

About Face

Vicki Bruce

Why faces are interesting

- Biological significance and universality of the face
- Range of social signals – mood, attention, speech, attractiveness
- Identity - general (age, sex, race) and specific (Vicki Bruce)

Computational influences

- Applications domains
- Methodological innovations
- Theoretical precision

Applications

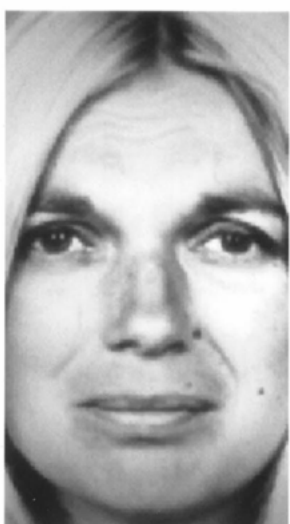
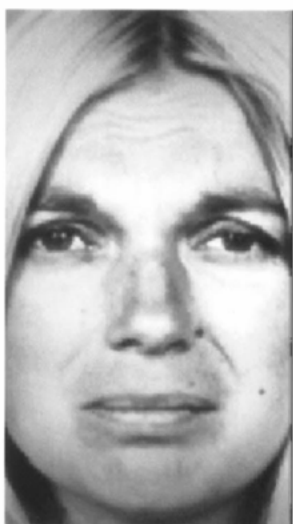
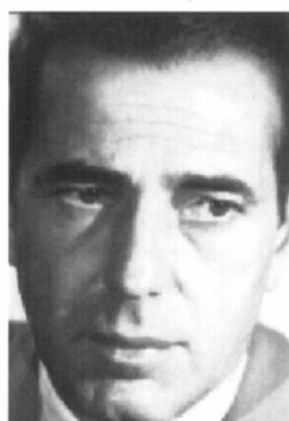
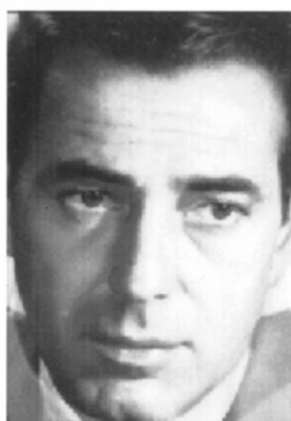
- Method and theory driven by applications context:
- Security (computers to recognise you, smart cards to verify your identity)
- Forensics – building up ID from witness memories or CCTV.
 - Better computer aids to this process...PRO-fit +; EvoFIT
- Cosmetics/prosthetics (3D modelling to simulate effects of surgery)
- Games and leisure (animation and simulation for games, stunt work, special effects)
- Robotics....androids

Methodological innovations

- Methods
 - Possible to make subtle changes in appearance for experiments.
 - Decomposing spatial frequency components
 - Morphing particularly influential in face perception field
 - Possible to analyse the structures and properties of large data-bases of images, faces, of their 3D structures, of their movements



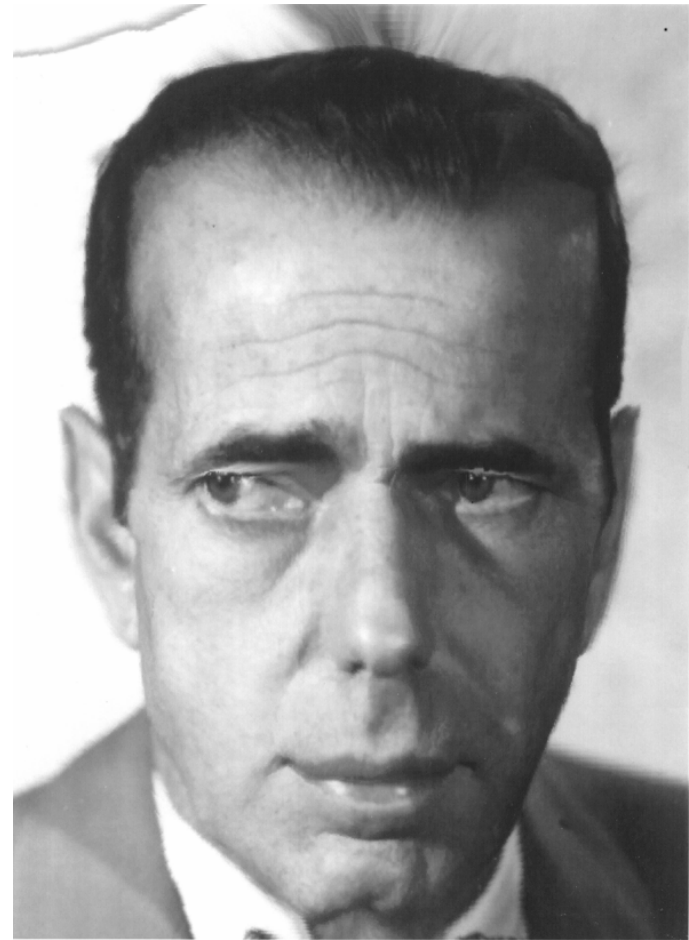
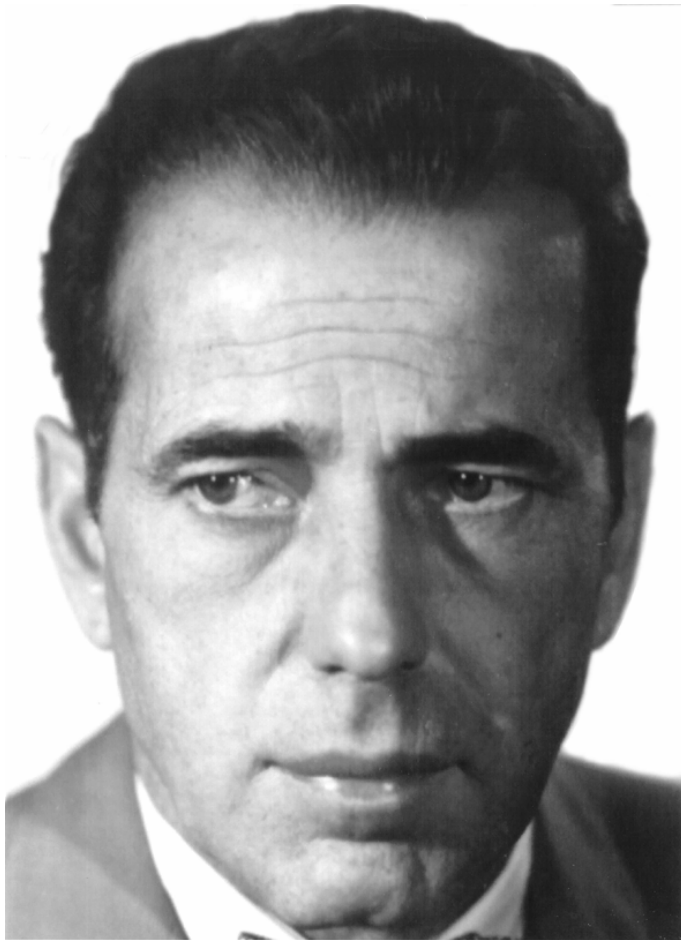
© Philippe G. Schyns & Aude Oliva, 1997.



Caricaturing



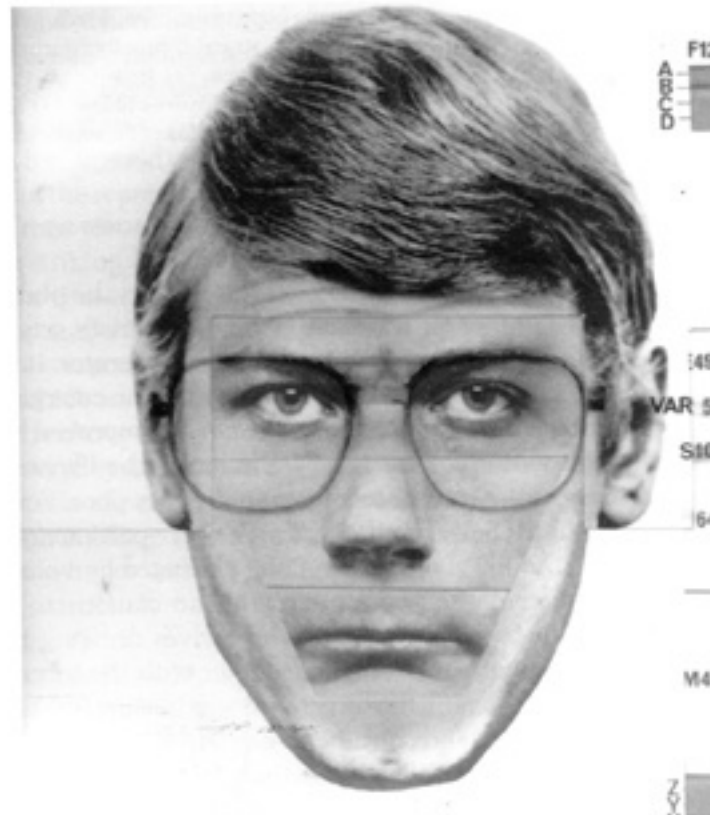
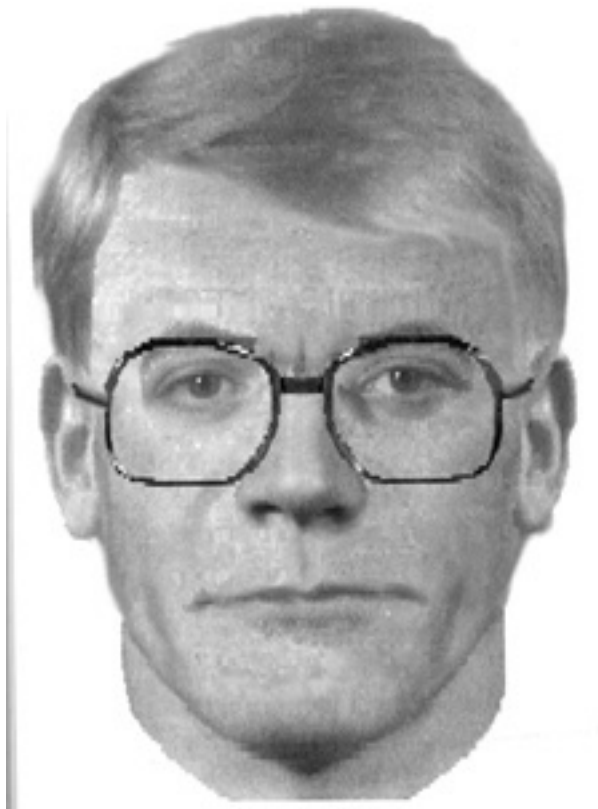
Caricature by Lee & Perrett



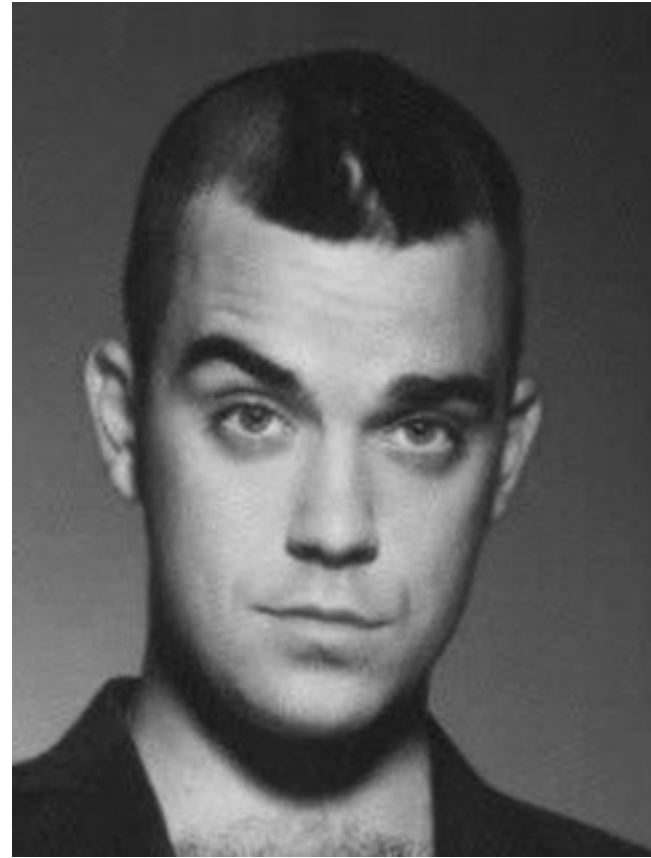
Recent application of morphing

- Bruce et al (2002) Four heads are better than one... *Journal of Applied Psychology*
 - Witnesses find composite production very difficult
 - No reason to suppose their errors are correlated
 - Morph together independently produced composites

Improvements in composite systems



Typical composite from memory



Experiment 1

- (From Bruce, Ness, Hancock, Newman & Rarity, 2002, *Journal of Applied Psychology*, 87, 894-902)
- ‘Proof of concept’ - no great ecological validity
- Four famous, four unfamiliar male targets
- Four composites made of each
 - with photo present
 - or from memory (30 secs view or 5 secs fam)

Four individual composites



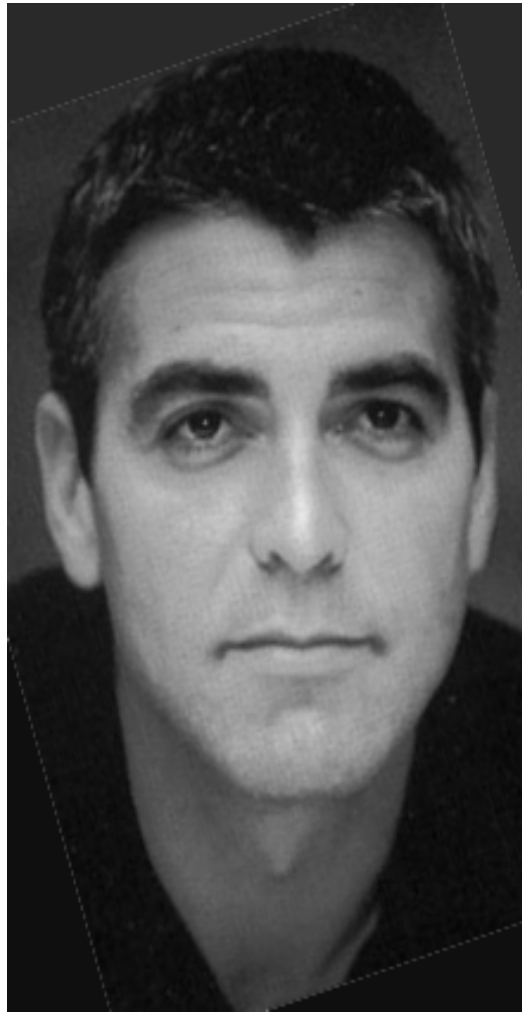
4-Morph - Who am I?



Who am I? (4-morph present)



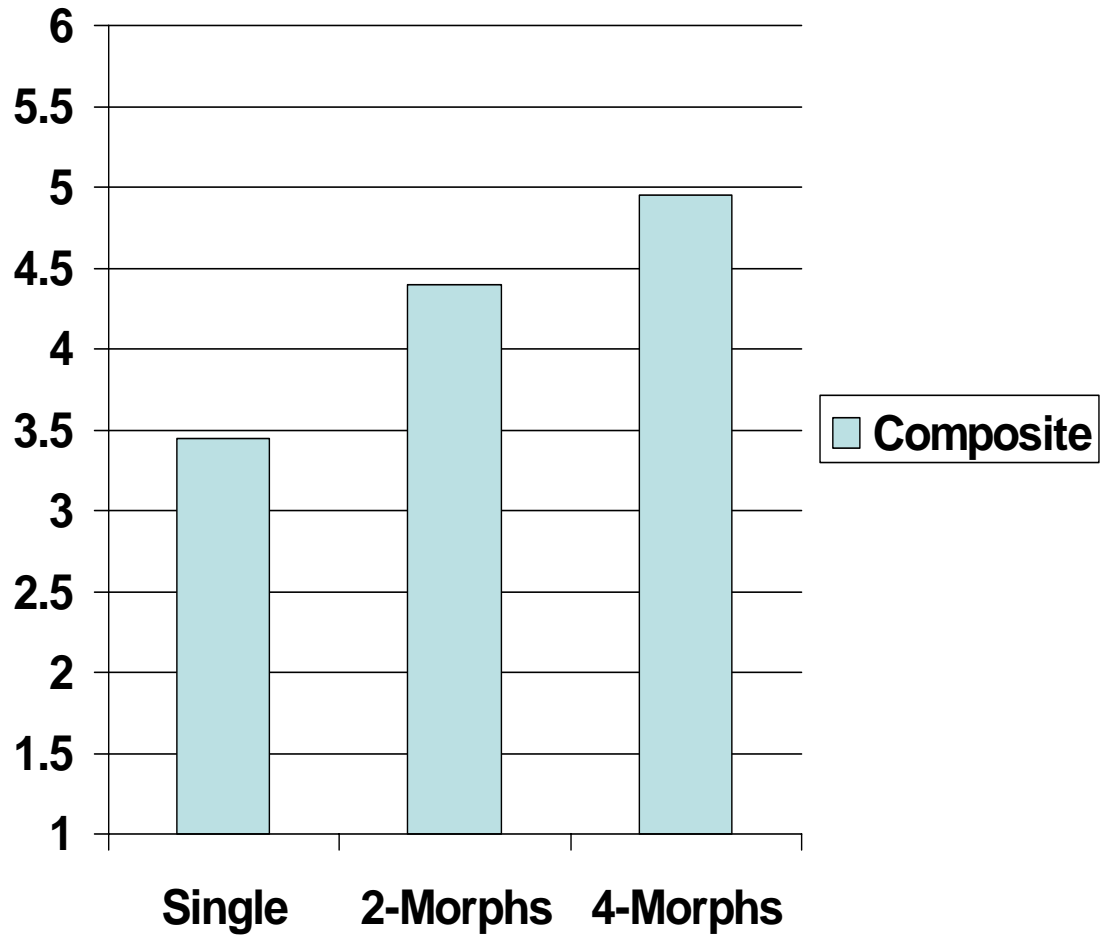
What's his name



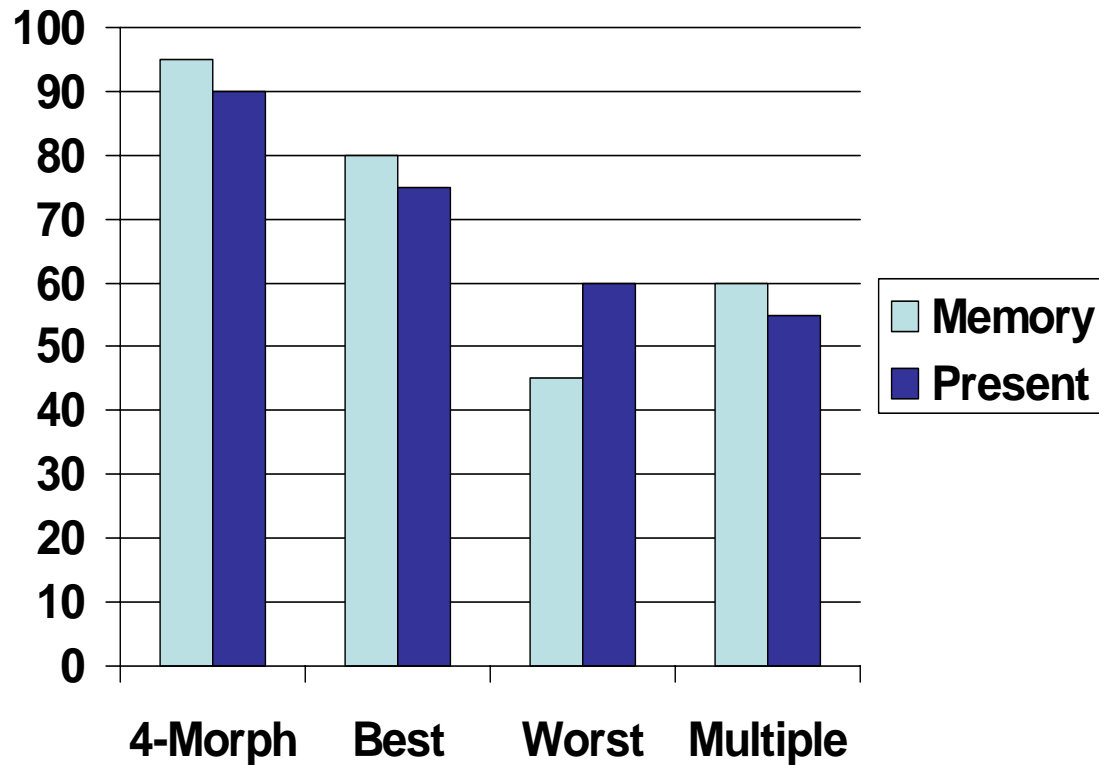
Typical composite from memory



Mean likeness ratings (/10)



6-alt FC for famous targets



New dimensions for Pro-Fit



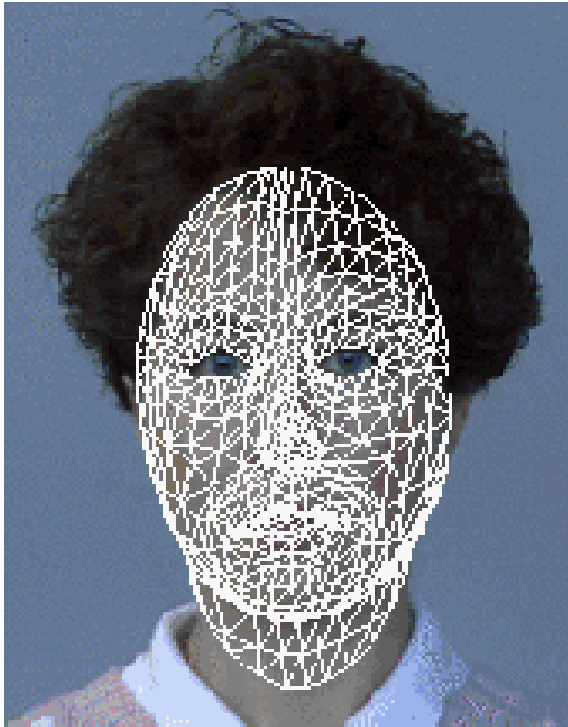
Theory

- General area of visual perception – Marr’s influence on computational theory and modelling approaches
- Modelling – Bruce & Young...IAC...PCA. IAC combines the conceptual transparency of a ‘paper’ model with the rigour of testable predictions
- Other faces, other minds and androids

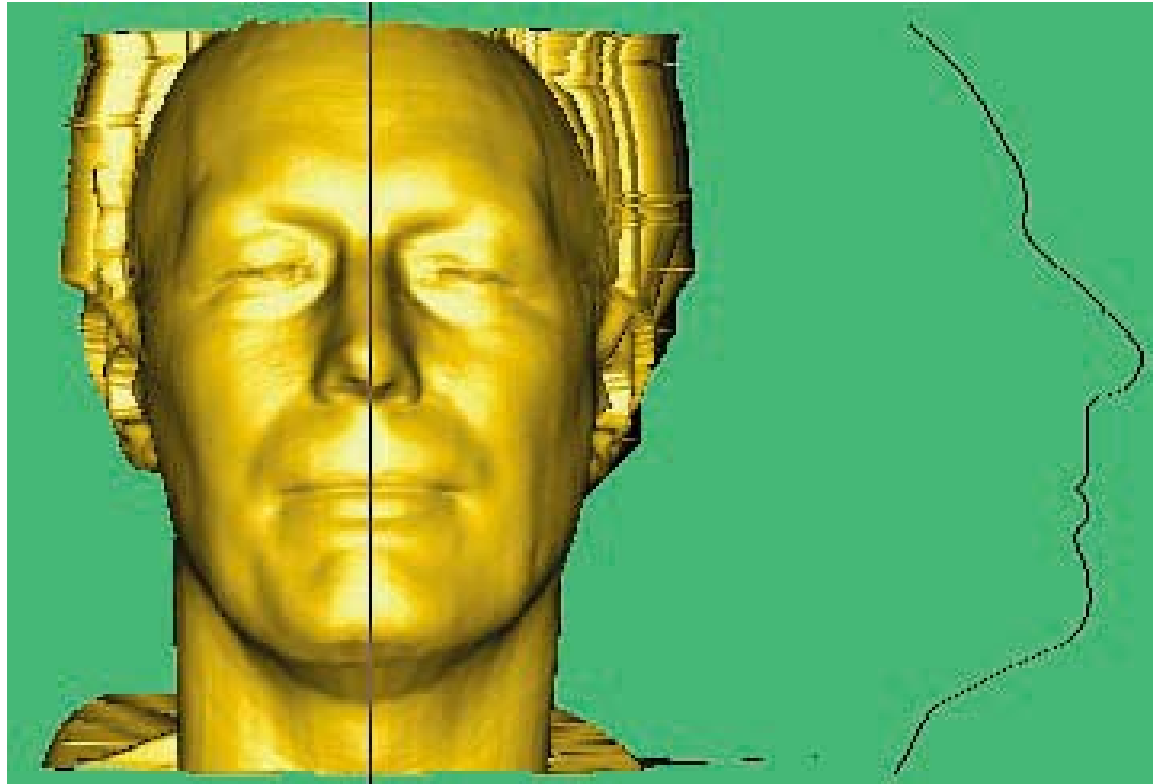
Computational red herring

- Marr's stages of visual representation
- Primal sketch, 2.5D sketch, 3D model
- Face as 3D surface rather than flat pattern.....

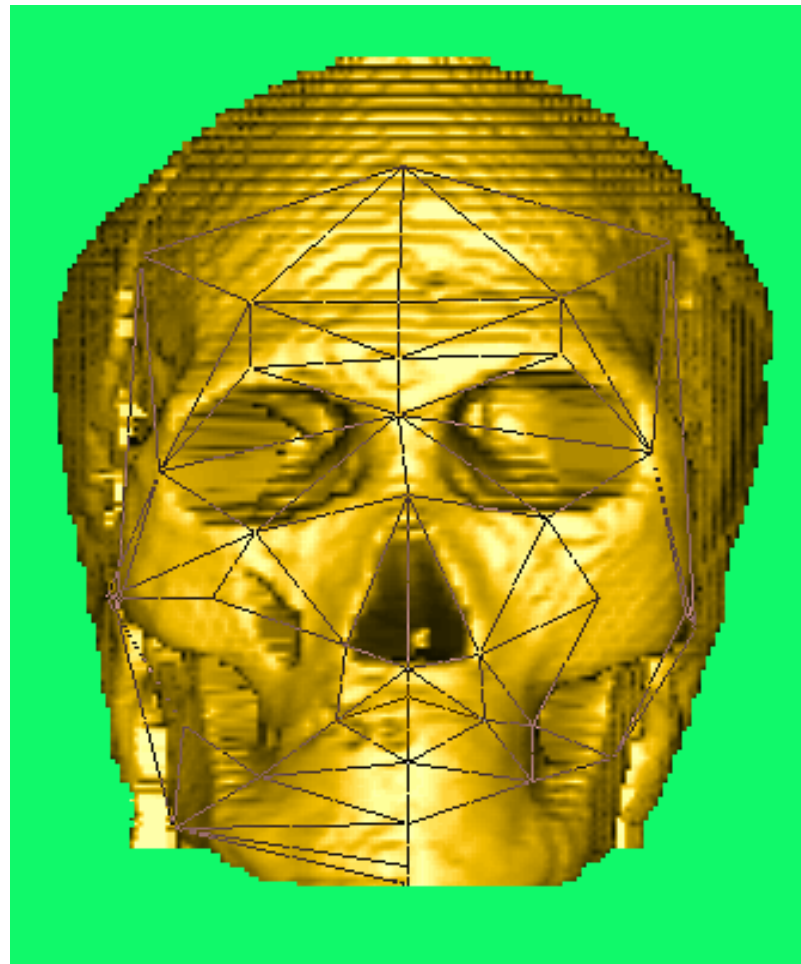
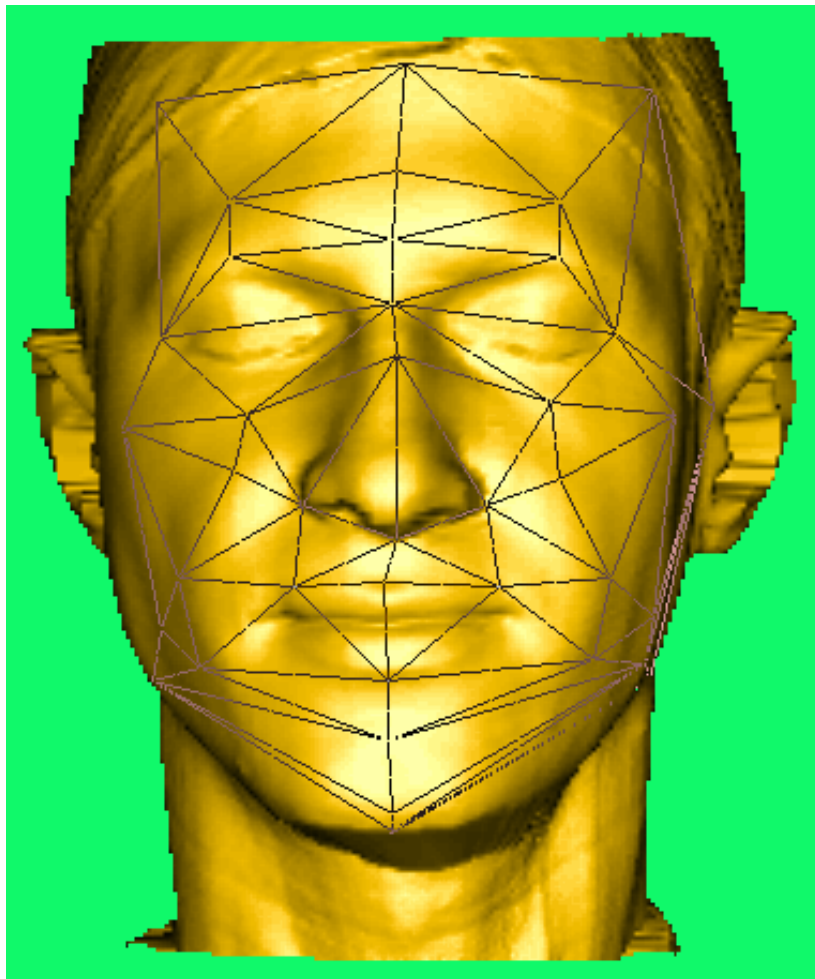
Faces are 3d objects



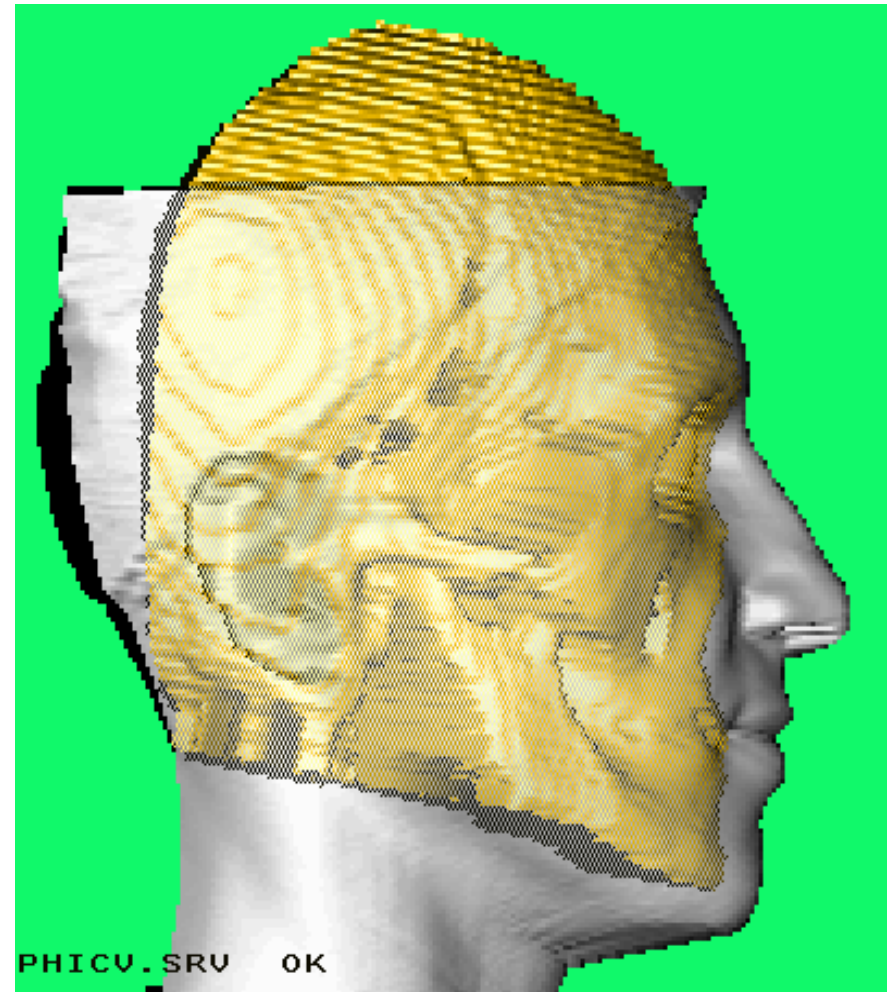
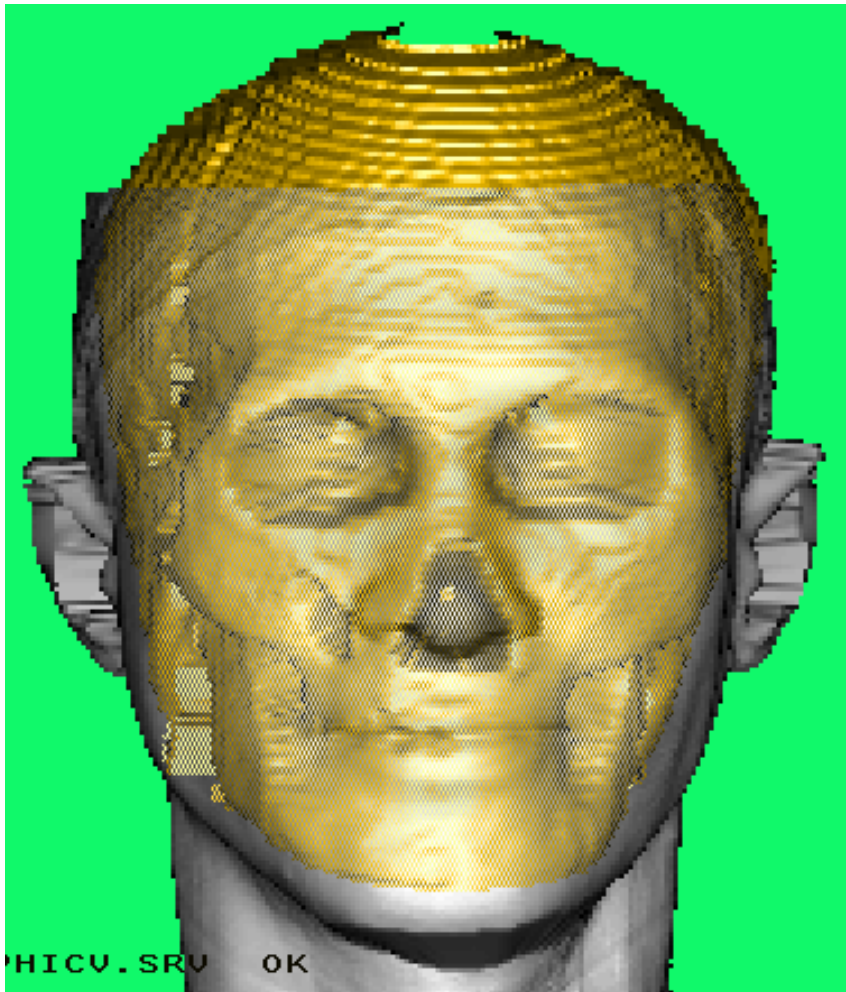
Laser scanner by Alf Linney



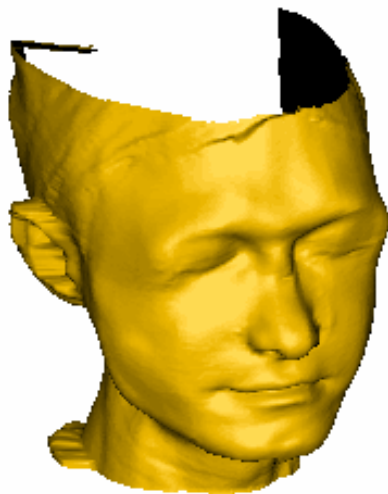
Finding correspondence



Superimposing surface on skull



Final reconstruction



Texture and shape: Hill, Bruce & Akamatsu (Proc Roy Soc B 1995)



Surface texture & shape



Surface representations of faces

- Clearly important for some things we do with faces
- No evidence that these play a role in recognising individual faces
 - E.g. Difficulty in coping with viewpoint transformation of unfamiliar face
- Much stronger evidence that brain uses a rather low-level image description of faces
 - E.g. Difficulties of recognising unfamiliar face across subtle changes of lighting/camera
 - E.g. Biederman & Koloc sai's work on comp s.f. components



1



2



3



4



5



6



7



8



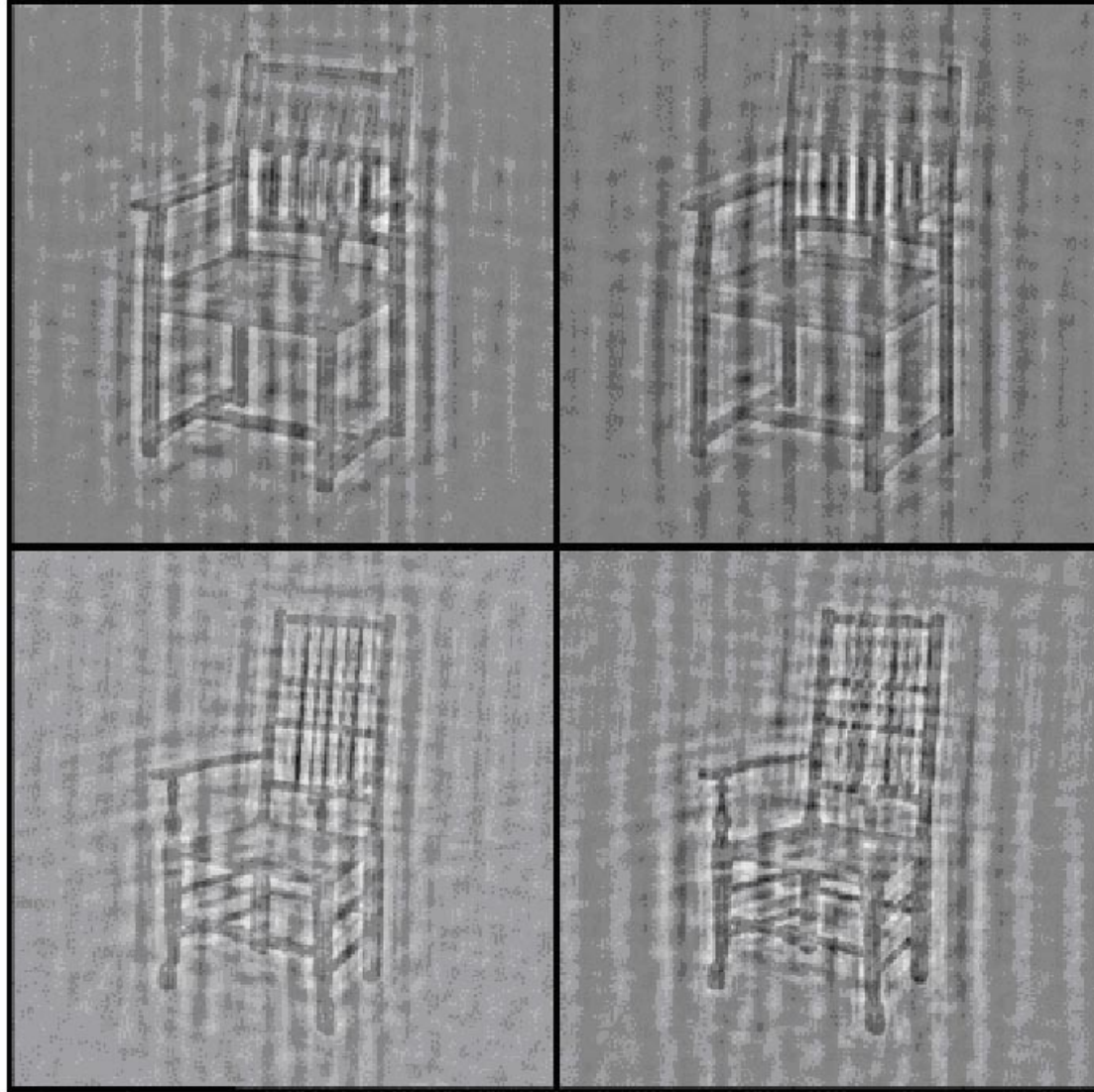
9



10

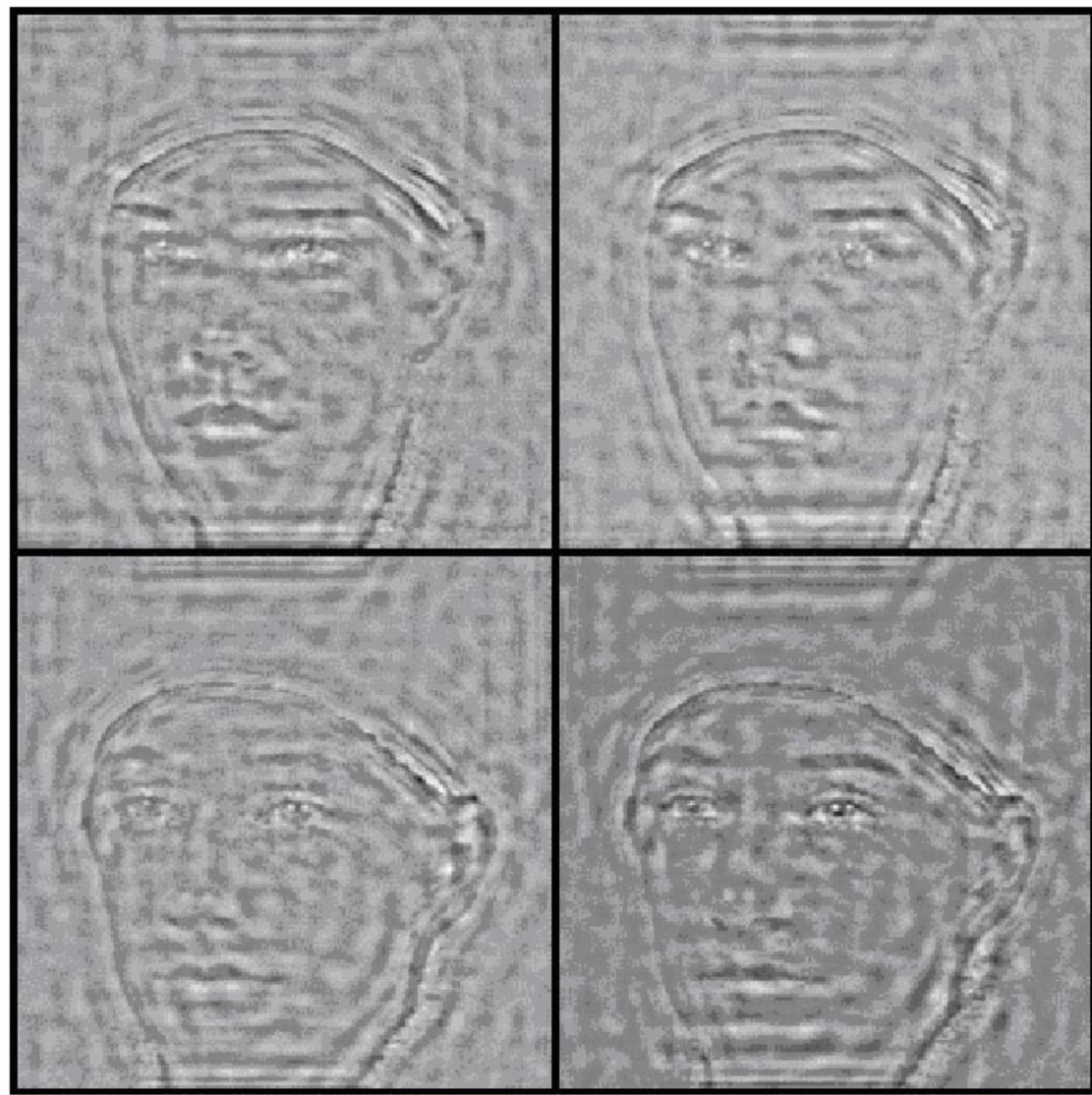
← Complements →

← Different Chairs →



← Complements →

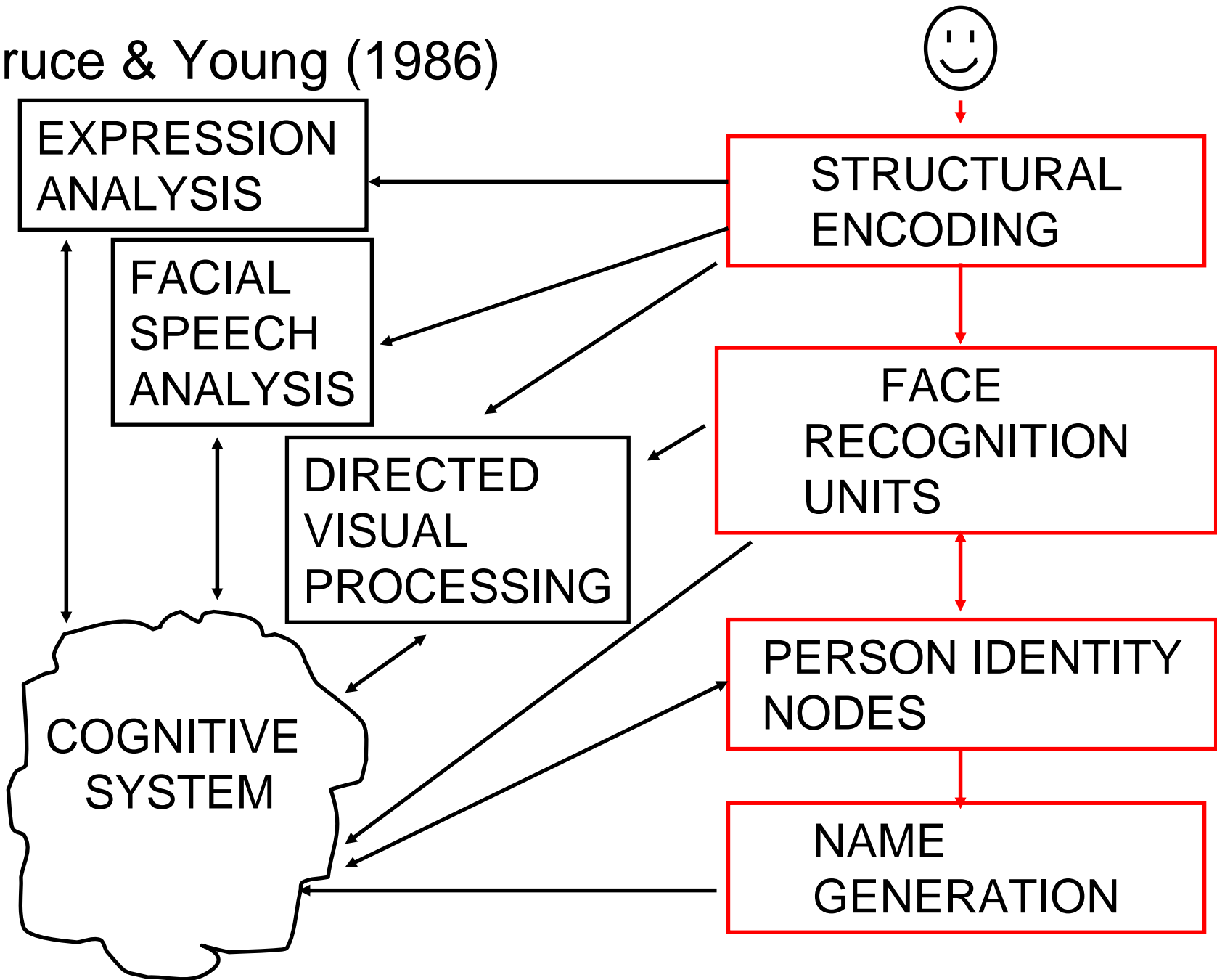
← Different People →



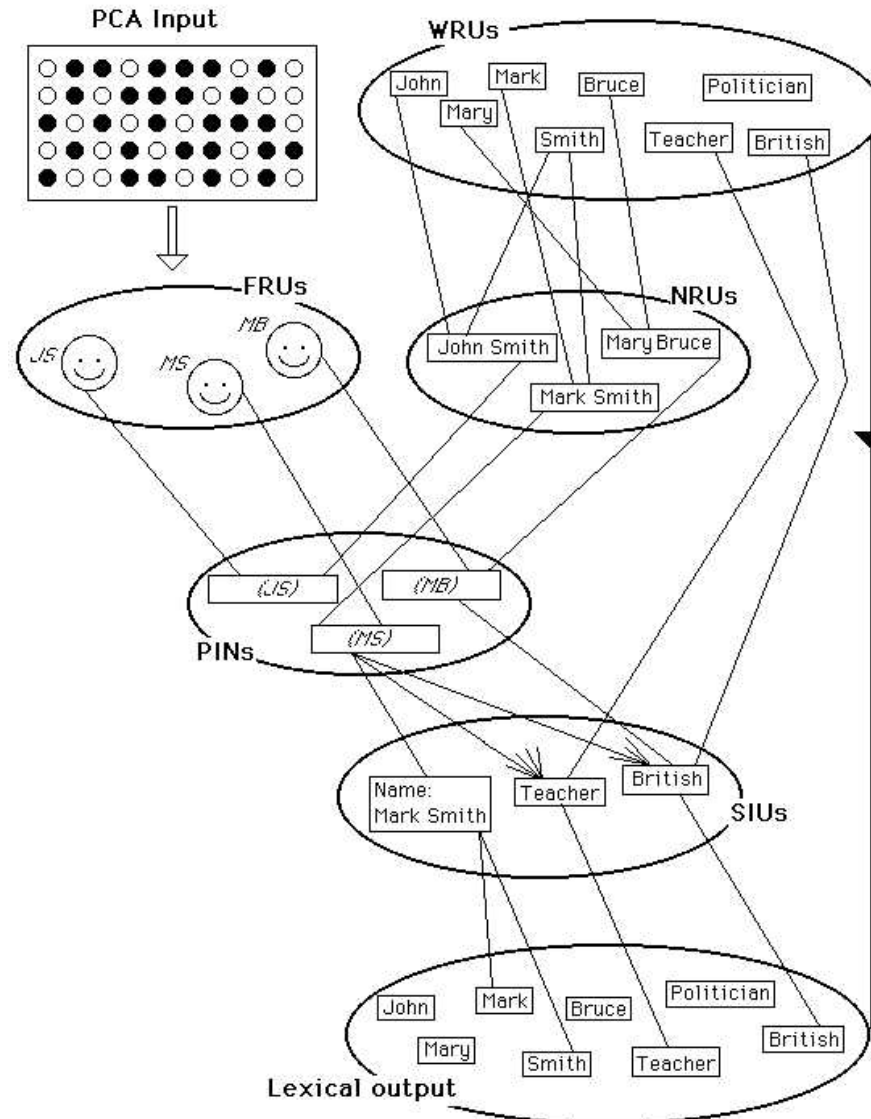
Models of face recognition

- Family of ‘functional’ models of face perception/recognition in 1980’s
- Though underspecified, these did make testable predictions
- But implementation of core stages in connectionist model allowed much better way of testing and developing key assumptions

Bruce & Young (1986)



Burton, Bruce & Hancock, Cognitive Science 1999



- Brain decomposes patterns in ways that are not obvious.
- Eyes + nose + mouth not the way the brain sees faces.
- ‘Configural’ holistic processing
- Acutely sensitive to spatial frequency range
- Principal Components Analysis of underlying image space – eigenfaces – does reasonable job of suggesting how we code unfamiliar faces
- Familiar faces may be represented as simple averages of past encounters

Separate
(‘Exemplar’)

Averaged
(‘Prototype’)

1



2



mean pixel
intensity



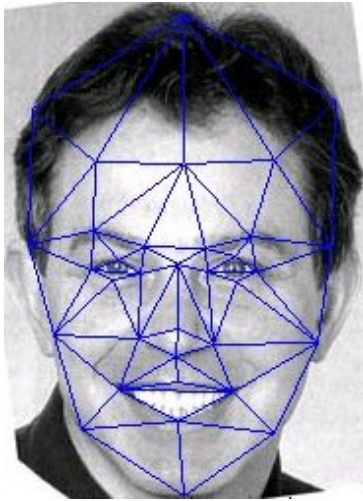
3



Just average

- From Burton, Jenkins, Hancock & White, *Cognitive Psychology*, 2005.

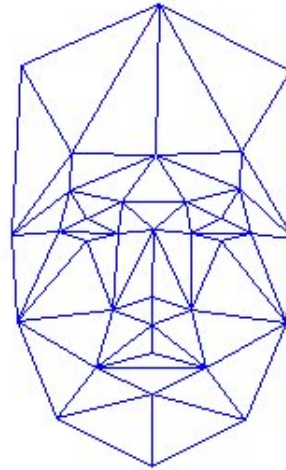
Blair image



Morph



common shape

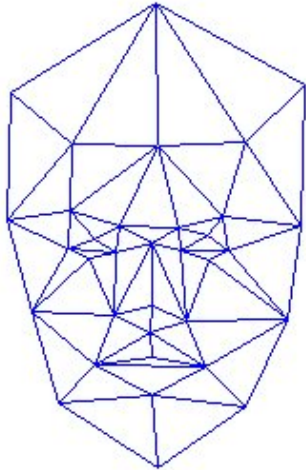


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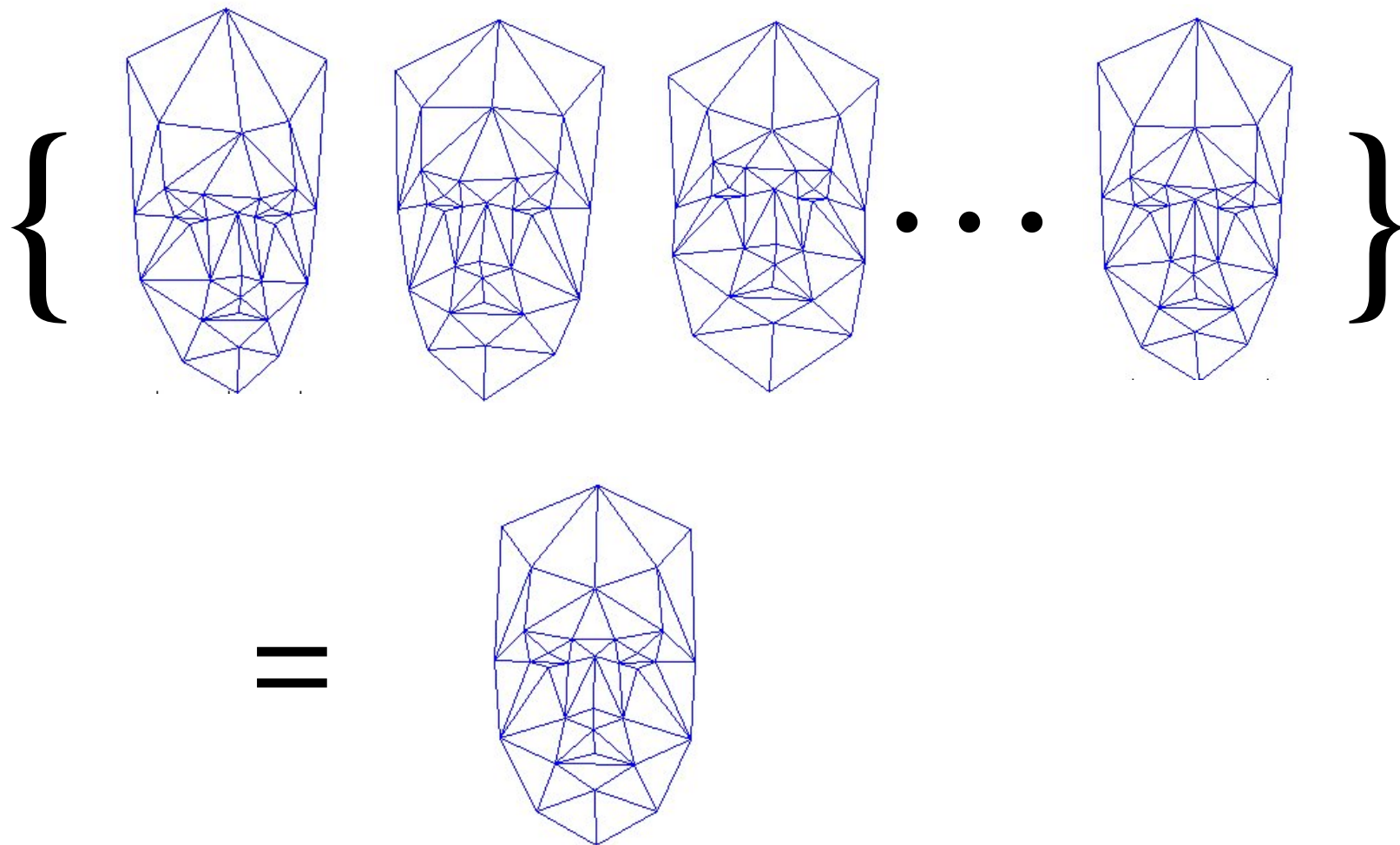
Shape free image



Blair image shape




Average of



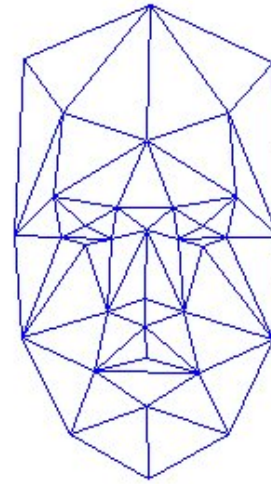
average Blair texture



Morph to

A black arrow pointing from the texture image to the shape image.

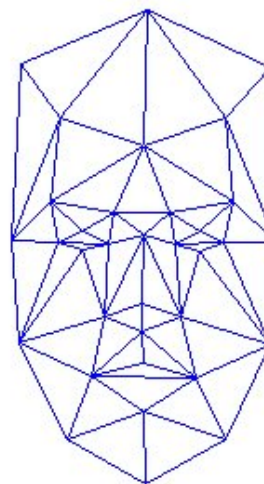
average Blair shape



average Blair texture



average Blair shape



Morph to



**average Blair
texture and shape**









Face Recognition Units?



Issues for the future

- Facial expressions and face gaze inform us about 'other minds'
- Importance of face for interacting with computers or robots
- Most animations and reconstructions get details and timings of facial actions wrong...