



Craniofacial Dysmorphism & Fetal Alcohol Exposure

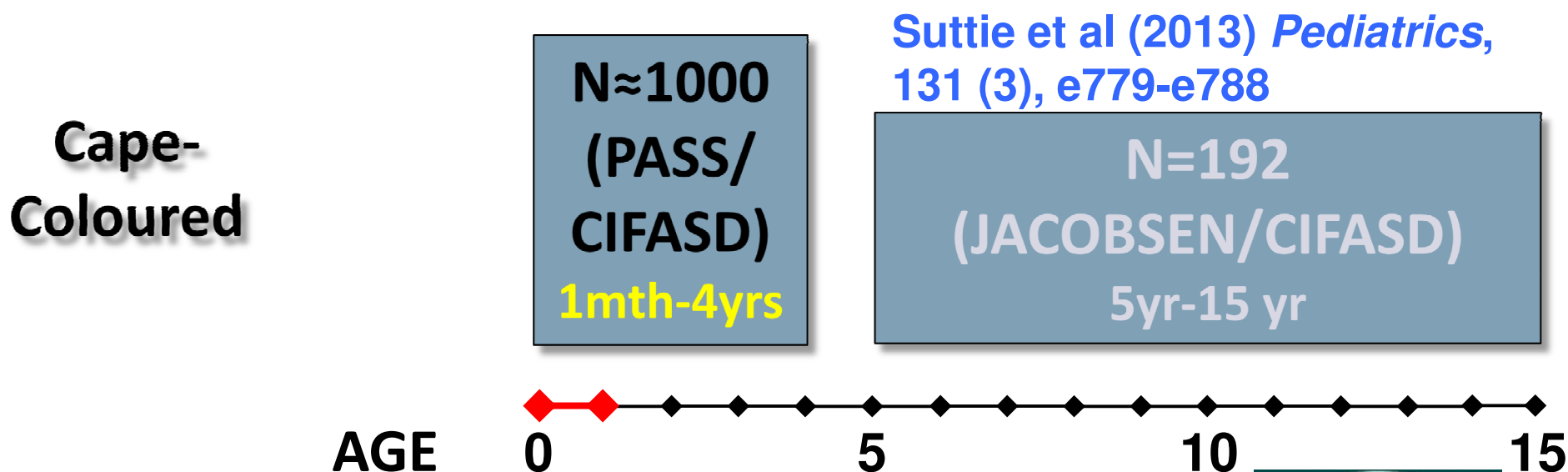
Tatiana Foroud and Peter Hammond (PIs)
Leah Wetherill, Mike Suttie



Analysis Objectives

- 1) *Develop a screening tool that would utilize the data from the 3D facial images and could be widely used to accurately identify individuals with a high likelihood of alcohol exposure*
- 2) *Recruit and analyze facial imaging data from very young populations to develop a screening tool that accurately identifies high risk individuals for future intervention*
- 3) *Combine face images, neurobehavioral data and brain images to identify common pathways and hence improve diagnosis of prenatal alcohol exposure*
- 4) *Extend existing and develop novel techniques and associated software to cope with demands of larger datasets and more diverse comparison of controls, alcohol exposed and other developmentally delayed subjects while accommodating multiple anatomical images per subject*

2) Recruit and analyze facial imaging data from very young populations to develop a screening tool that accurately identifies high risk individuals for future intervention

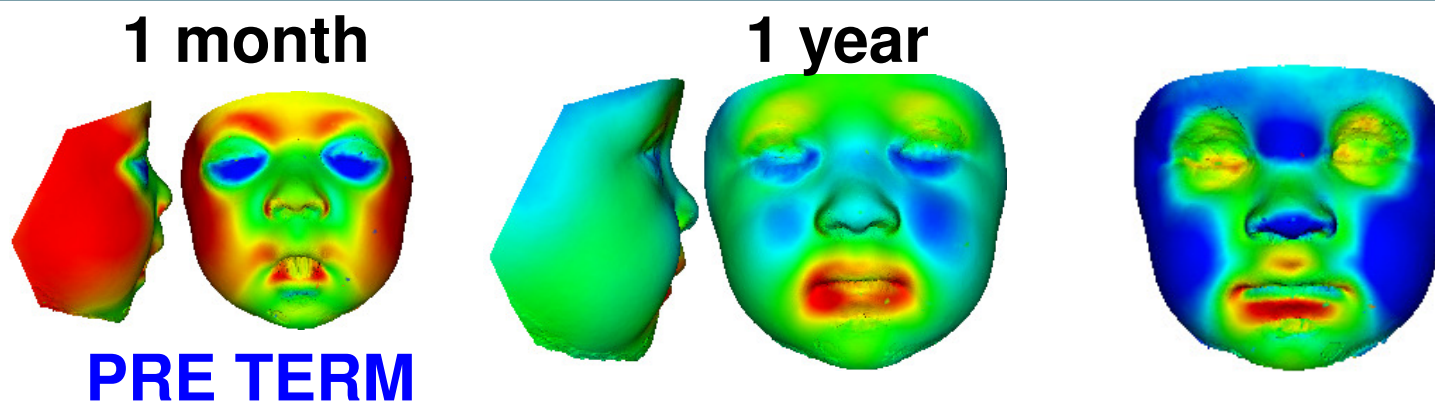
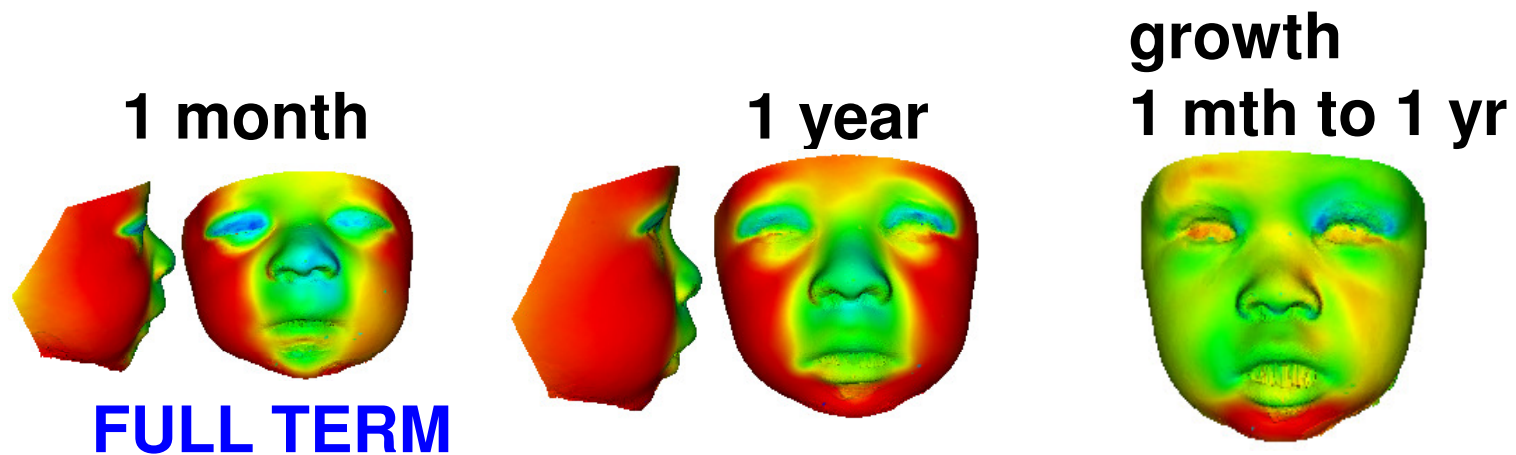


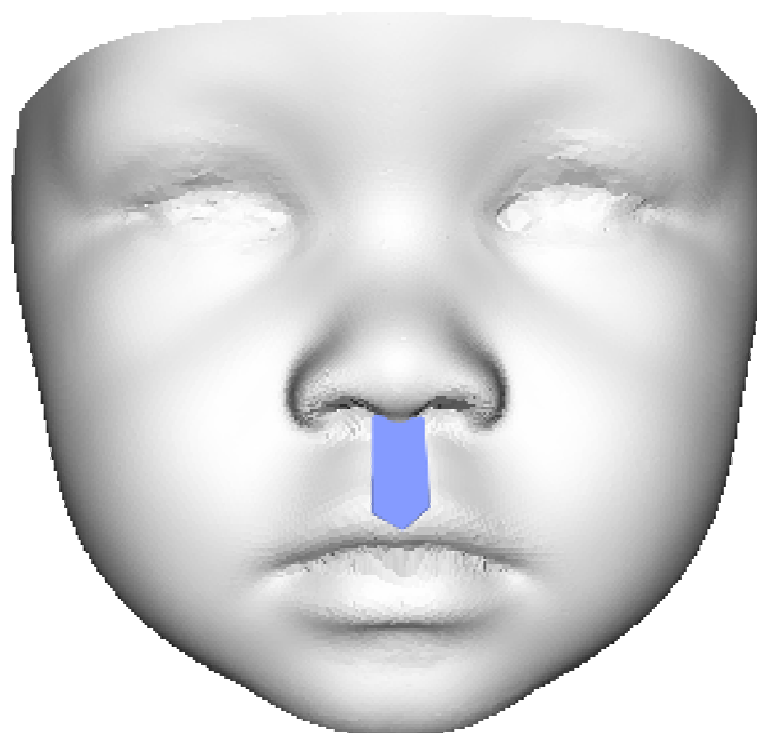
3D facial analysis of 272 PASS infants
not exposed (controls) 91 (43 M/48 F)
unknown exposure 182 (83 M/98 F)



Example facial growth in 1st year of life

Normalised w.r.t 40 controls



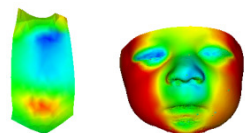




UNKNOWNNS WITH SMOOTH PHILTRUM

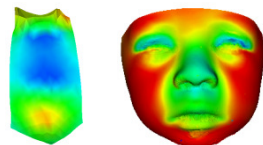
all at 2.0 SD sensitivity unless otherwise indicated

1M



1.5 SD

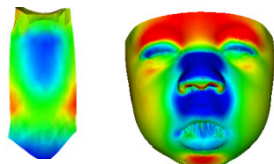
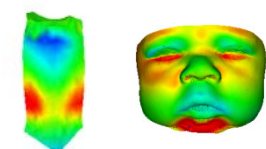
1Y



1Y PFL

SD: - 2.05

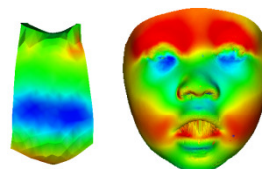
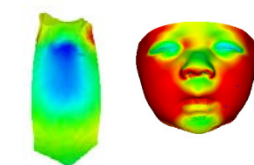
<10th pc: ✓



1Y PFL

SD: - 1.39

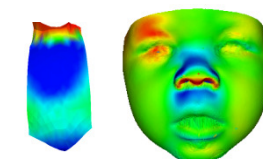
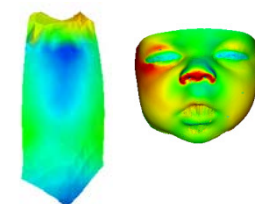
<10th pc: ✓



1Y PFL

SD: -1.8

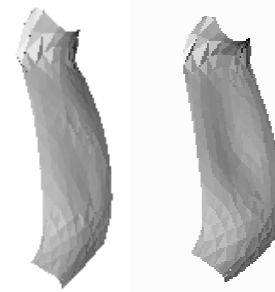
<10th pc: ✓



1Y PFL

SD: -2.18

<10th pc: ✓

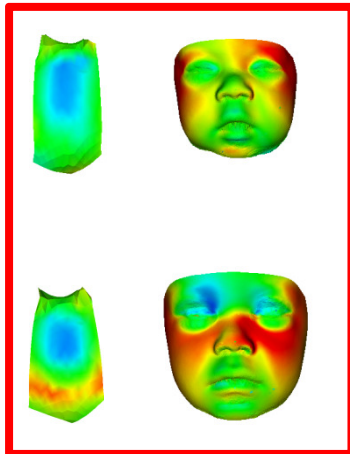
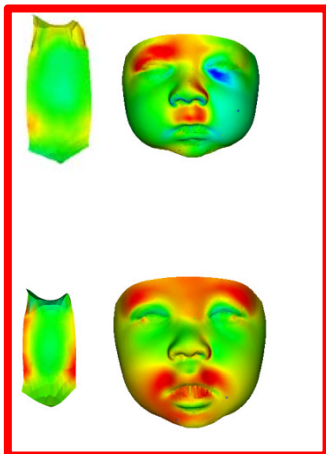




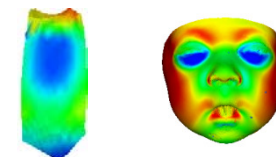
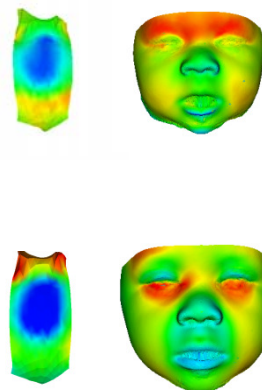
UNKNOWNNS WITH SMOOTH PHILTRUM

all at 2.0 SD sensitivity unless otherwise indicated

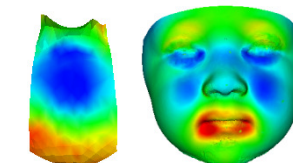
1M



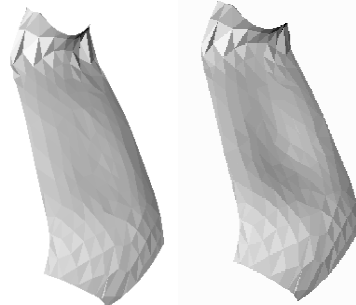
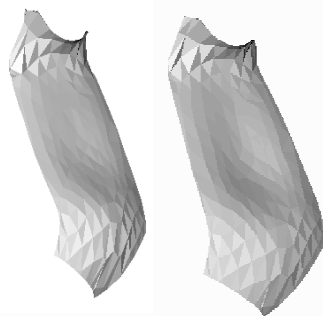
1Y



1.5 SD



1.5 SD



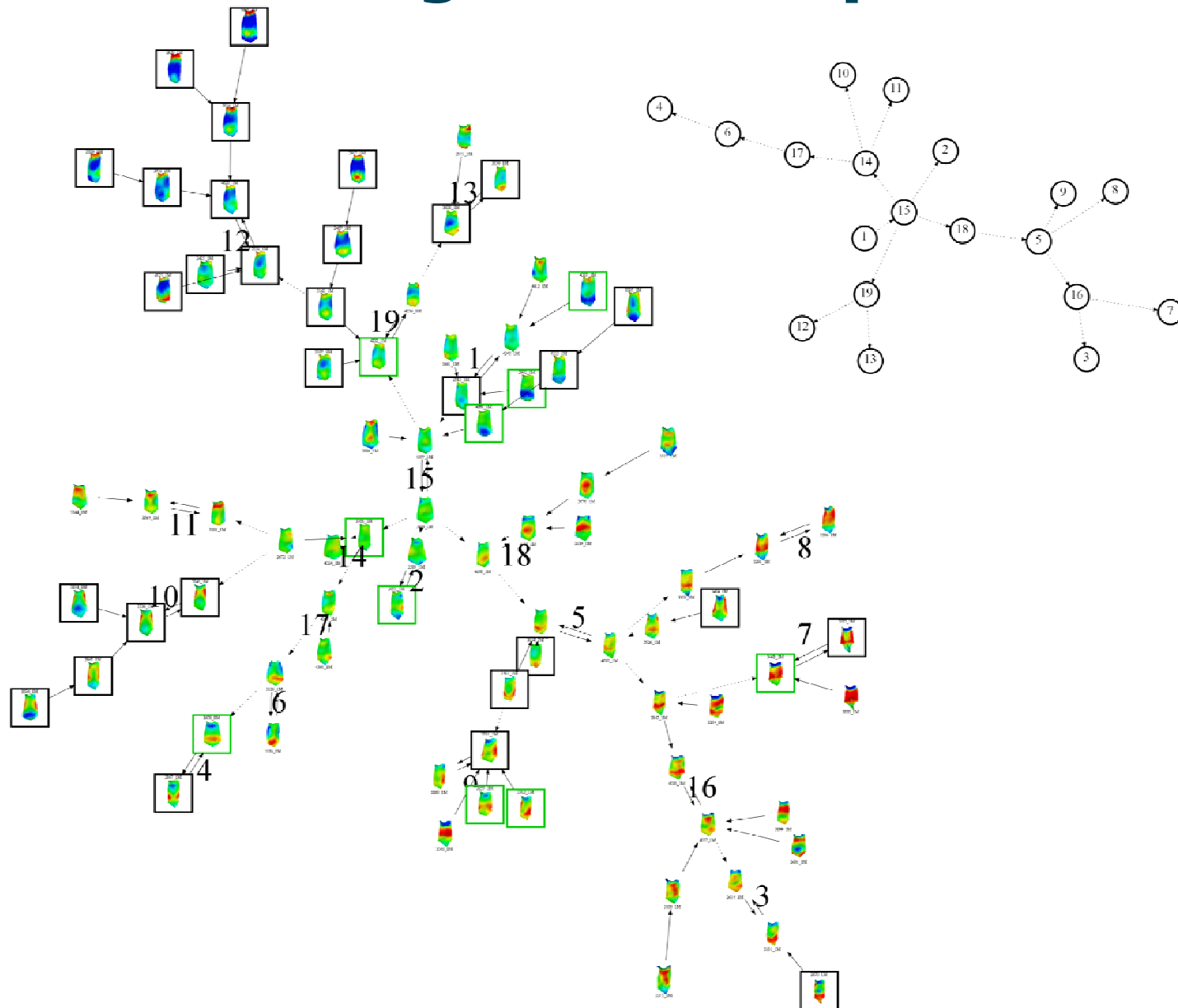
1Y PFL
SD: -2.34
<10th pc: ✓

1Y PFL
SD: 0.21
<10th pc: ✗

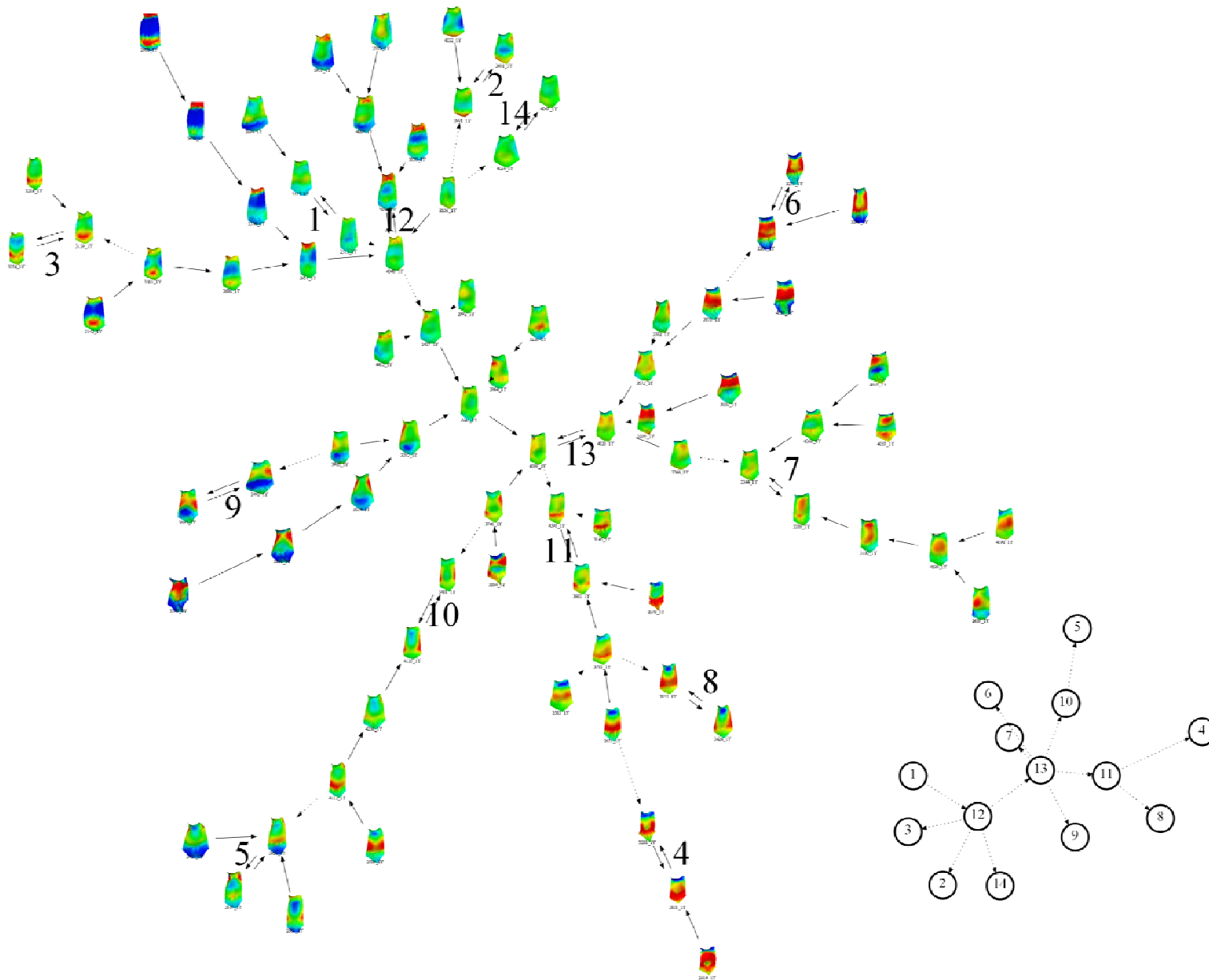
1Y PFL
SD: -0.5
<10th pc: ✗

1Y PFL
SD: -0.42
<10th pc: ✗

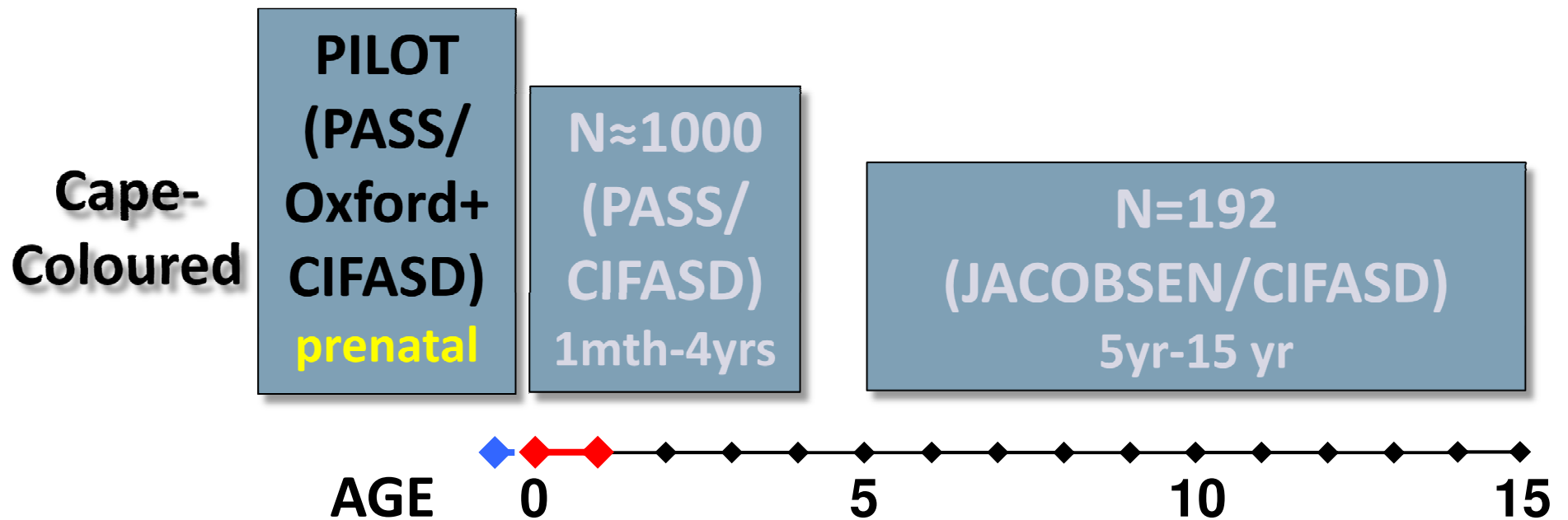
Male Philtrum Signature Graph at 1 Month



Male Philtrum Signature Graph at 1 Year



Development Project: Jan'14 - May'14



Combine 3D U/S & face analysis to detect FASD facial effects prenatally



Alison Noble

Head, Biomedical Imaging Lab
Biomedical Engineering,
Oxford University



Tom Rackham

(writing up DPhil)

**Hein Odendaal,
Rosemary Meyer**

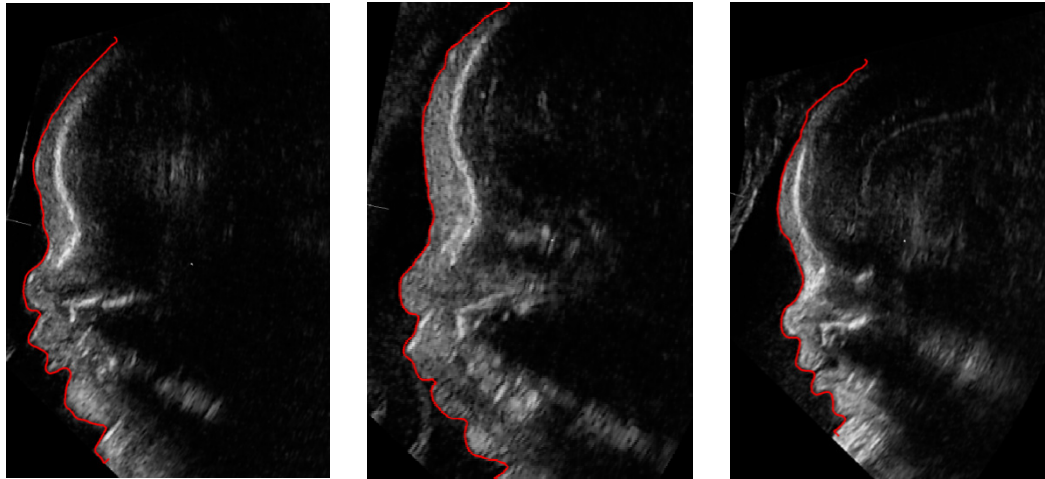
(Stellenbosch Univ, South Africa)



Combine 3D U/S & face analysis to detect FASD facial effects prenatally

- identify variation in quality of face surfaces segmentable from 3D U/S images
- determine if “3D” curve of face mid-line profile is reliably segmentable
- determine which face patches produce shape models good enough for face discrimination

Segment mid-line face profiles & build shape model

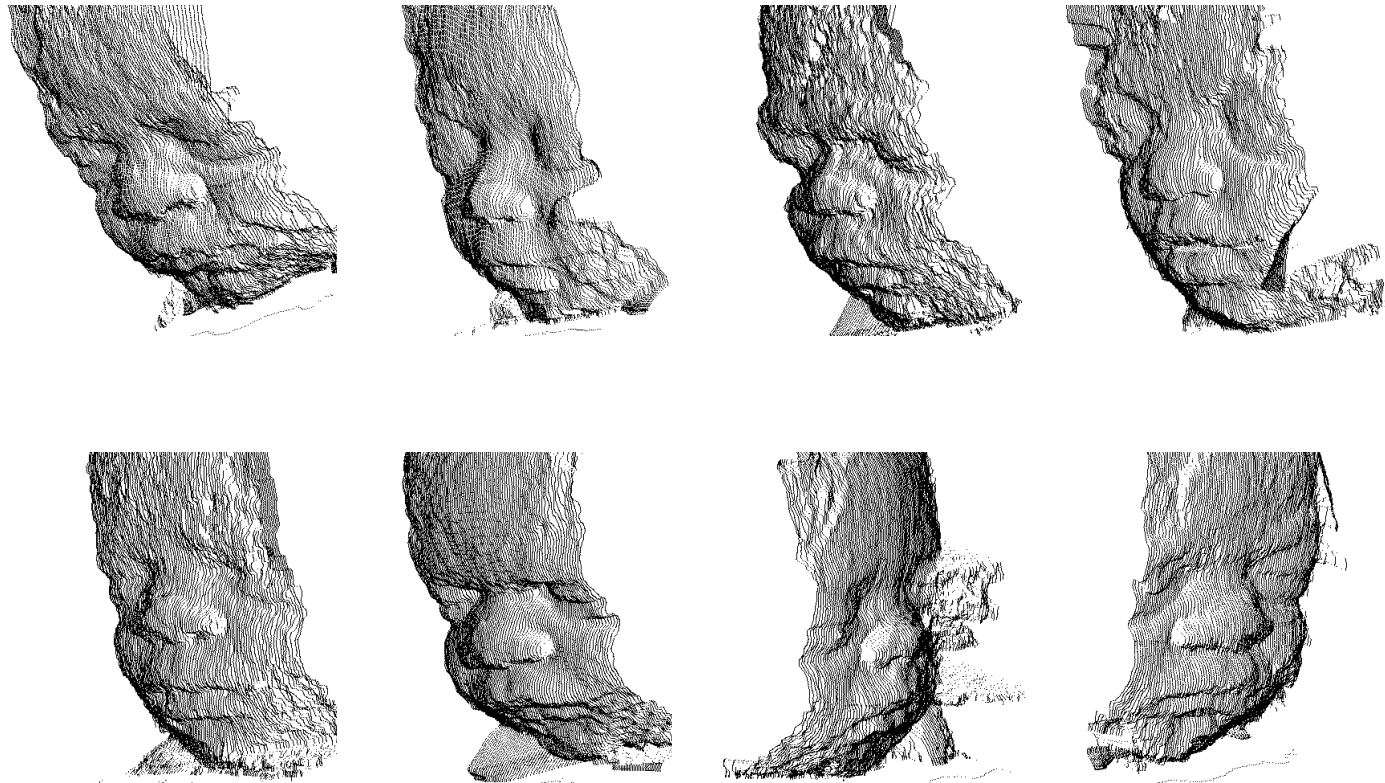


Examples of mid-line profiles (n=21)
6 landmarks added manually



PC1: -2 SD <-> +2 SD

Extract face surface point cloud



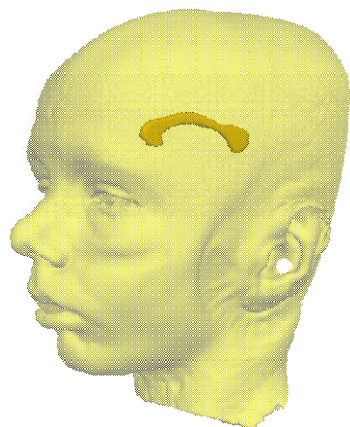
Future work

- work with experienced sonographer to define protocol for optimal face capture, e.g. covering exocanthi to derive PFL
- for future delineation of brain structures, need 2nd protocol:
 - Dr Noble's lab has manuscript on new techniques under review
 - “Predicting Fetal Neurodevelopmental Maturation in Ultrasound Images”



3) *Combine face images, neurobehavioral data and brain images to identify common pathways and hence improve diagnosis of prenatal alcohol exposure*

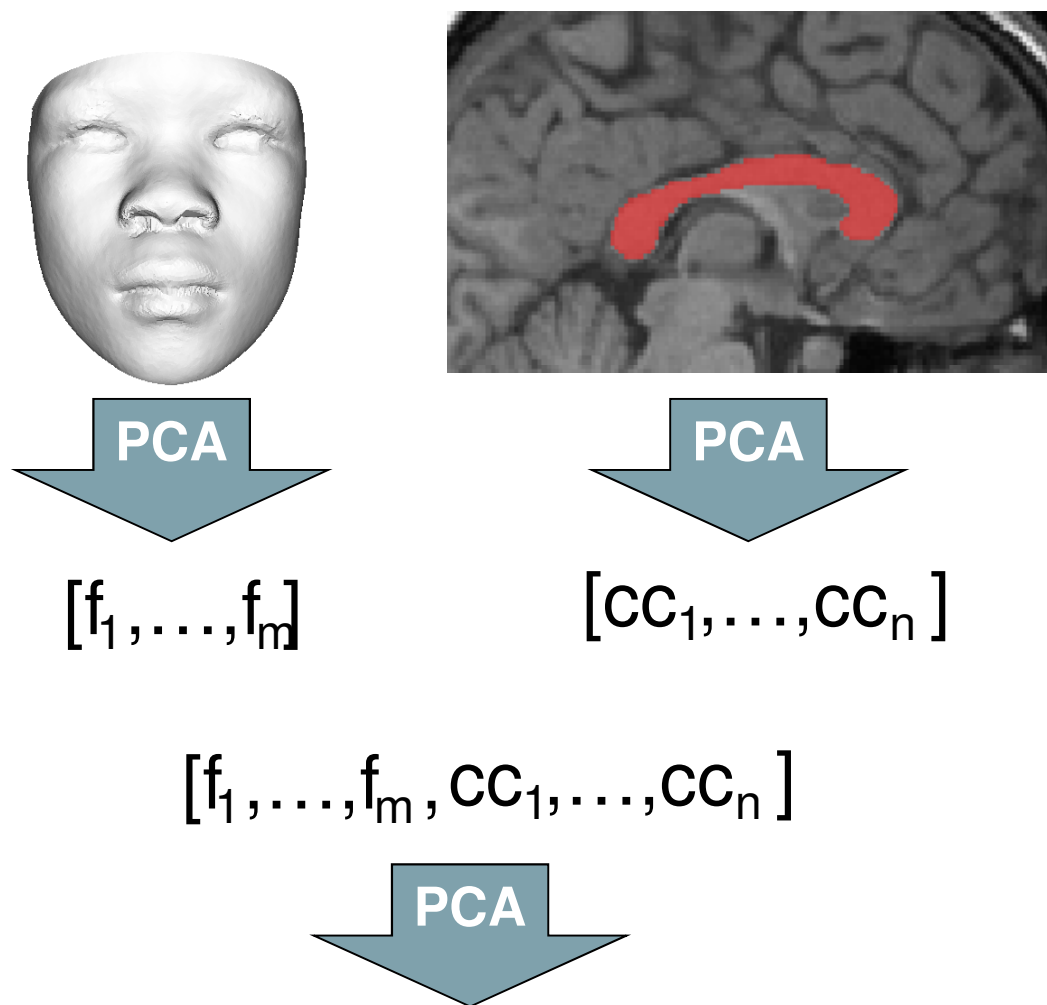
**PILOT (FAS:7; HC:11)
(JACOBSEN/CIFASD)**
9yr-10yr



3D MRI

**FAS:12; HC:21; HE:24
(USA/CIFASD)**
8.6yr-18.1yr

Extension to dense surface model construction

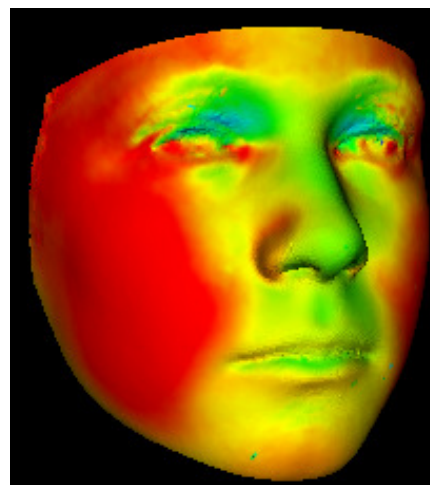


Mean FAS (N=12) vs Mean HC (N=21) joint model: Face & Corpus Callosum

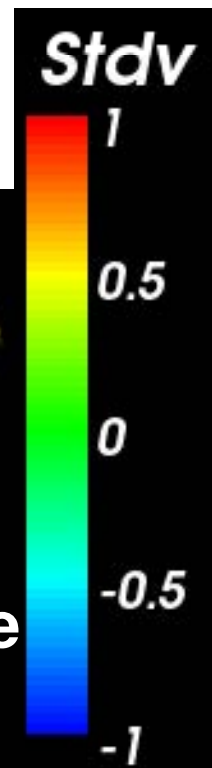
reduced
size
smooth
philtrum
smaller PF



corpus callosum narrower
at localised regions

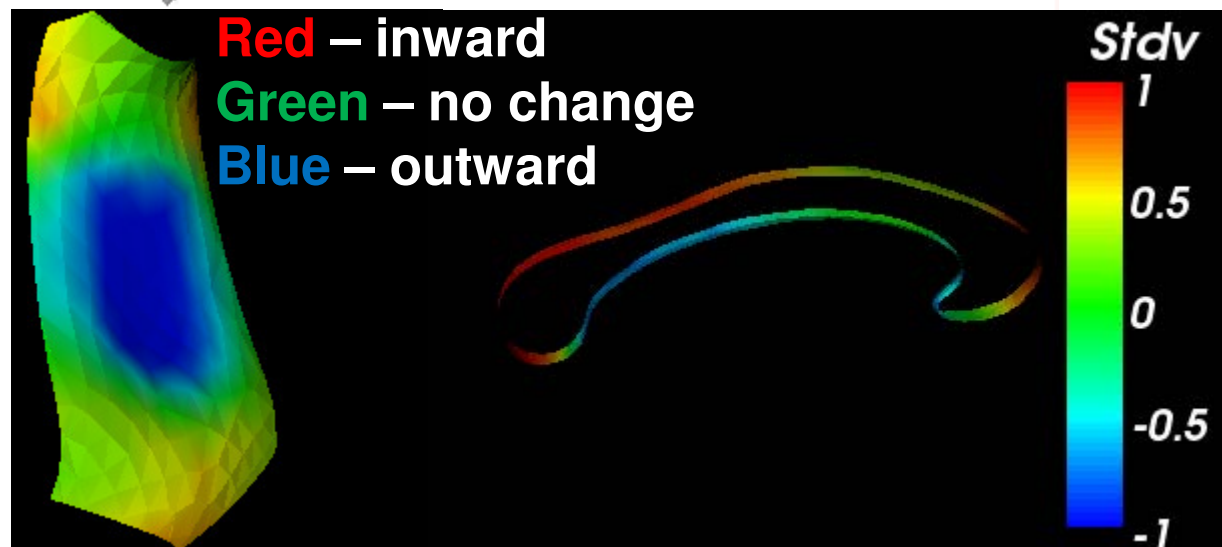
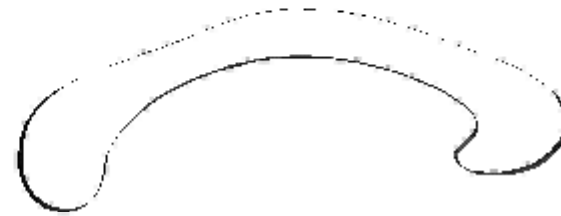
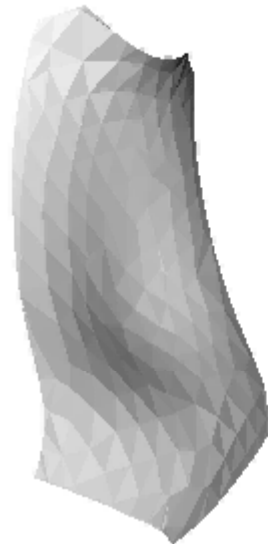


Red – inward
Green – no change
Blue – outward



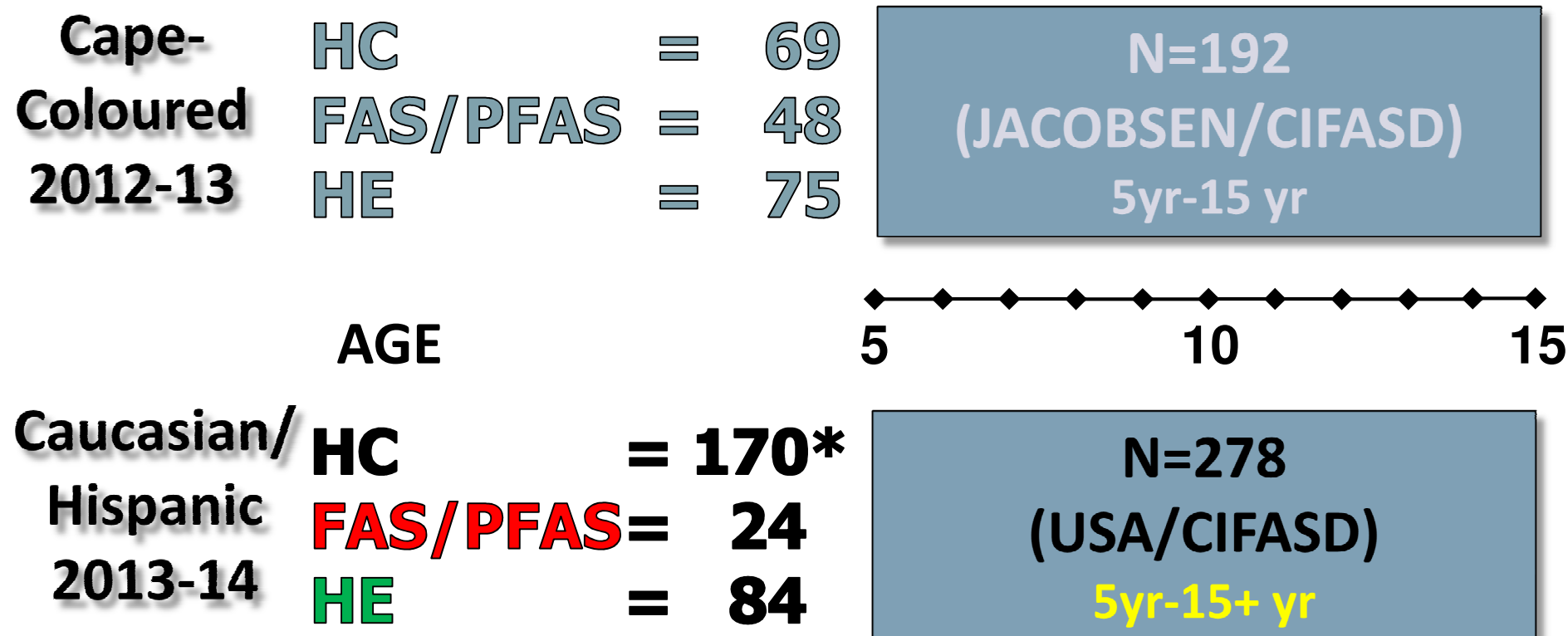


Mean FAS (N=12) vs Mean HC (N=21) joint model: Philtrum & Corpus Callosum



4) Extend existing and develop novel techniques and associated software to cope with demands of larger datasets and more diverse comparison of controls, alcohol exposed and other developmentally delayed subjects while accommodating multiple anatomical images per subject

Suttie et al (2013) *Pediatrics*, 131 (3), e779-e788



HC vs FAS

Cape-Coloured

Probability of correctly classifying random pair (1 HC & 1 FAS)

Face
Periorbit
Perioral
Perinasal
Profile

US Caucasian/ Hispanic

	CM	LDA	SVM
Face	0.88	0.89	0.90
Perinasal	0.91	0.92	0.92
Profile	0.89	0.89	0.95
Philtrum	0.83	0.80	0.86

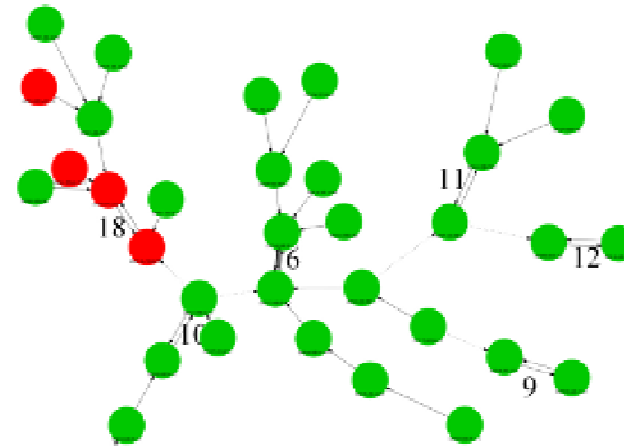


Cape-Coloured: 2012-13

FAS/PFAS
HE

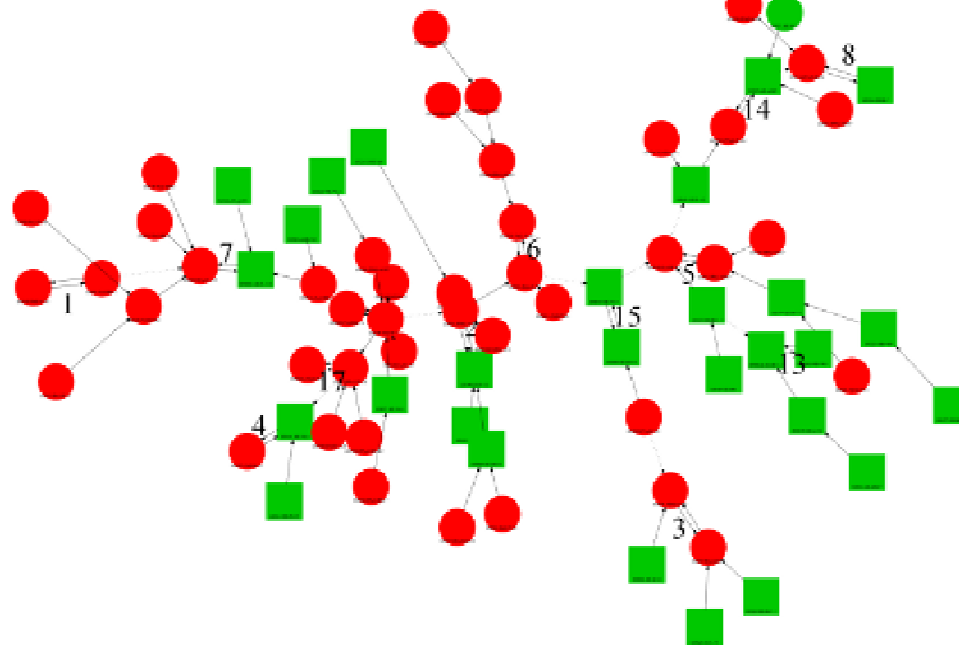
HE2 ●

facial differences more control like than FAS/PFAS



HE1 ■

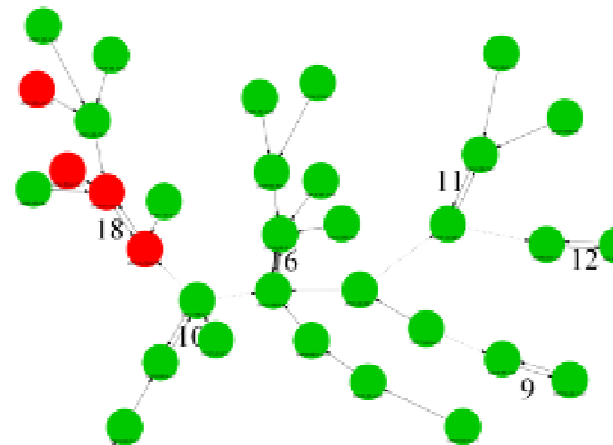
facial differences more FAS/PFAS like than control



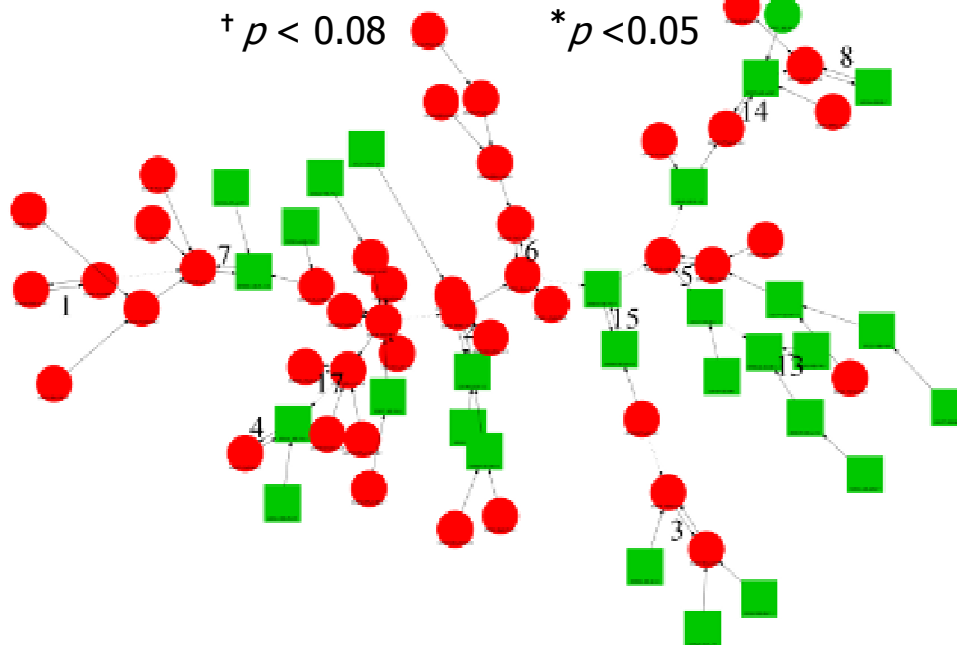
Cape-Coloured: 2012-13

FAS/PFAS
HE

	HE2	HC	HE1 vs HE2 (<i>t</i>)
WISC IQ	73.3	73.3	-1.80 [†]
CVLT-C 1	47.3	45.8	-2.02*
CVLT-C 2	93.7	93.2	-1.89 [†]

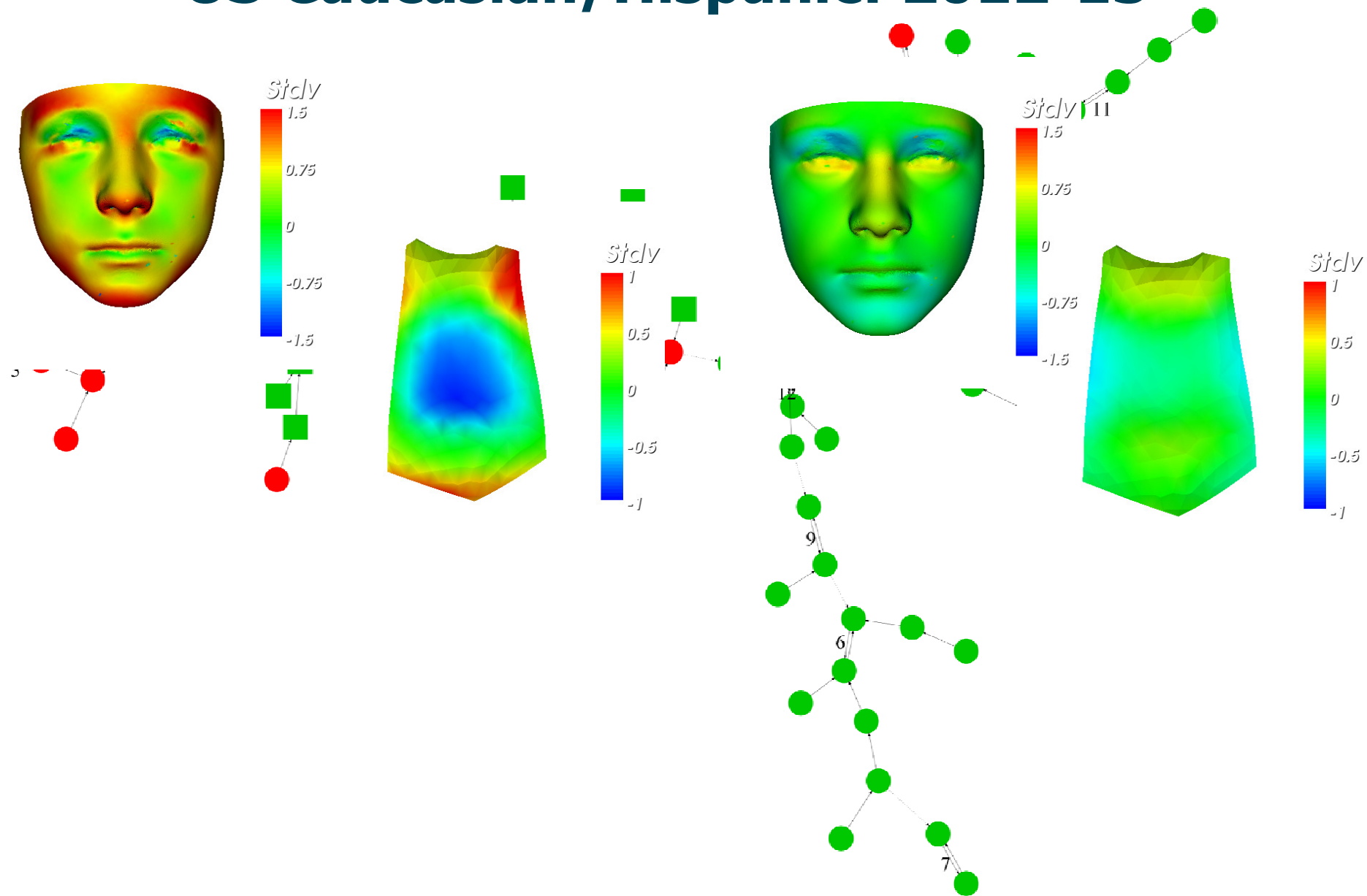


[†] $p < 0.08$ * $p < 0.05$



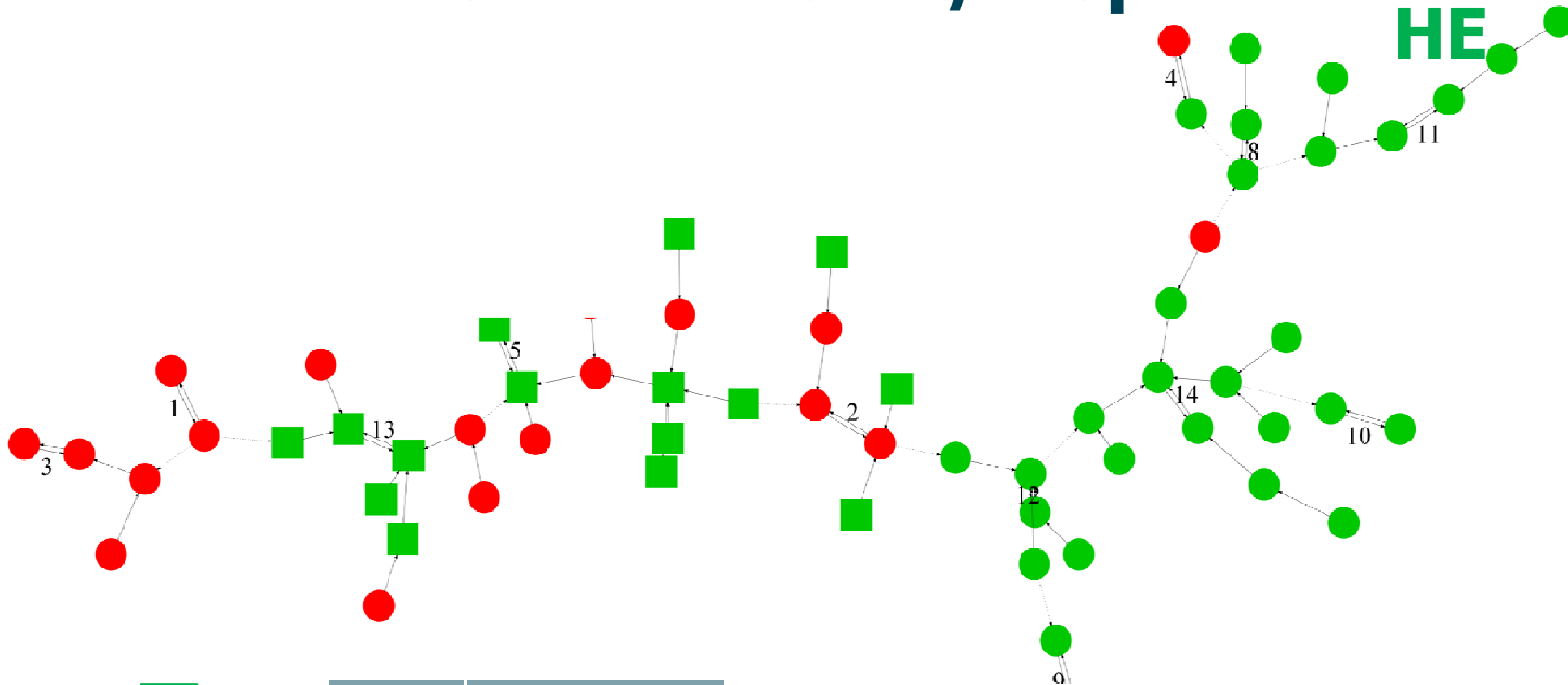
	HE1	FAS	PFAS
WISC IQ	65.5	65.4	63.0
CVLT-C 1	40.0	42.7	41.5
CVLT-C 2	84.3	88.5	88.3


US Caucasian/Hispanic: 2012-13




US Caucasian/Hispanic



FAS/PFAS
HE



	HE1	FAS
WISC FULL SCALE	76.8	83.1
WISC BLOCK DES SCALE	6.9	7.05
WISC VERB COMPR	92.9	87.1



	HE2	HC	HE1 vs HE2 (<i>p</i>)
WISC FULL SCALE	86.2	103.8	0.2
WISC BLOCK DES SCALE	8.93	10.11	0.03*
WISC VERB COMPR	95.3	108.4	0.63

Cape-Coloured

	HE1	FAS		HE2	HC	HE1 vs HE2 (<i>t</i>)
WISC IQ	65.5	65.4	WISC IQ	73.3	73.3	-1.80 [†]
CVLT-C 1	40.0	42.7	CVLT-C 1	47.3	45.8	-2.02 [*]
CVLT-C 2	84.3	88.5	CVLT-C 2	93.7	93.2	-1.89 [†]

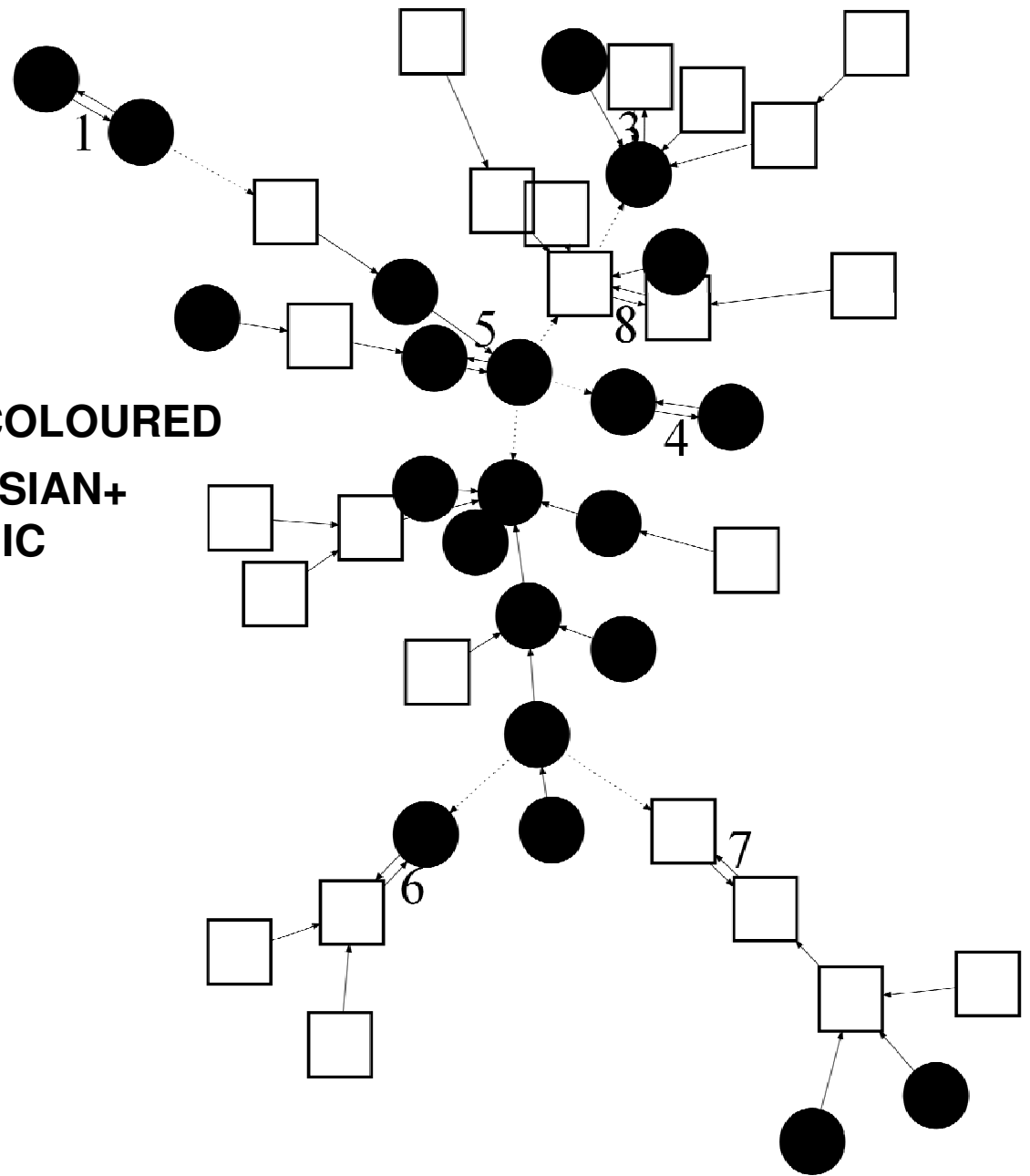
[†] $p < 0.08$
^{*} $p < 0.05$

US Caucasian/Hispanic

	HE1	FAS		HE2	HC	HE1 vs HE2 (<i>p</i>)
WISC FULL SCALE	76.8	83.1	WISC FULL SCALE	86.2	103.8	0.2
WISC BLOCK DES SCALE	6.9	7.05	WISC BLOCK DES SCALE	8.93	10.11	0.03 [*]
WISC VERB COMPR	92.9	87.1	WISC VERB COMPR	95.3	108.4	0.63

SIG GRAPH: FAS USA+JACOBSEN

● CAPE COLOURED
□ CAUCASIAN+
HISPANIC



Plans for 2014-2015

- Write up/submit USA Caucasian face analysis
- Complete/write up/submit Face-Brain-Behaviour analysis (? USA/? Jacobsen)
- Complete/write up/submit (?) PASS 1m-1yr analysis after discussion with PASS network
- Seek funding to undertake 3D ultrasound/face analysis