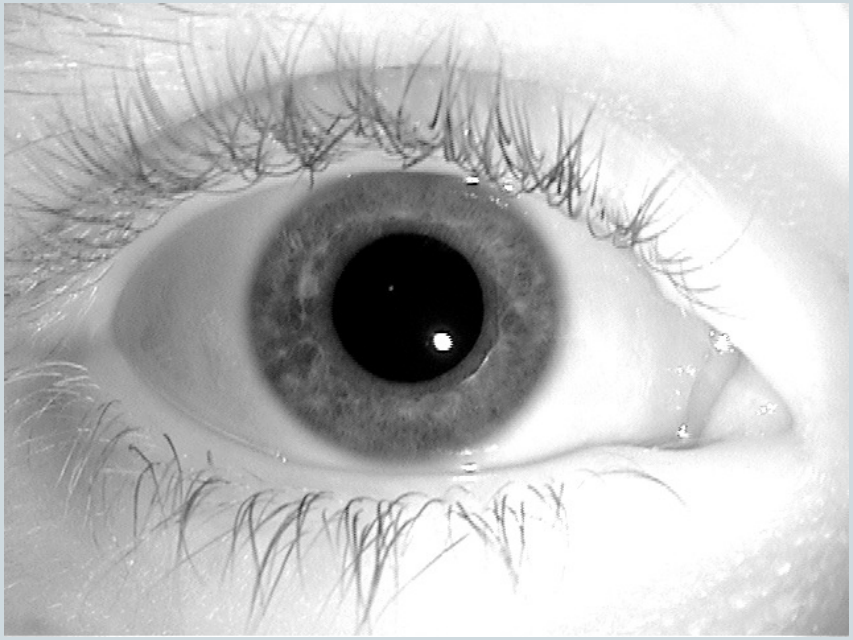
Same person

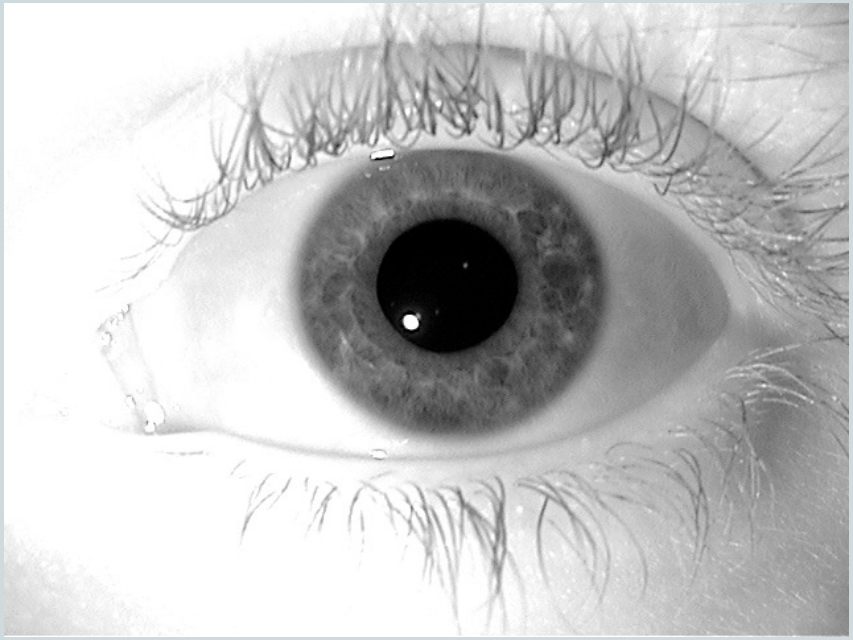
L-R Iris Texture Similarity



Different persons

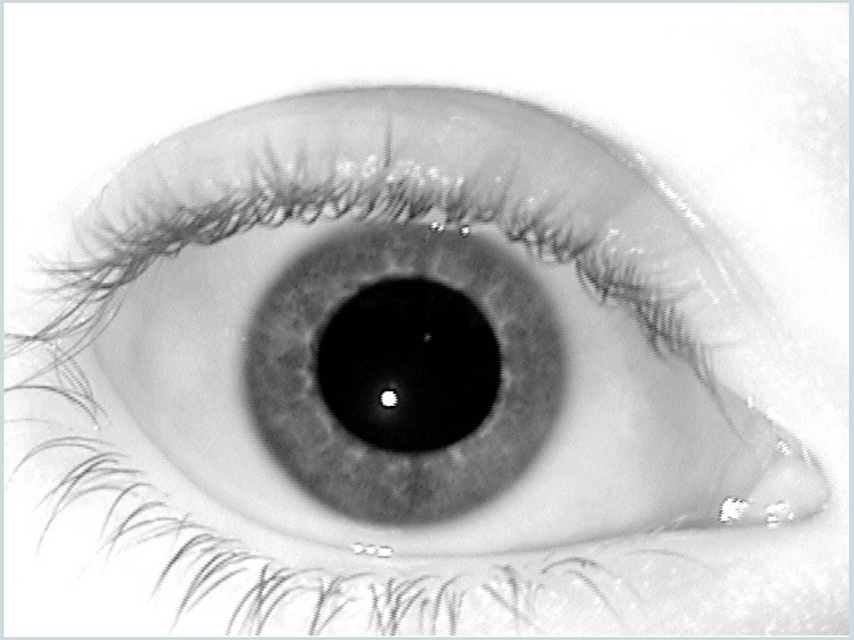
L-R Iris Texture Similarity

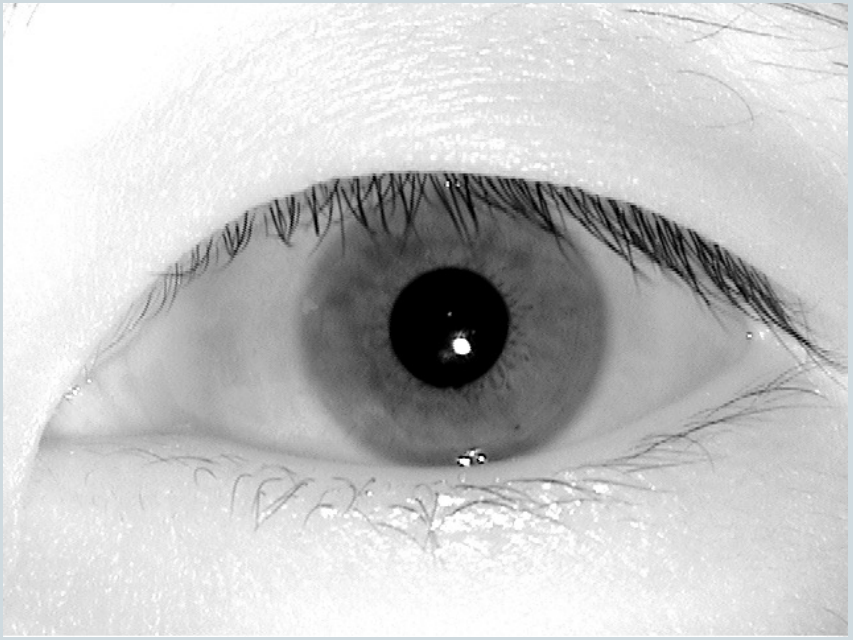




Same person

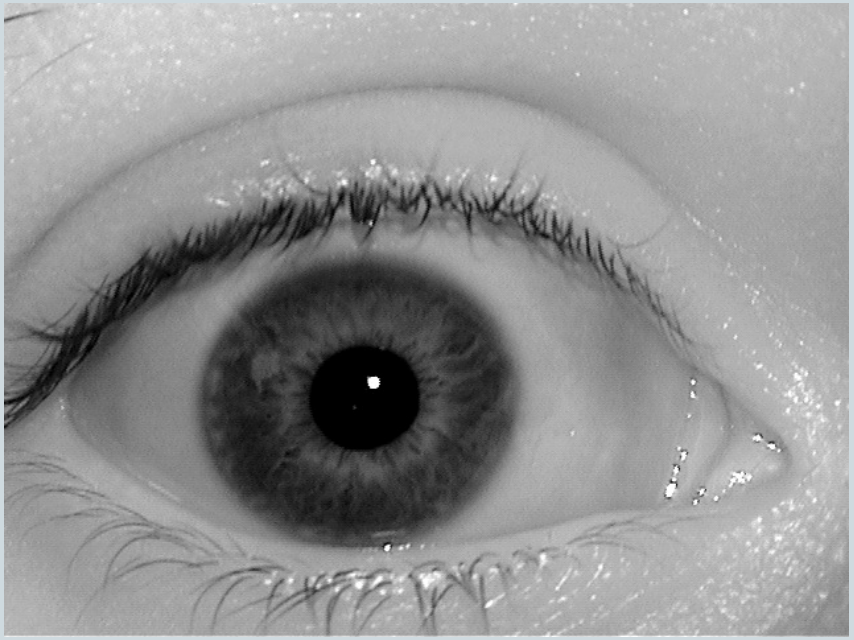
L-R Iris Texture Similarity





Different persons

L-R Iris Texture Similarity



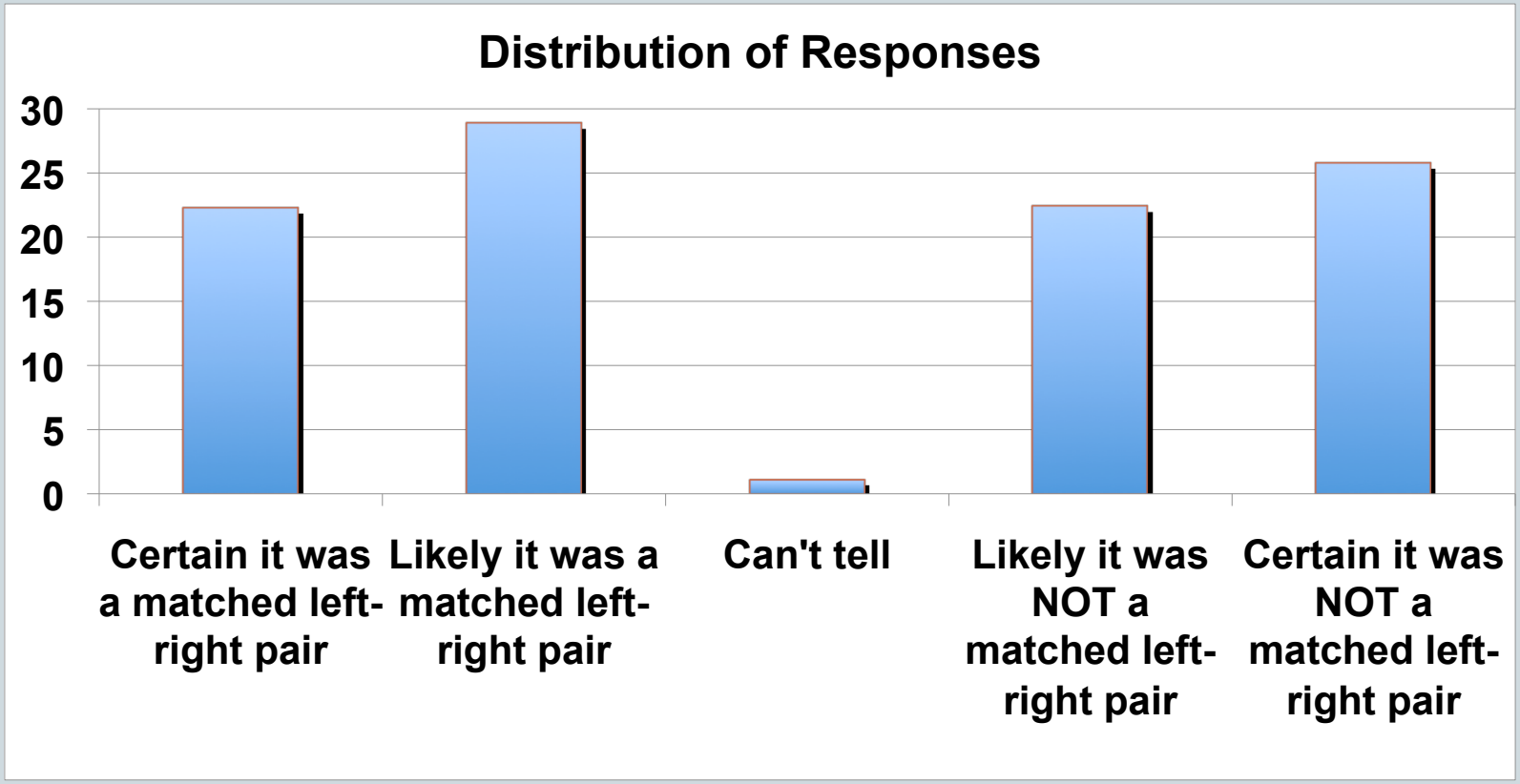
Same person

L-R Iris Similarity

Experimental method:

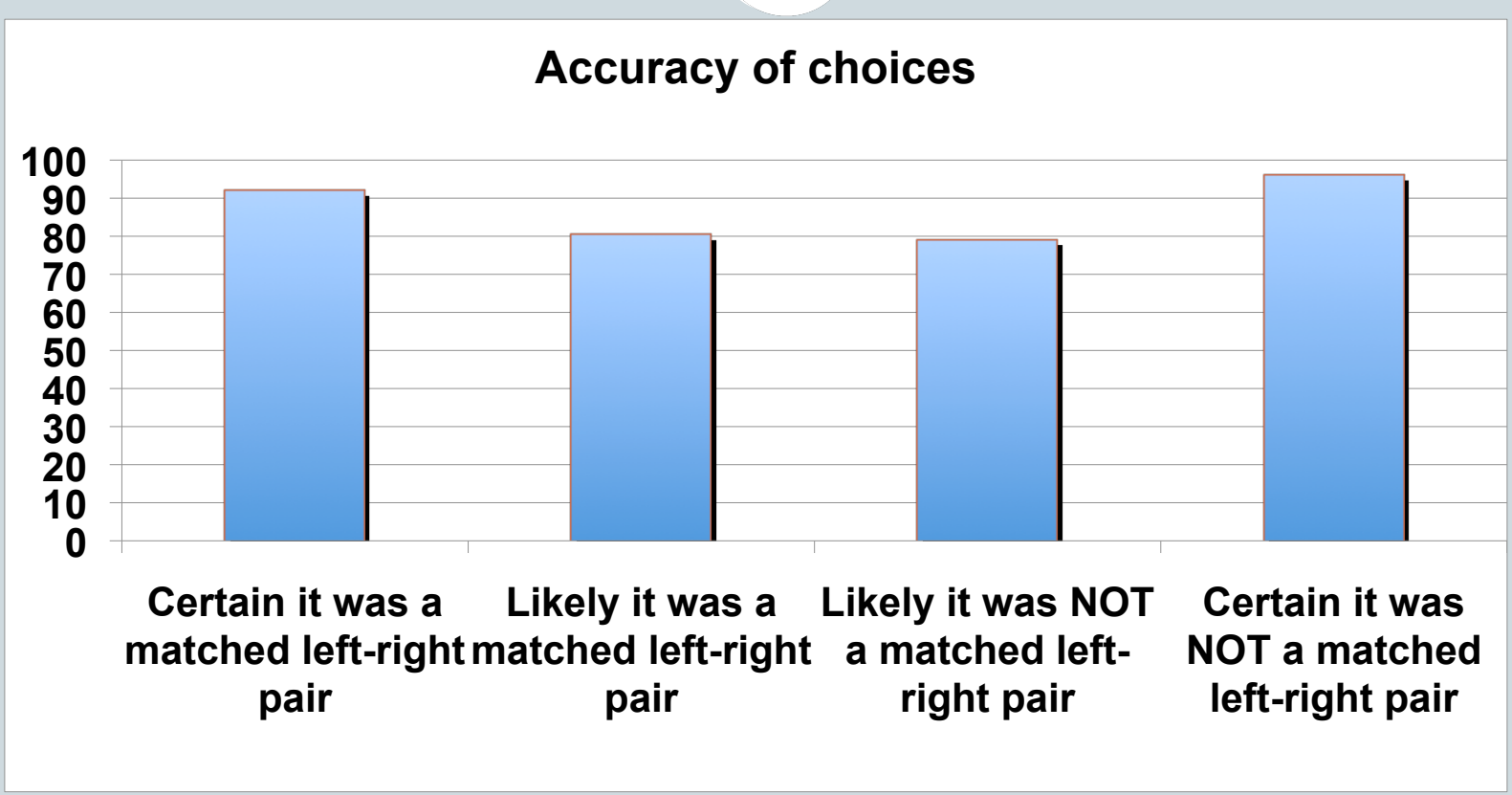
- 4 second viewing of image pair
- 210 trials: equal same / different
- Random presentation order
- 5-point rating scale
- 27 naïve observers

L-R Iris Similarity



Subjects rarely respond with “can’t tell”.

L-R Iris Similarity



90%+ on “certain”; 80% on “likely”.

L-R Iris Similarity

Result & Conclusion:

- Naïve observers with 4s viewing are quite accurate at classifying L-R irises as same/different person.
- There is more to iris texture than what is seen by iris biometrics.

Outline

- Biometrics & monozygotic irises
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Monozygotic: Twins

- LG 2200 iris video data acquired at Twins Days 2009; Twinsburg, Ohio
- 76 pairs of self-reported identical twins, plus others
- Frames selected for good focus, low occlusion, approximately centered

Twins Iris Similarity

Options for design of the study:

- **View the whole iris image**
- **View only the iris region**
- **View only the periocular region**

We opted for both “iris only” and “periocular” stimulus conditions.

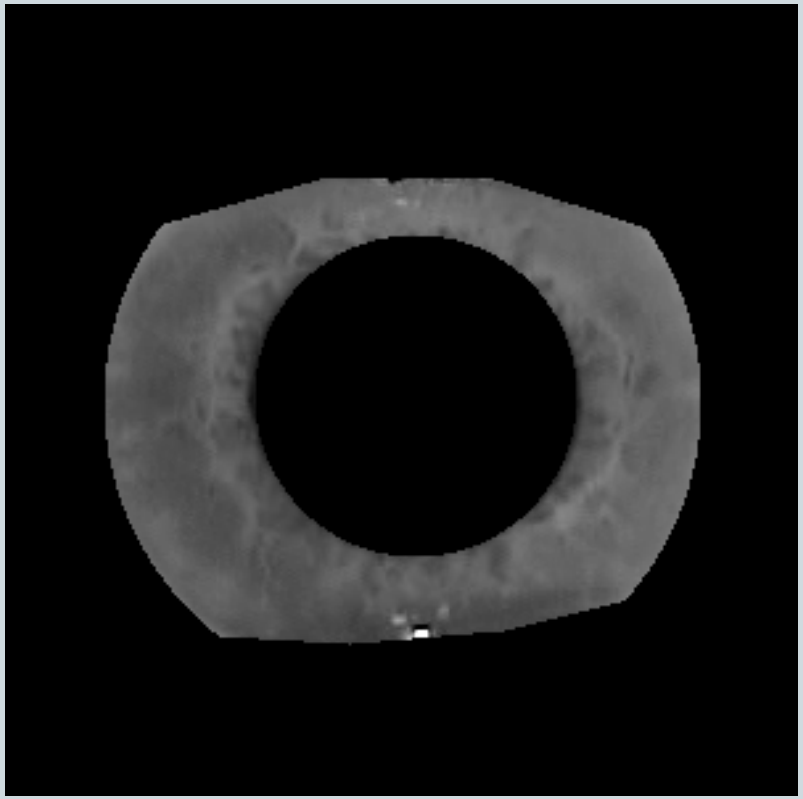
Twins Iris Similarity

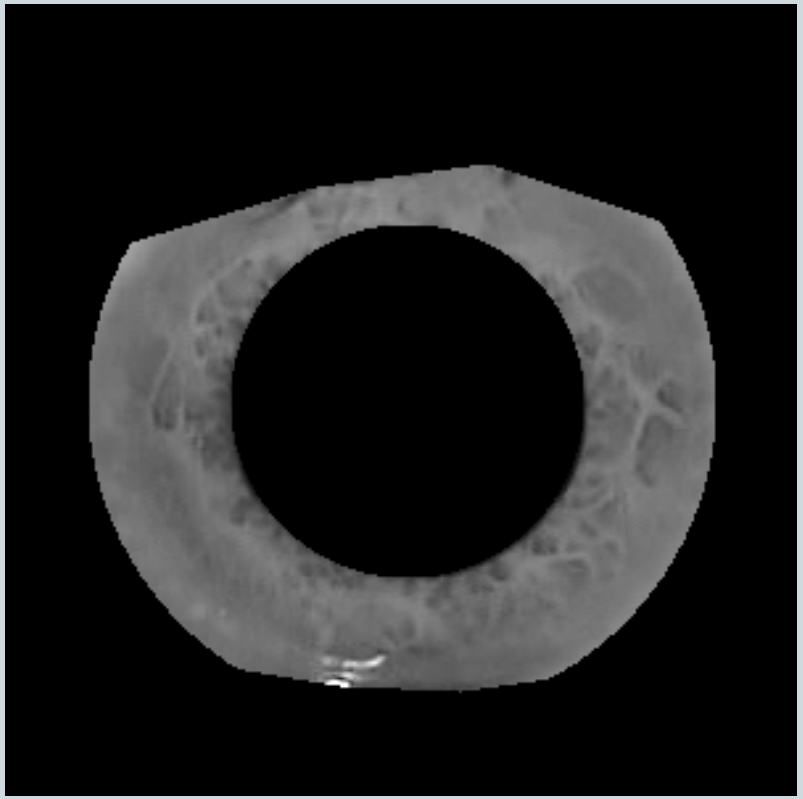
- Image pair presented for 3 sec
- 5-point response scale
- 28 subjects (no overlap with L-R)
- Iris-only trials presented first, then periocular trails

Twins Iris Similarity

First, some “iris only” trials.

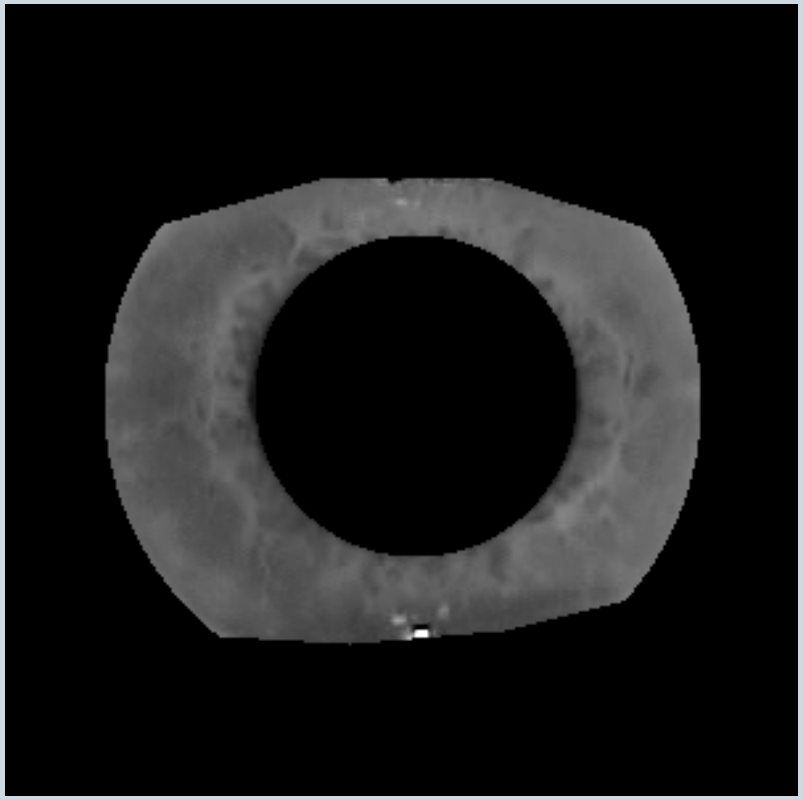
Twins Iris Similarity

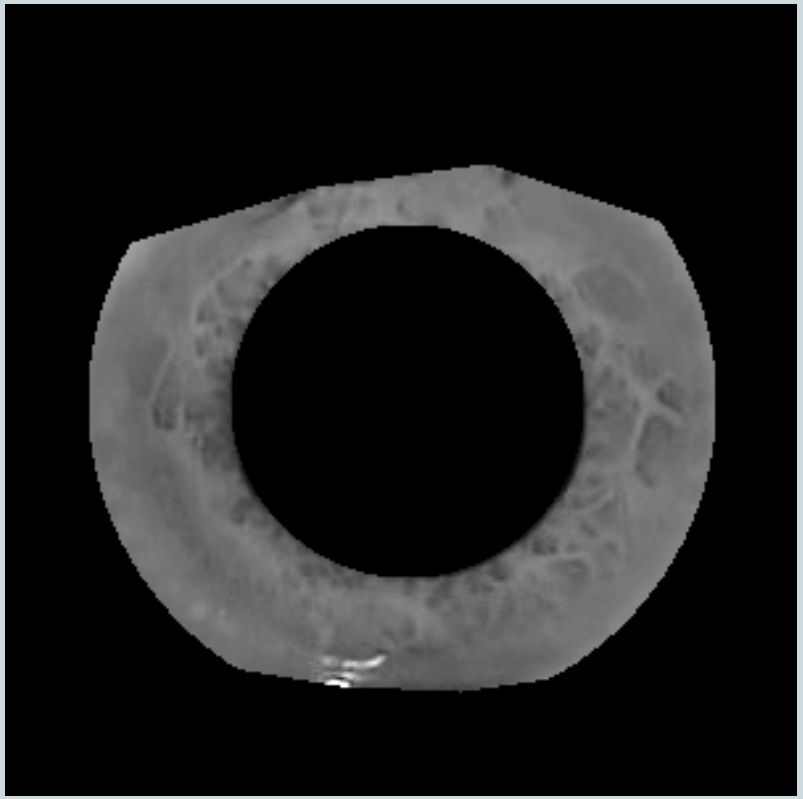




Twins or Unrelated?

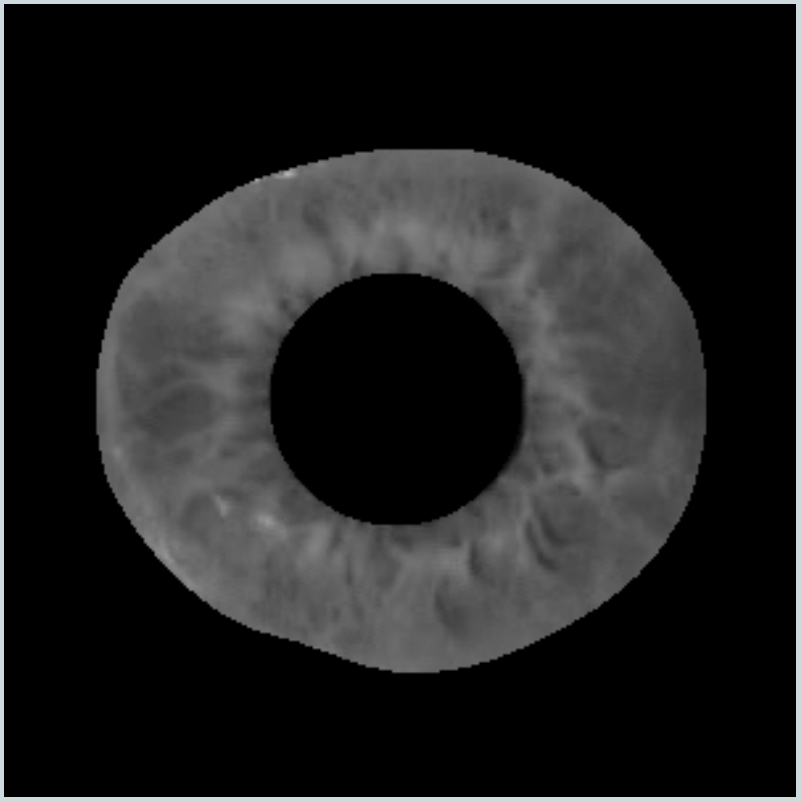
Twins Iris Similarity

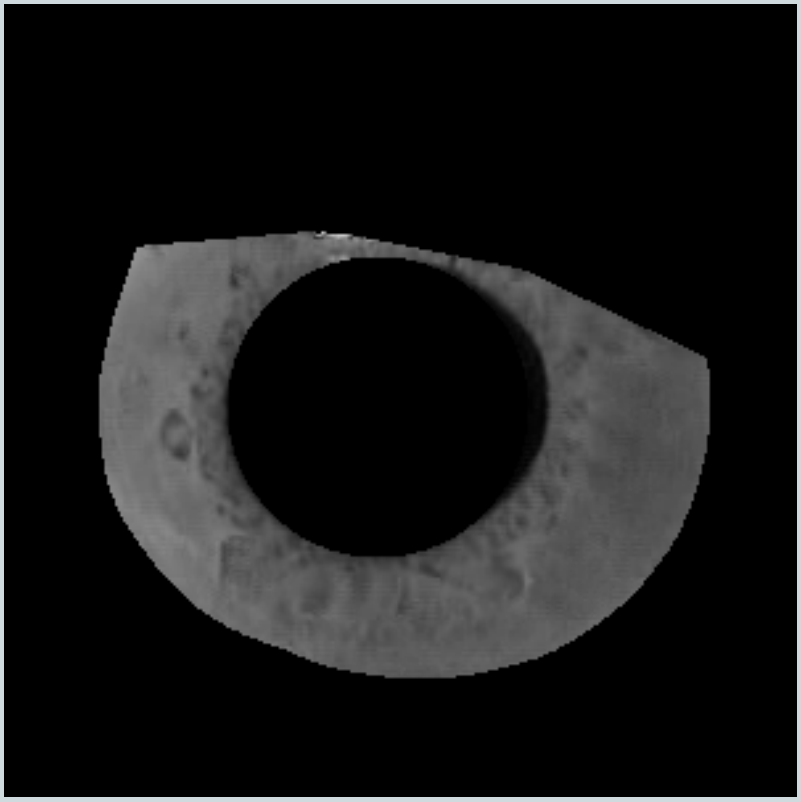




Twins.

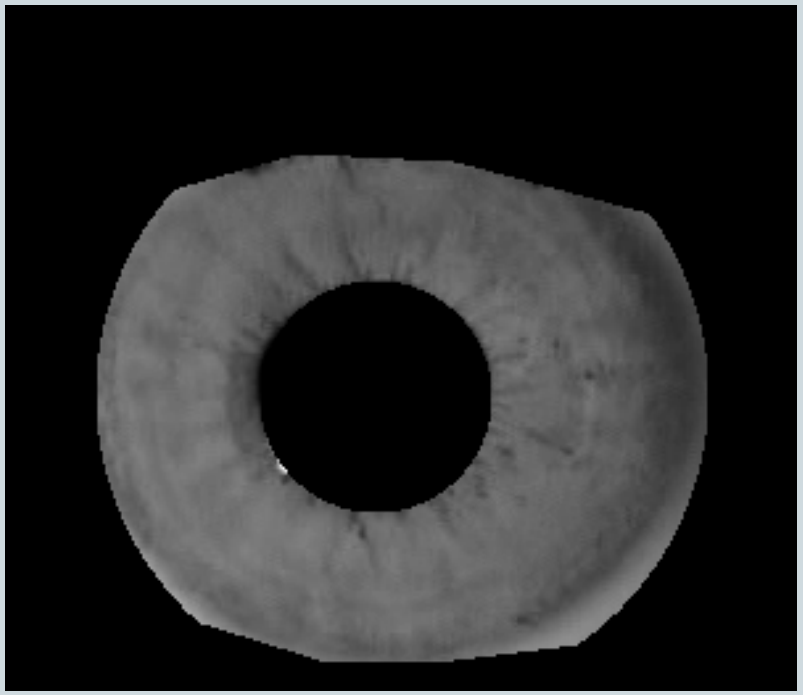
Twins Iris Similarity

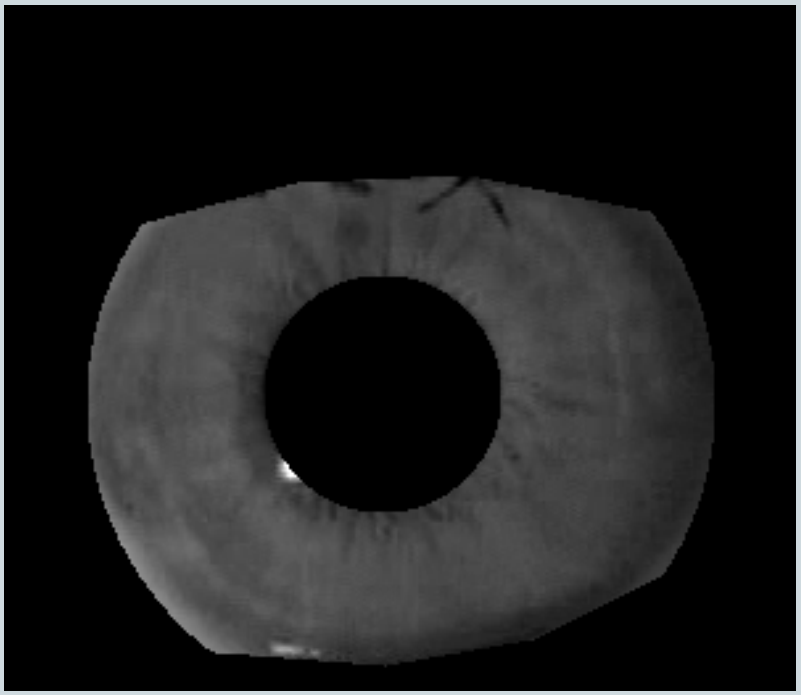




Unrelated.

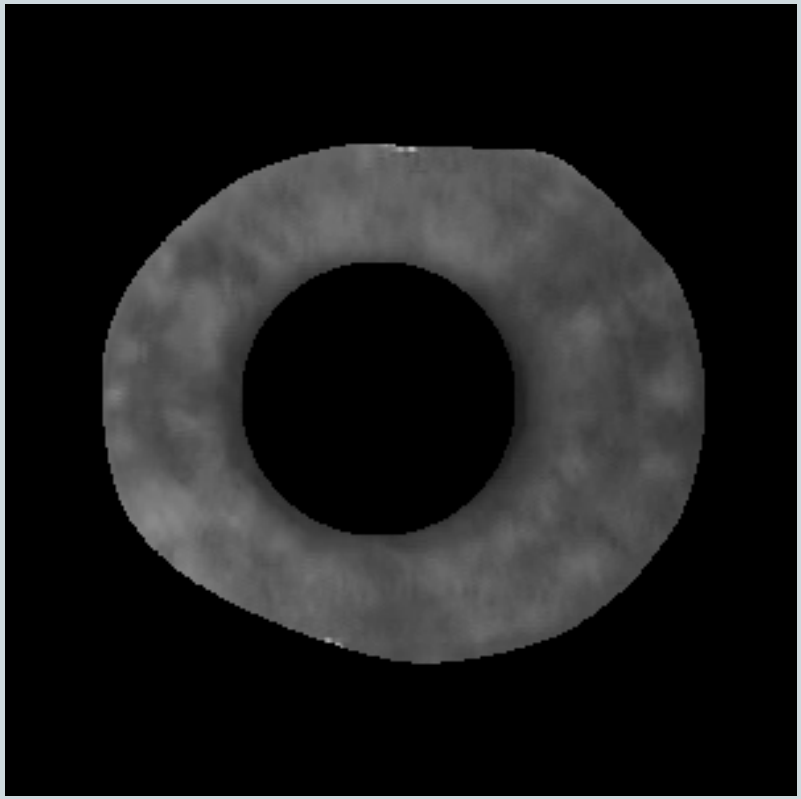
Twins Iris Similarity

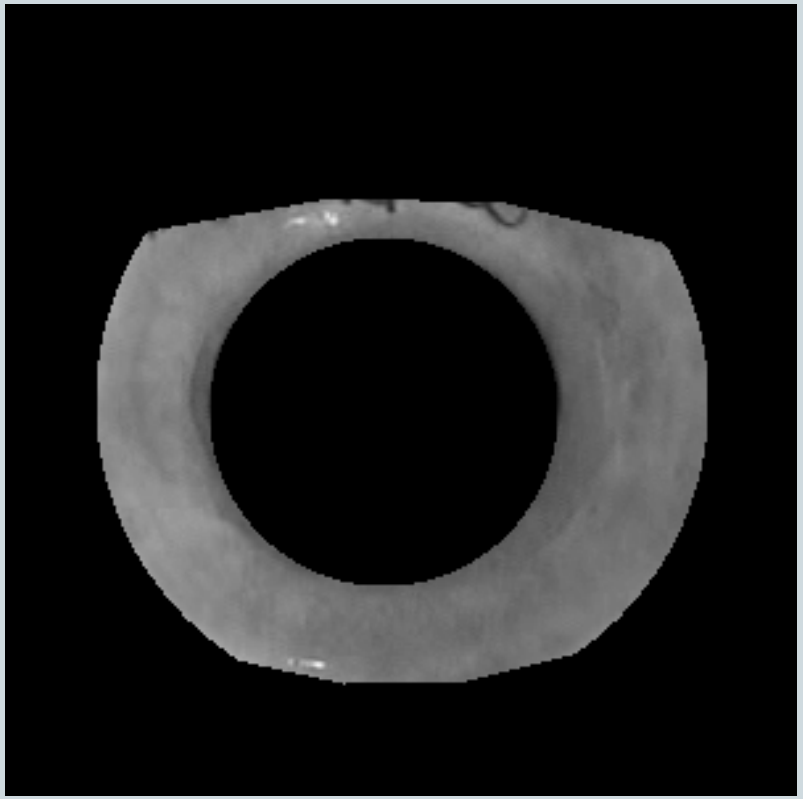




Twins. (28/28 correct)

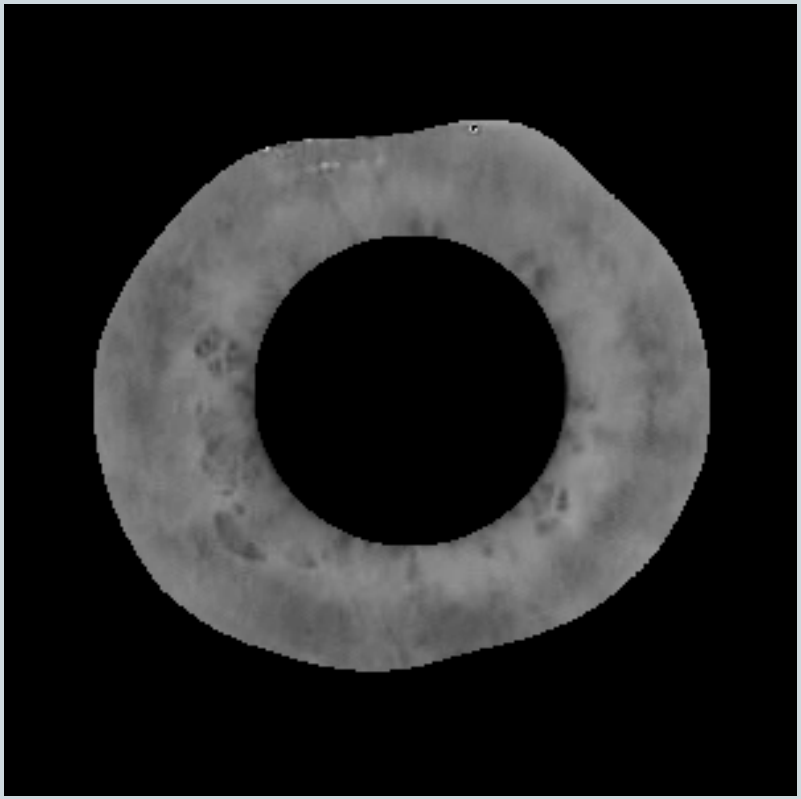
Twins Iris Similarity

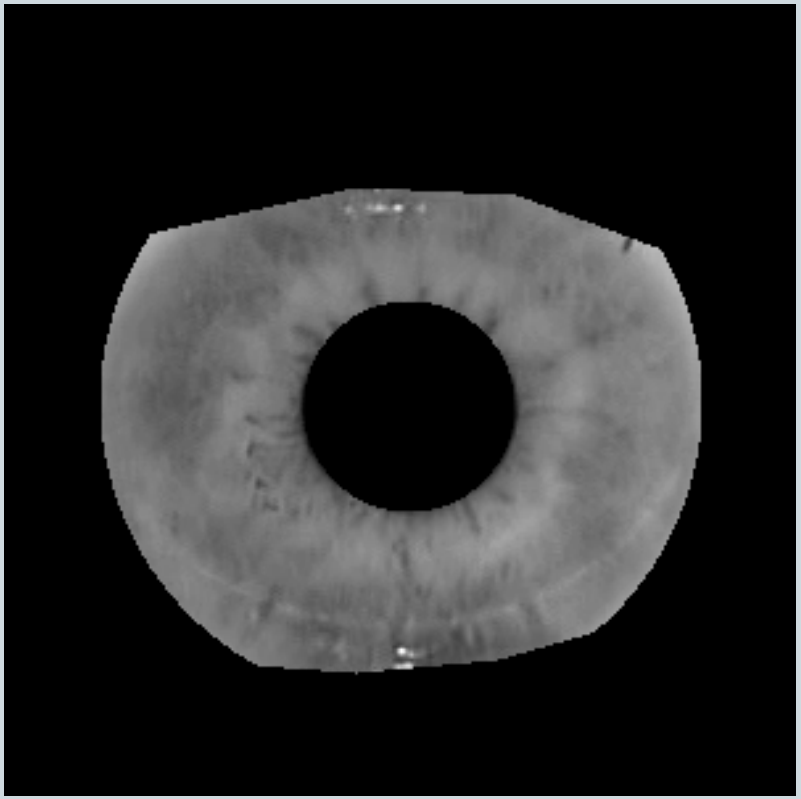




Unrelated. (28/28 correct)

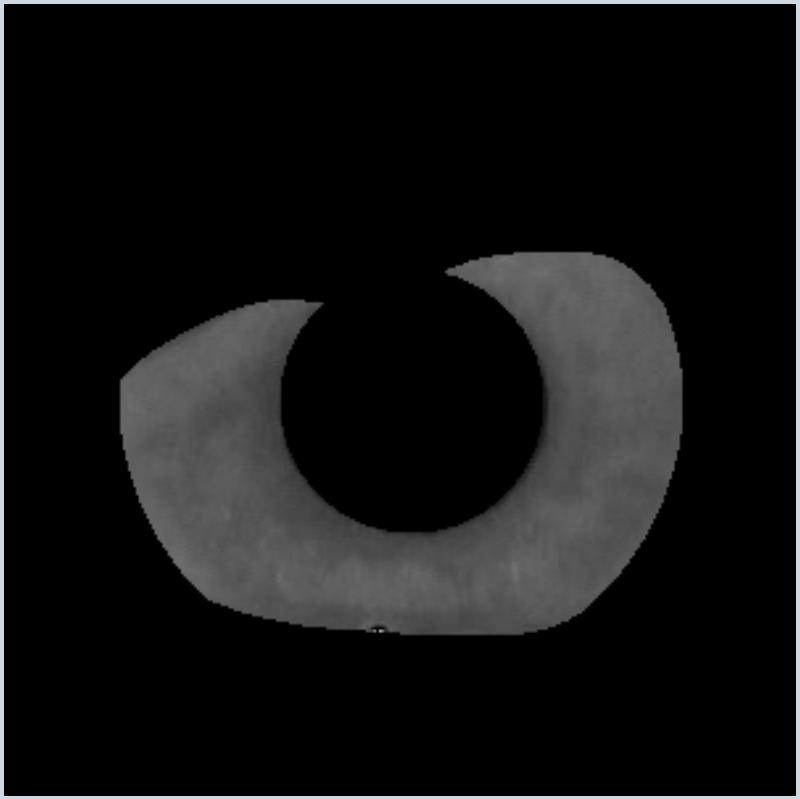
Twins Iris Similarity

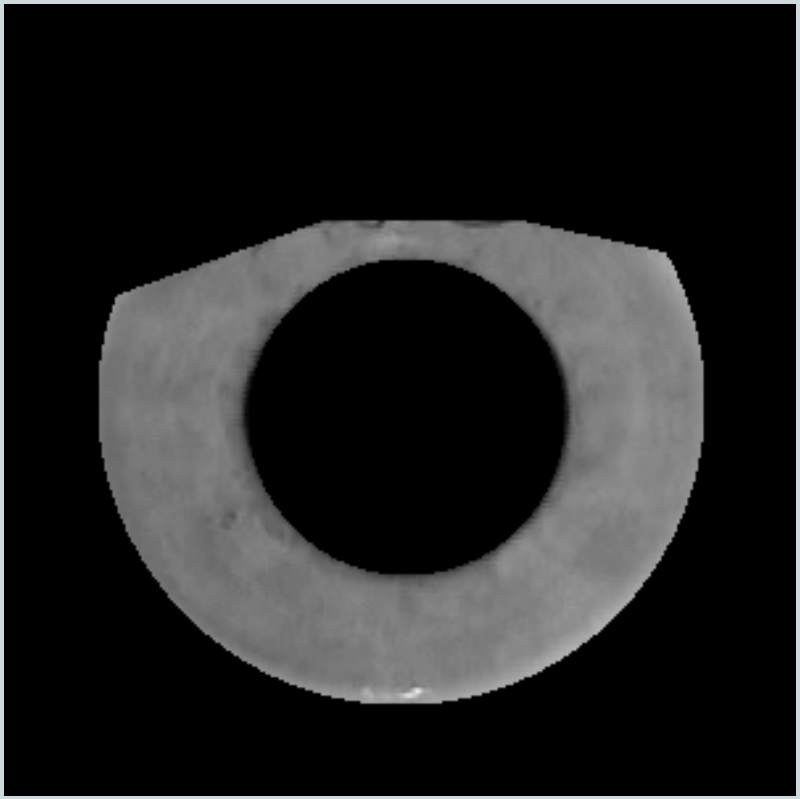




Twins. (25/28 incorrect.)

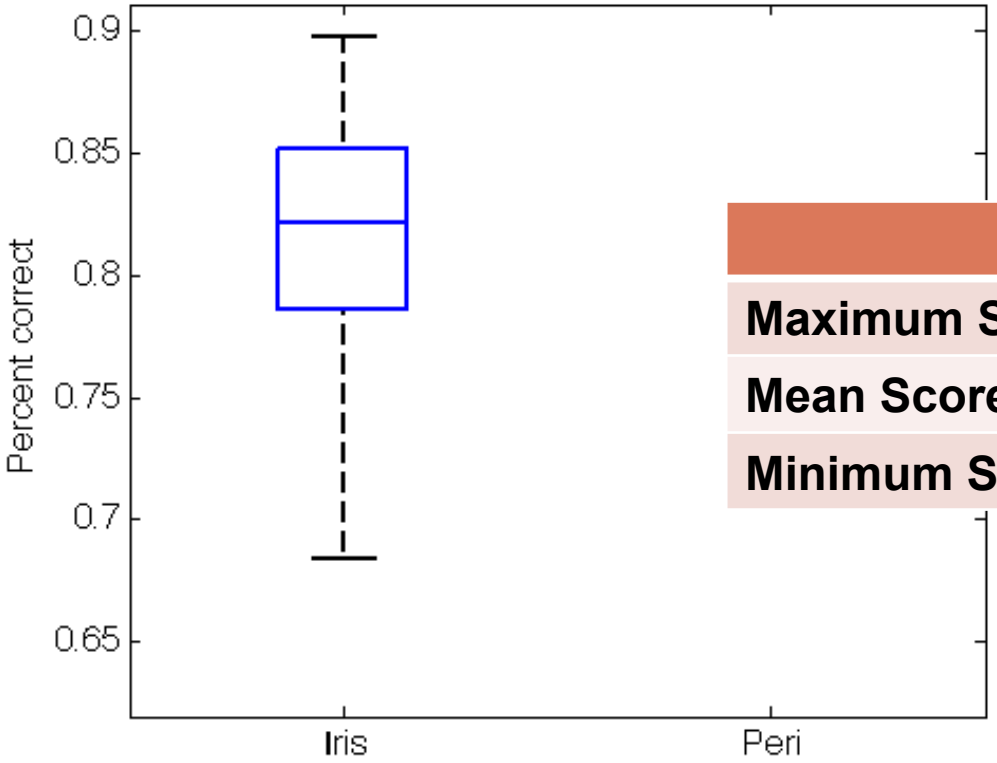
Twins Iris Similarity





Unrelated. (24/28 incorrect.)

Twins Iris Similarity

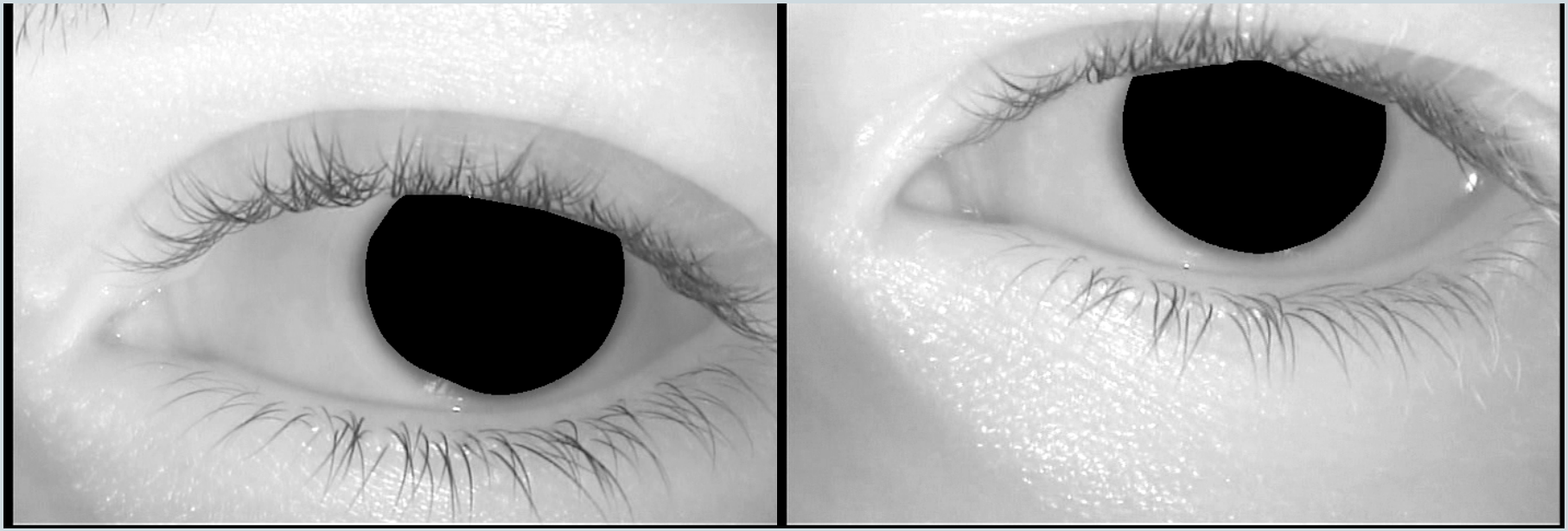


	Iris	Periocular
Maximum Score	89.8%	
Mean Score	81.3%	
Minimum Score	68.4%	

Twins Iris Similarity

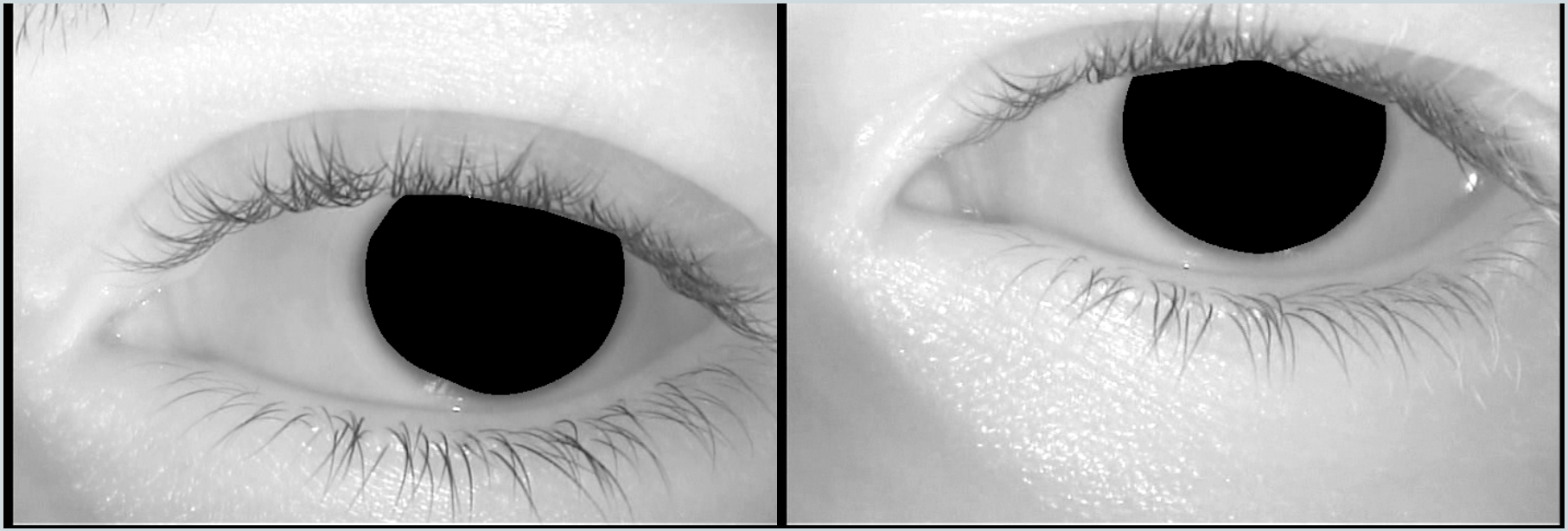
Next, some “peri-ocular” trials.

Twins Iris Similarity



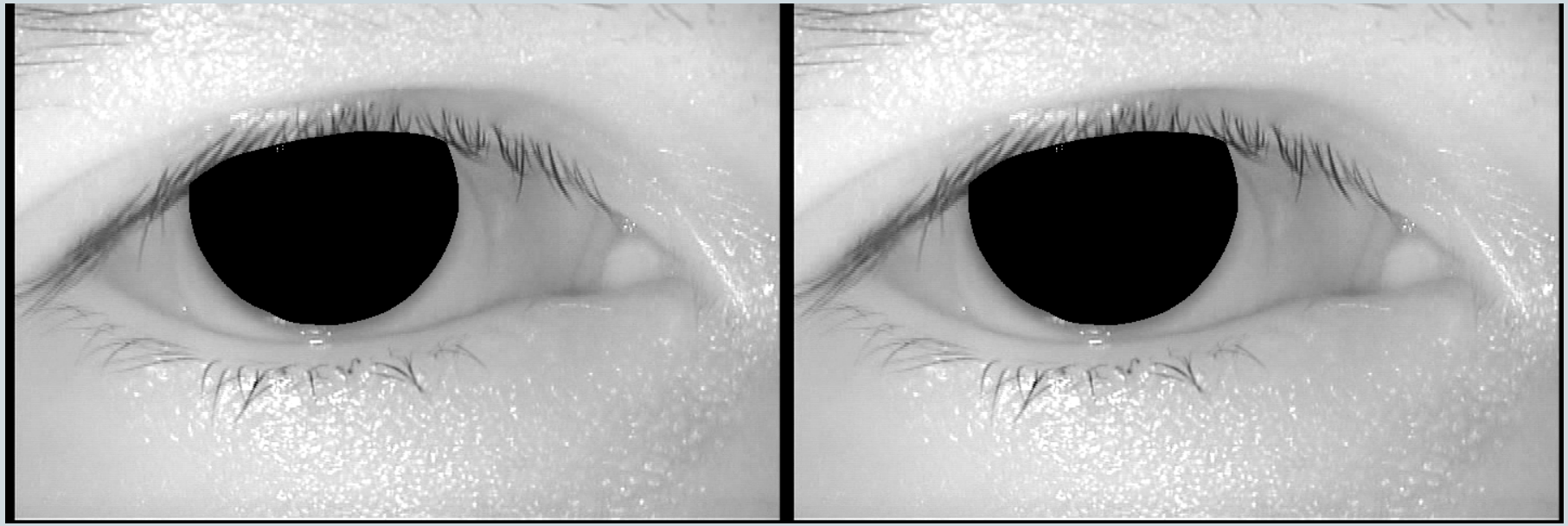
Twins or Unrelated?

Twins Iris Similarity



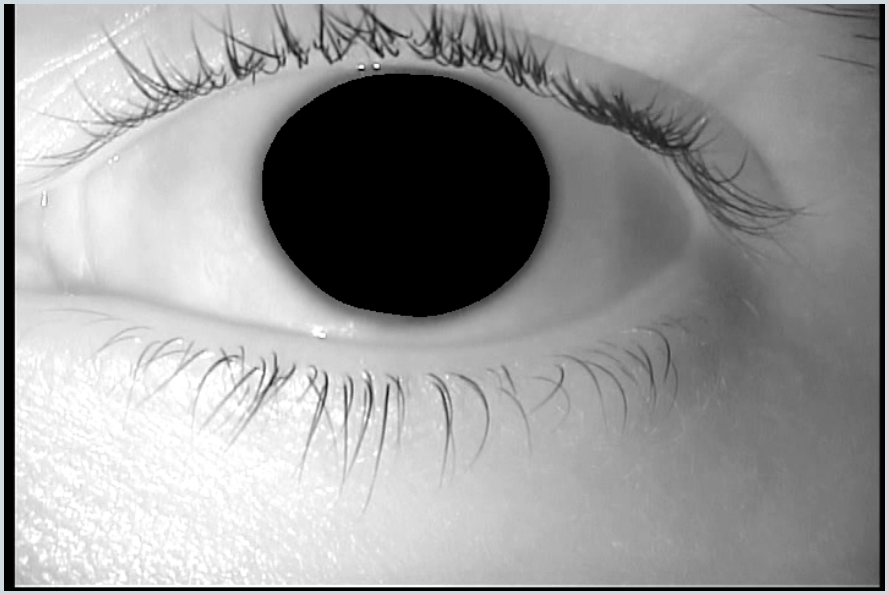
Twins.

Twins Iris Similarity



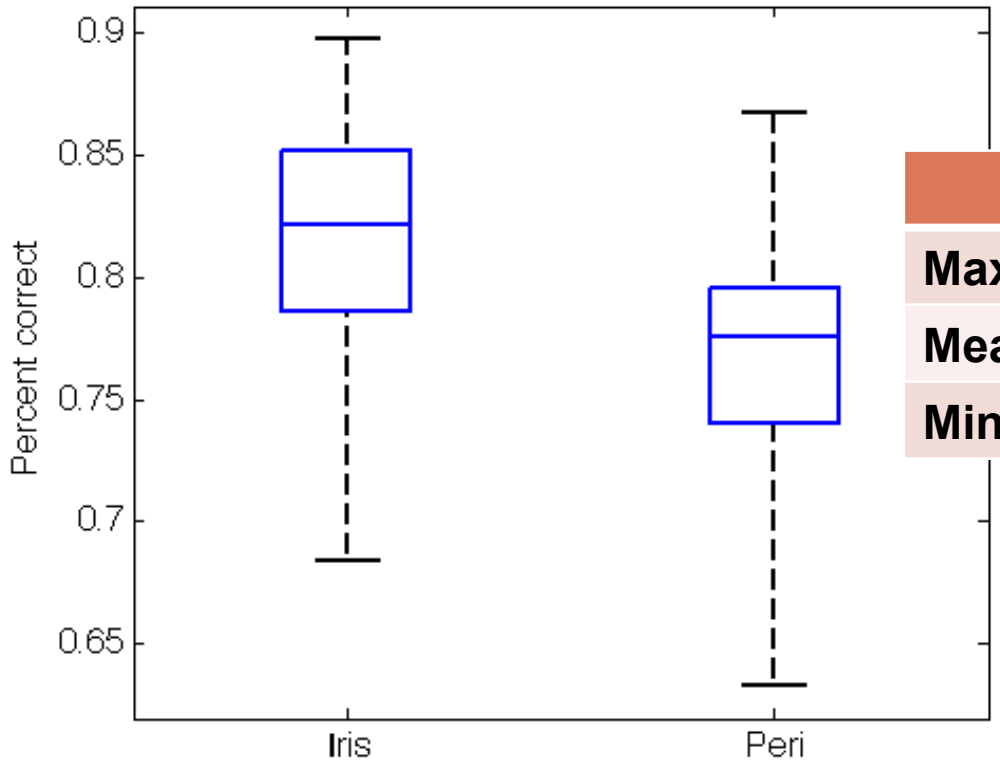
Twins. (28/28 correct)

Twins Iris Similarity



Unrelated. (28/28 correct)

Twins Iris Similarity



	Iris	Periocular
Max Score	89.8%	86.7%
Mean Score	81.3%	76.5%
Min Score	68.4%	63.3%

Twins Iris Similarity

- Overall 80% + accurate in twins / non-twins from iris only
- Overall 76% + accurate from periocular
- 92% and 93% accurate on the “certain” responses

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- Biometrics & monozygotic irises
- Human perception of L,R irises
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- Conclusions & future research

The Main Point

In biometrics, each iris is independent of all others, even of related persons.

The Main Point

Stated differently –

a sample grid of phase of Gabor filter responses cannot detect similarity in monozygotic irises.

The Main Point

Humans readily perceive iris texture similarity that biometrics do not.

The Main Point

Stated differently –

Monozygotic irises DO have similar texture: humans can see it, biometrics cannot.

The Main Point

The discovery of texture similarity that is not captured by iris biometrics suggests new avenues for iris texture analysis.

Future Research

- What other relationships can be detected from iris texture?
- Can we combine “peri-ocular” and iris texture to improve performance?

Future Research

- How accurately could trained observers classify images?
- What is a good procedure for observers matching images?

Questions ?

Additional detail on our biometrics research:
http://www.cse.nd.edu/~kwb/publications.htm

Survey of iris biometrics:
http://www.cse.nd.edu/~kwb/BowyerHollingsworthFlynnCVIU_2007.pdf

“Fragile” bits in the iris code:
http://www.cse.nd.edu/~kwb/HollingsworthBowyerFlynnPAMI_2008.pdf

Pupil dilation effects:
http://www.cse.nd.edu/~kwb/BowyerHollingsworthFlynnCVIU_2008.pdf

Template aging:
http://www.cse.nd.edu/~kwb/BakerBowyerFlynnICB_2009.pdf