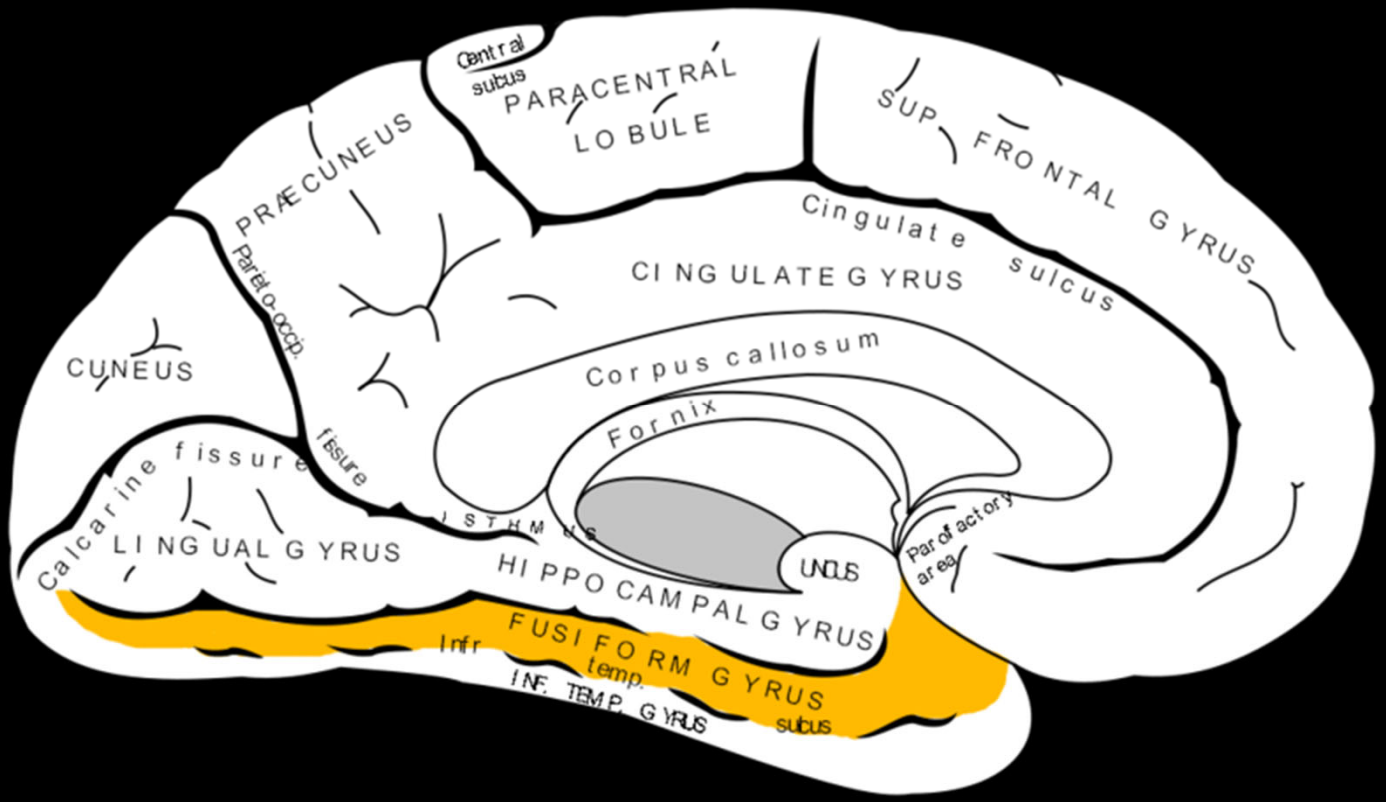
Expressive Facial Modeling and Animation

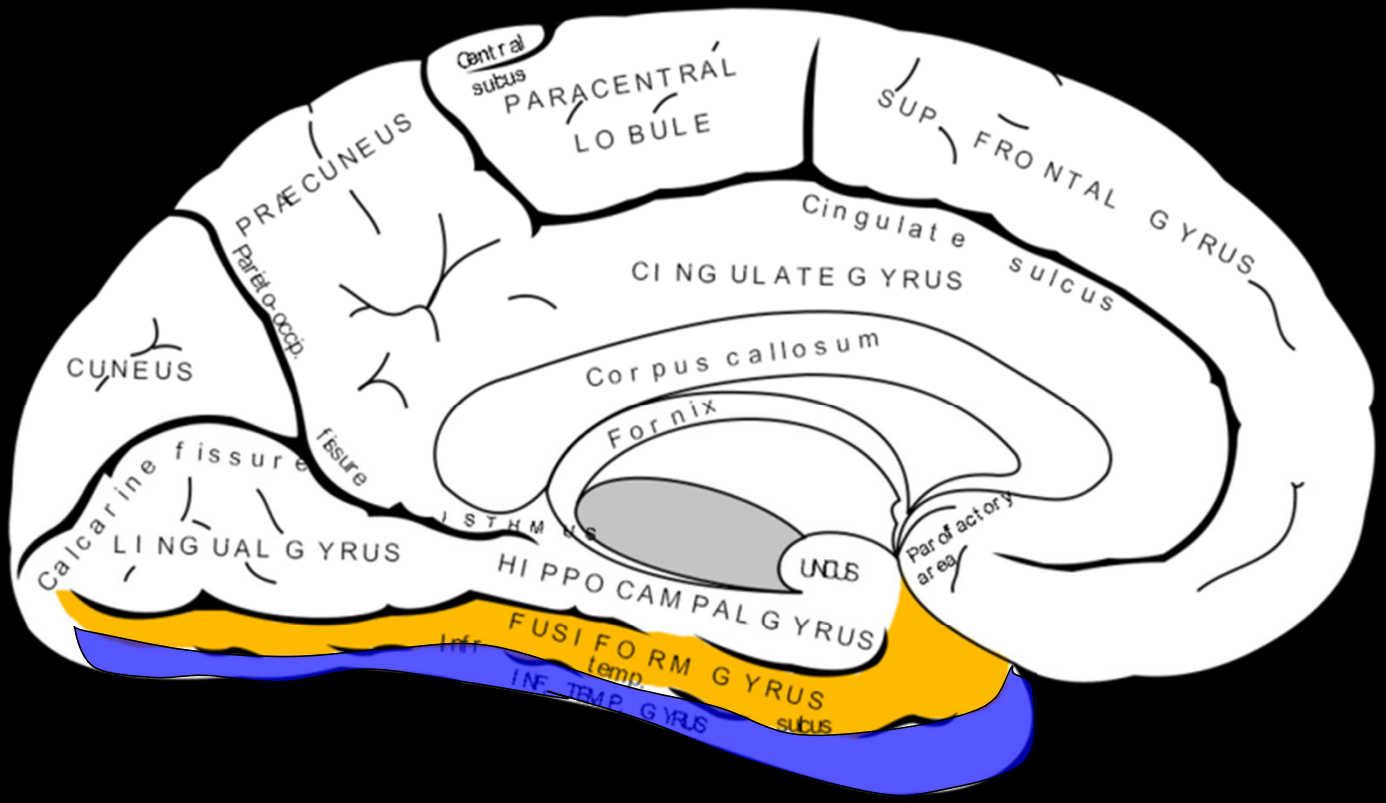
Karan Singh

Who is this and what is their mood? (32x32 pixels)



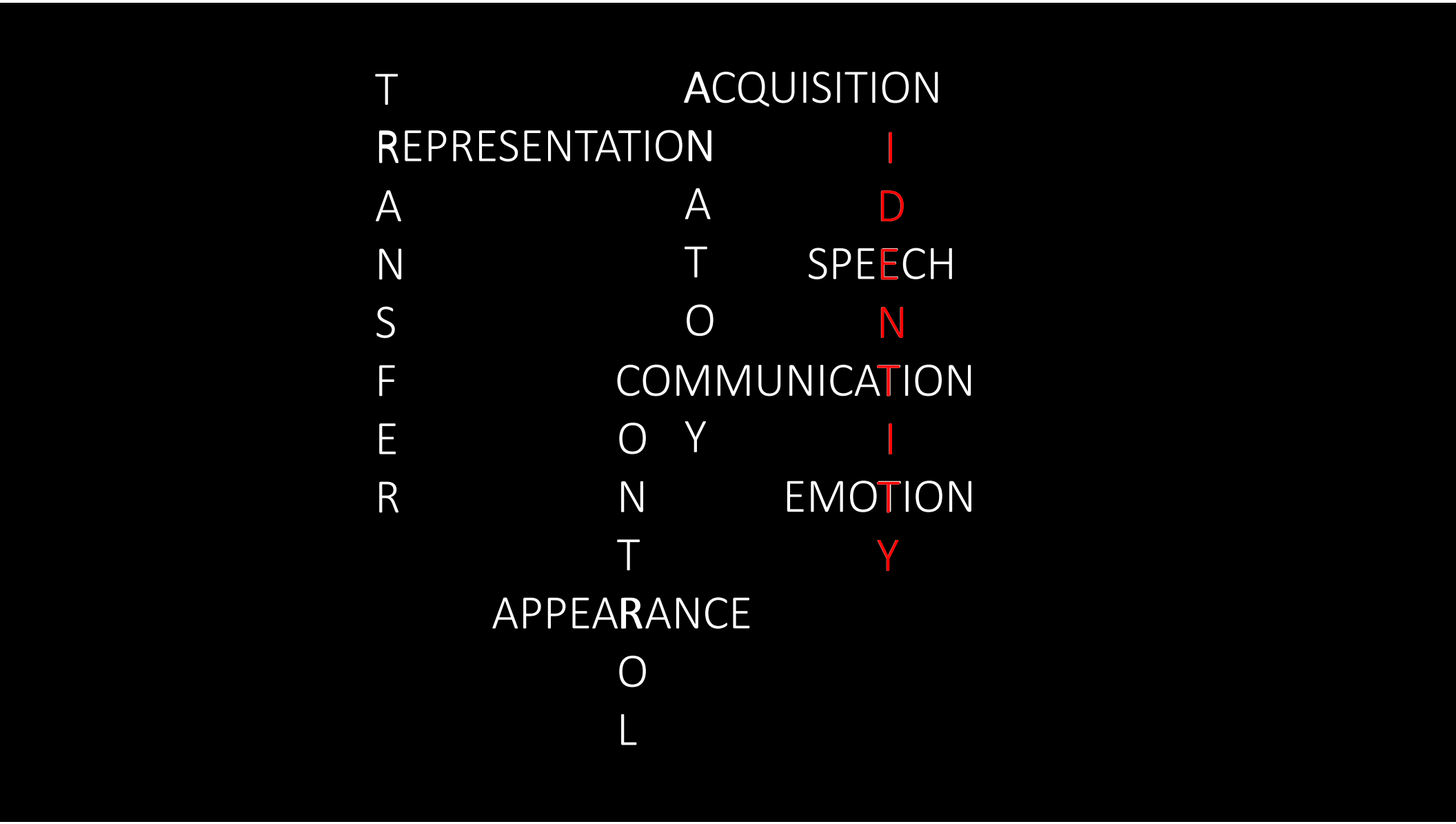
The Fusiform Gyrus:

where the brain recognizes faces



The Inferior Temporal Gyrus:

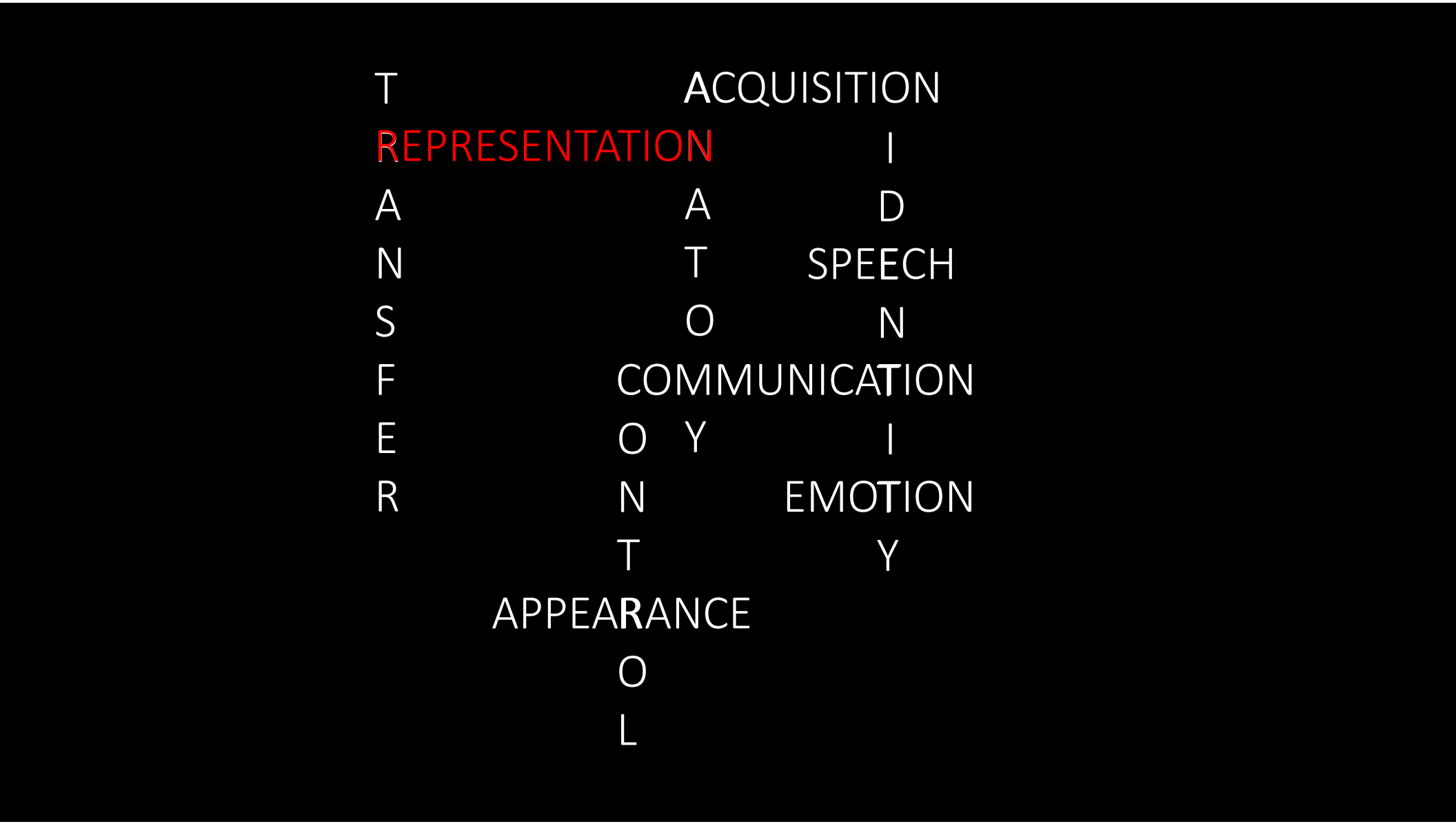
where the brain recognizes everything else

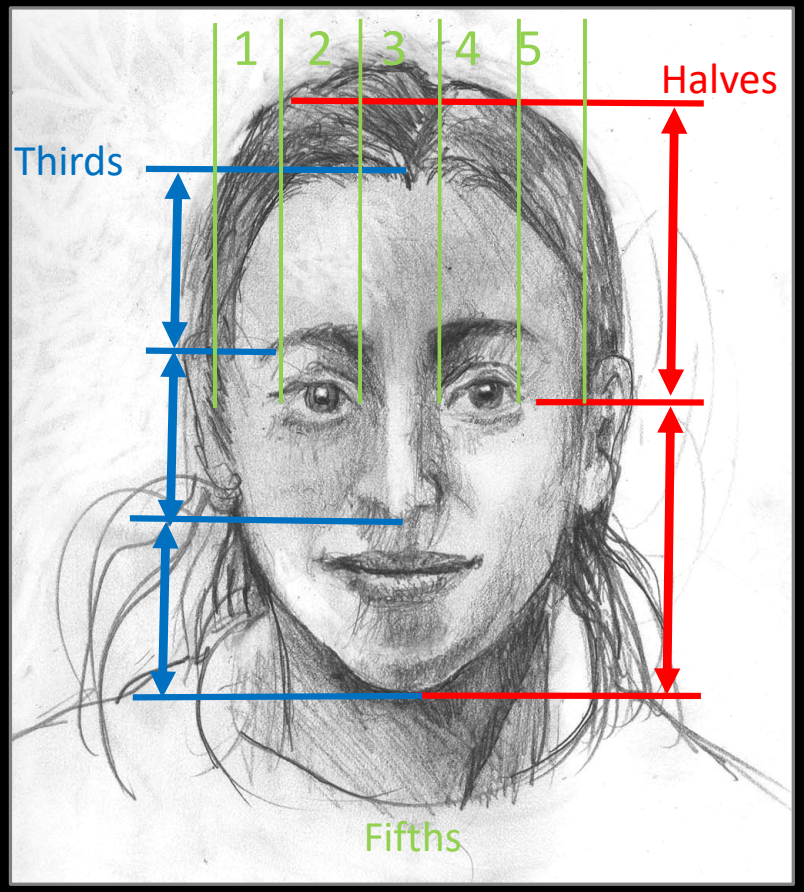

TRANSFER
REPRESENTATION
ACQUISITION
AUTO
COMMUNICATION
IDENTITY
SPEECH
EMOTION
CONTROL
APPEARANCE

Are animated digital faces, fingerprints of the future?

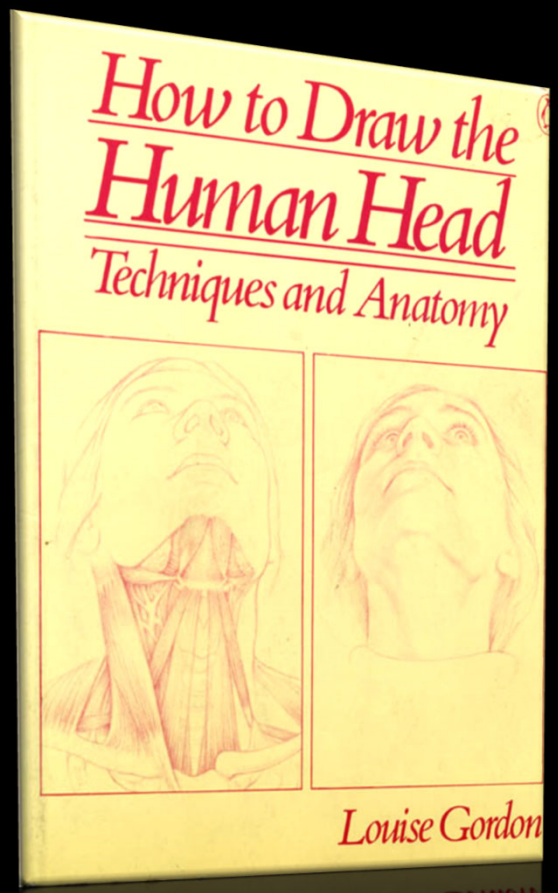
Which of these faces is Keanu Reeves?

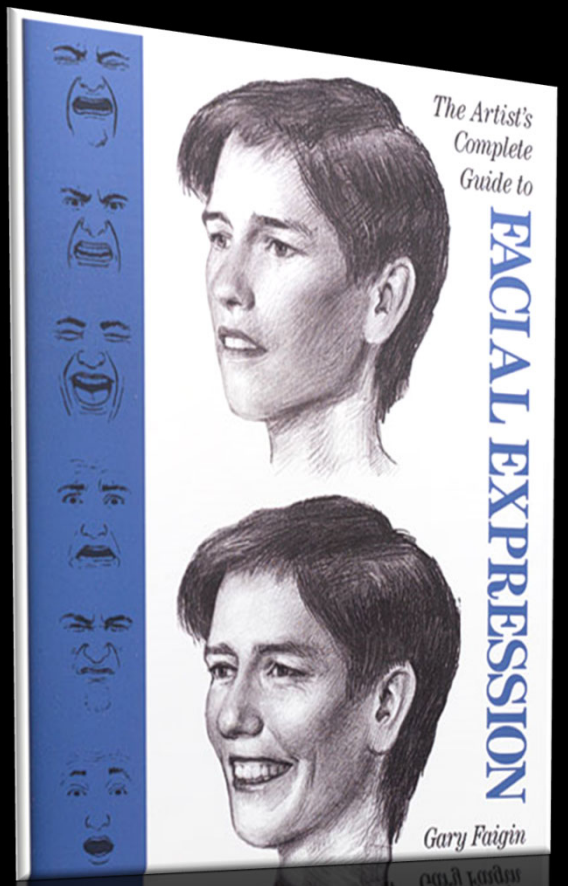
Who are all these people?


TRANSFER
REPRESENTATION
ACQUISITION
IDENTITY
SPEECH
COMMUNICATION
EMOTION
CONTROL
APPEARANCE



Basic proportions of the human head


How to Draw the
Human Head
Techniques and Anatomy
Louise Gordon


The Artist's
Complete
Guide to
FACIAL EXPRESSION
Gary Faigin

FACS: Facial Action Coding System

FACS *[Ekman Friesen 1976]:*
Face Geometry (≈10-100K vertices), posed using 50+ Action Units (AUs).

Robert Deniro in **Cape Fear**, 1991

AU 20

20a. L + R (shown)

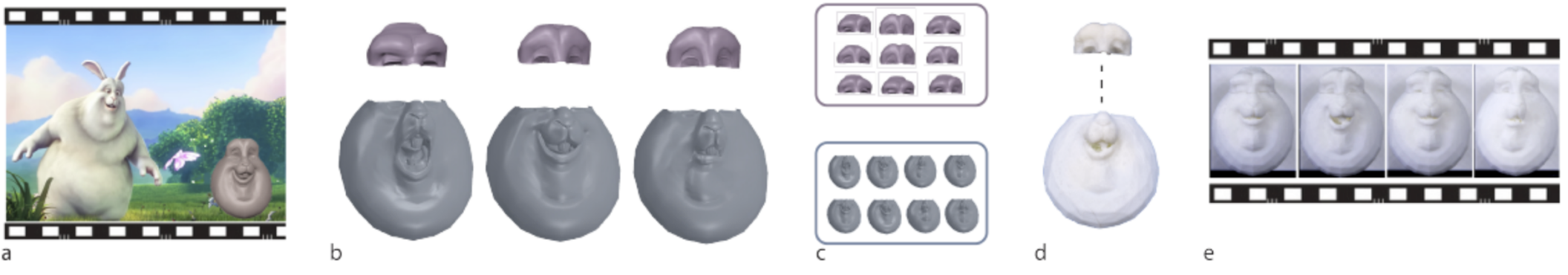
20b. L only

20c. R only

Action: Grimace
Muscle: Risorius/Platysma
Signature: Stretched lower lip

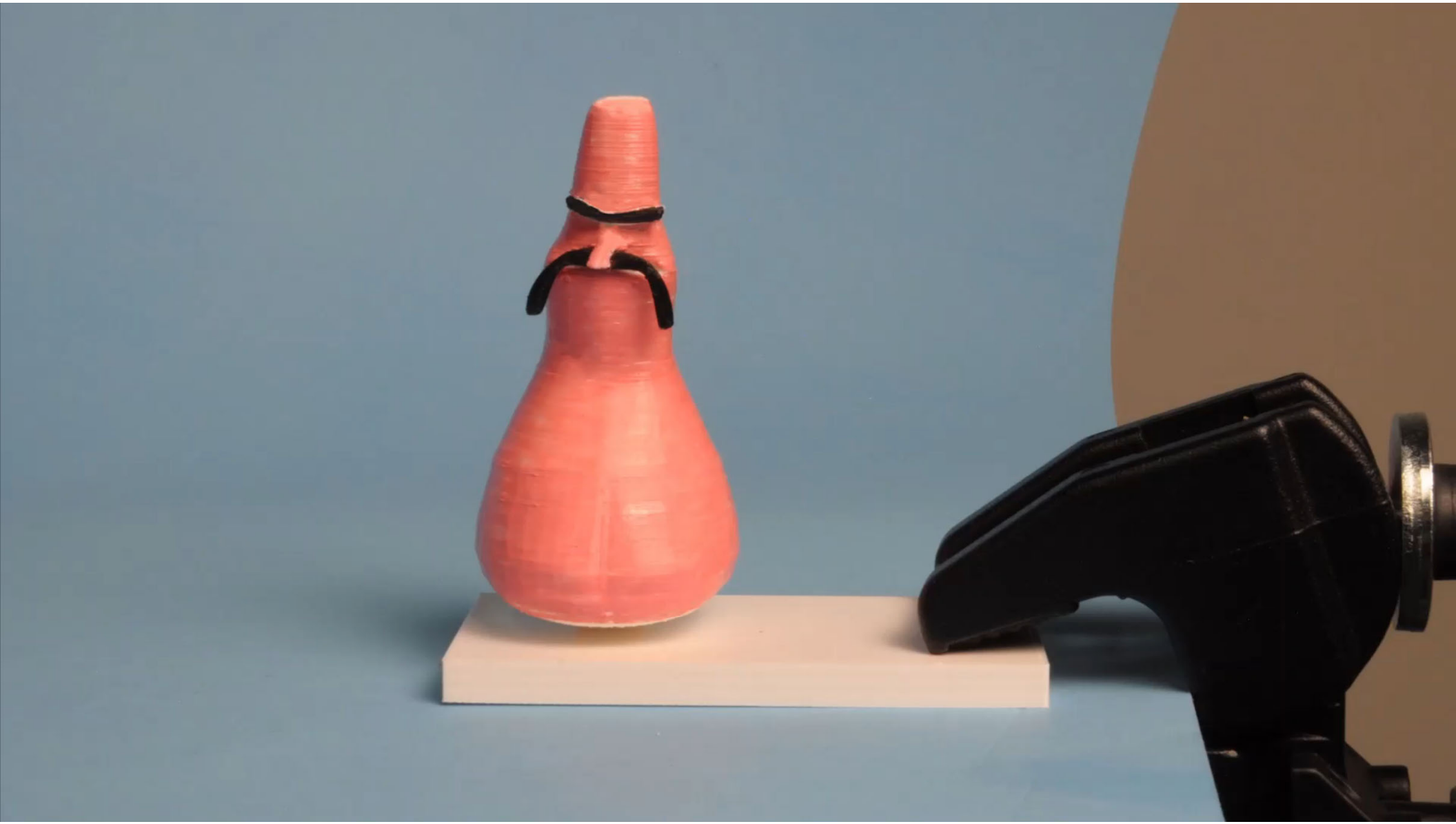
High-Dimensional: animated geometry

30K faces = 8308 lb printer powder & 226 gallons of ink! (credit: LAIKA)

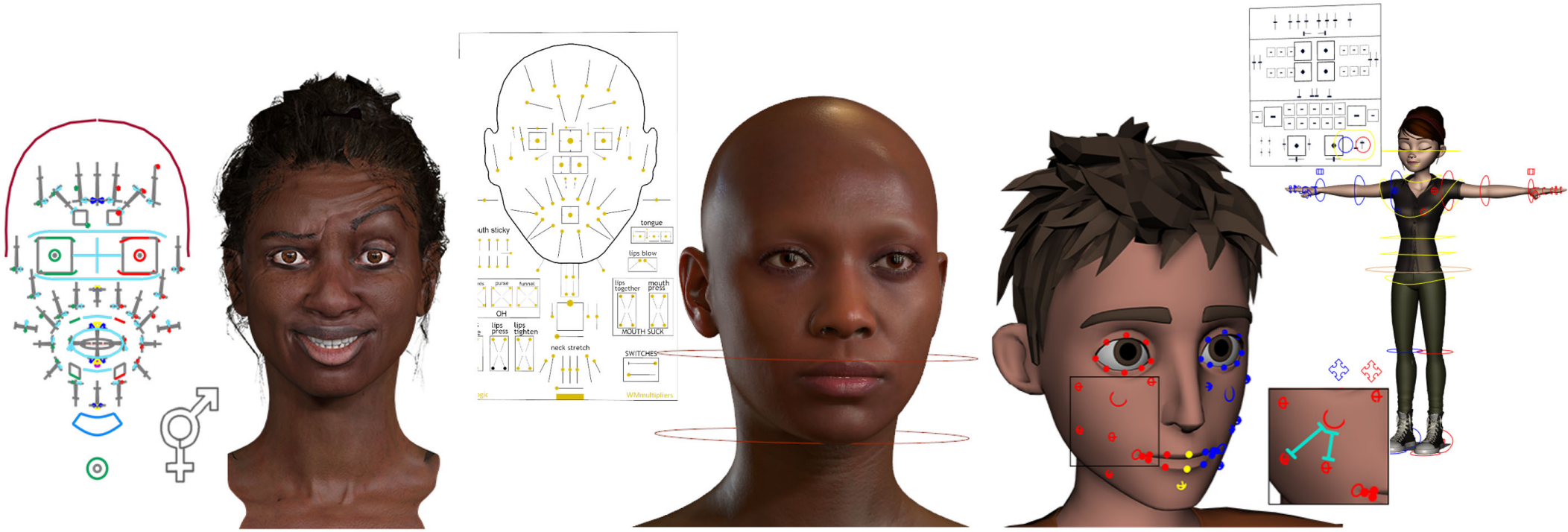


Cut – Deform – Cluster (position and velocity)

[A system for efficient 3D printed stop-motion face animation, Abdrashitov, Jacobson, Singh, *ACM TOG, 2019*]



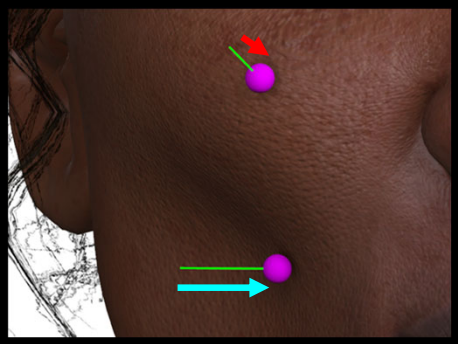
High-Dimensional: rig layouts



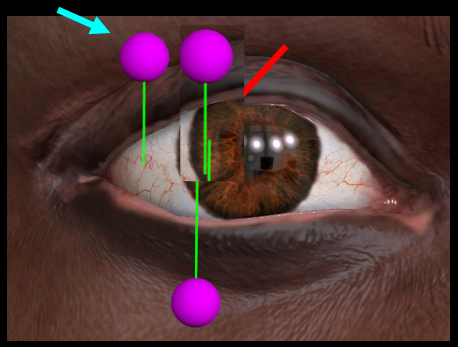
Dakar Valley Girl ©Chris Landreth, Metahuman ©Epic Games, Inc., Ray Character Rig by CGTarian ©UAB MOCAP.LT.

[Optimizing UI Layouts for Deformable Face-Rig Manipulation. Kim & Singh, *ACM SIGGRAPH, 2021*]

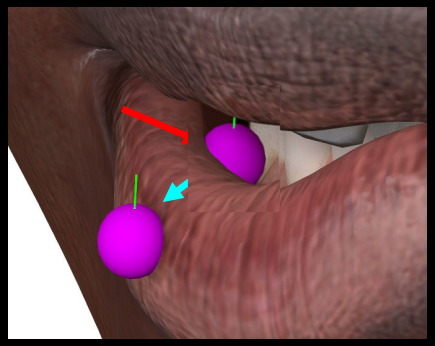
High-Dimensional: rig layouts



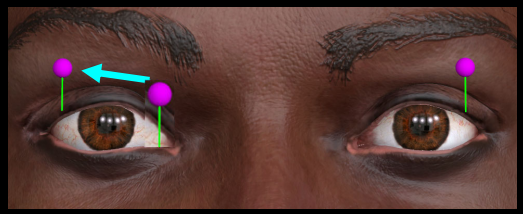
max. displacement



min. overlap



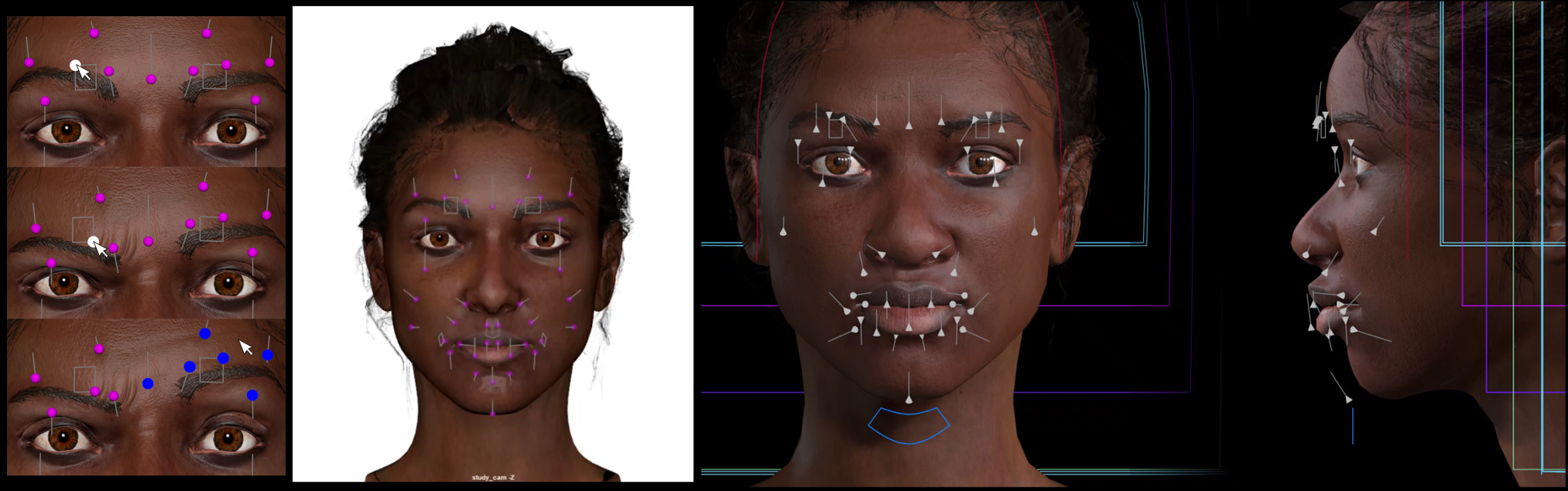
min. occlusion



max. symmetry …

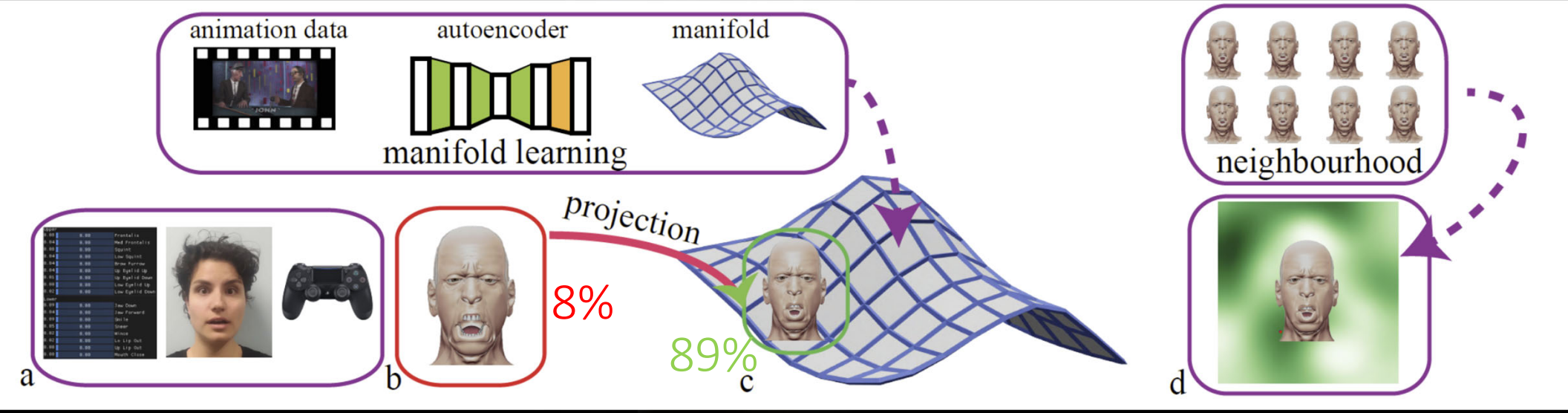
[Optimizing UI Layouts for Deformable Face-Rig Manipulation. Kim & Singh, *ACM SIGGRAPH, 2021*]

High-Dimensional: manipulation

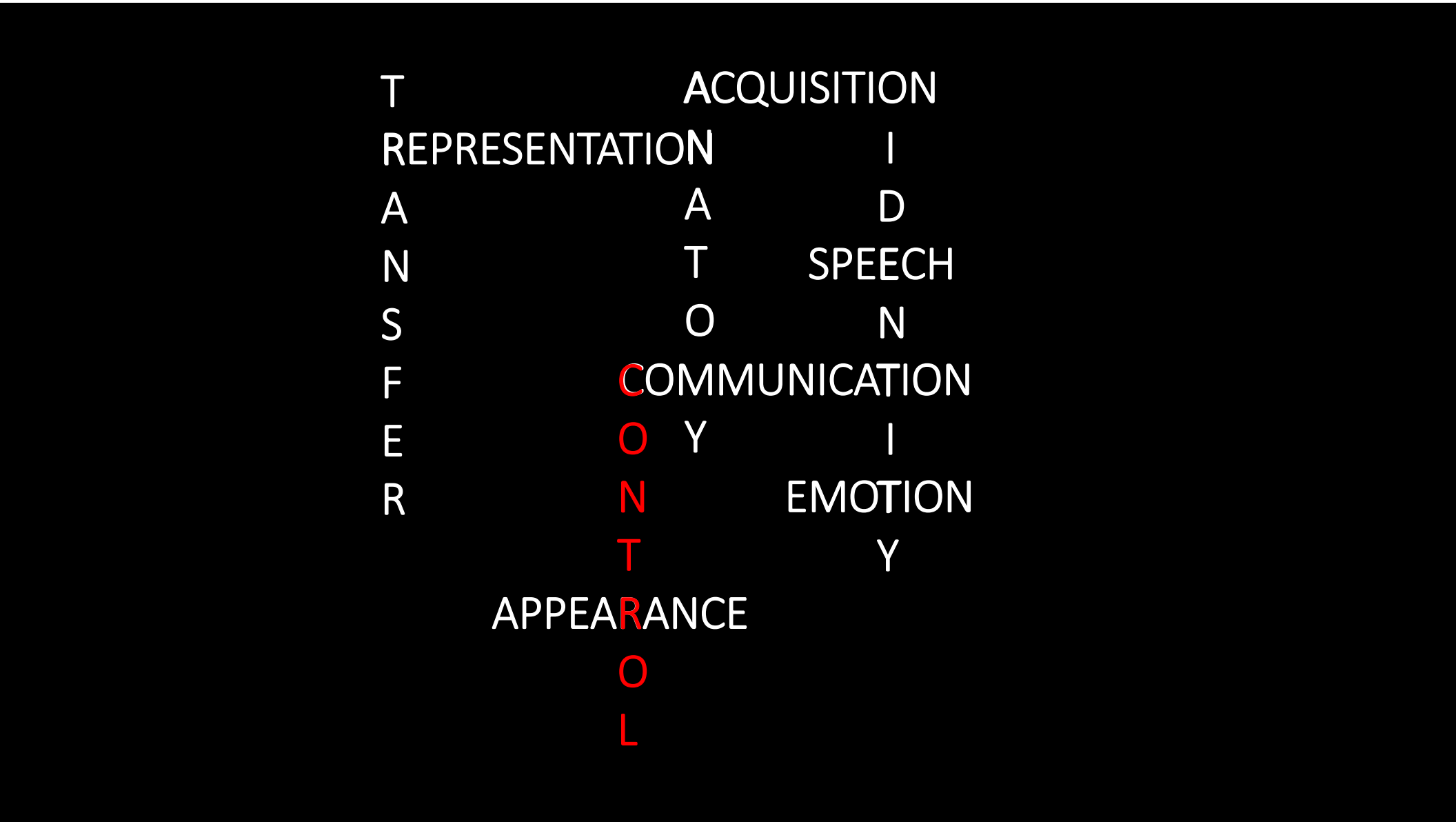


[Optimizing UI Layouts for Deformable Face-Rig Manipulation. Kim & Singh, *ACM SIGGRAPH, 2021*]

High-Dimensional: manifolds



[Interactive Exploration and Refinement of Facial Expression using Manifold Learning. Abdrashitov, Chevalier, Singh ACM UIST 2020]


TRANSFER
REPRESENTATION
ACQUISITION
ANATOMY
IDENTITY
SPEECH
COMMUNICATION
EMOTION
CONTROL
APPEARANCE

Control

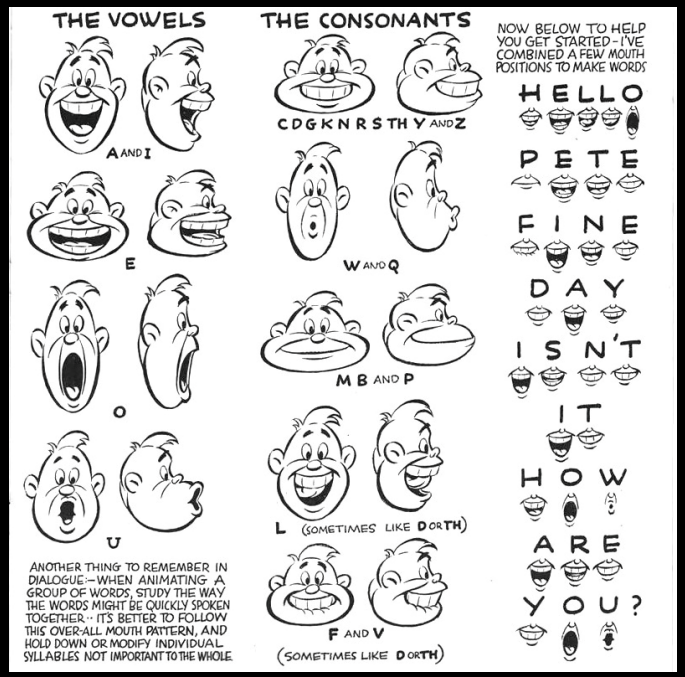
real-time hand-animated **vocap** mocap AI...

vocap: JALI

Audio+Phonetic Analysis

[JALI: An Animator-Centric Viseme Model for Expressive Lip-Synchronization, Edwards, Landreth, Fiume & Singh, *SIGGRAPH, 2016*]
[VisemeNet: Audio-Driven Animator-Centric Speech Animation, Zhou, Xu, Landreth, Kalogerakis & Singh, *SIGGRAPH, 2018*]

JALI Insight



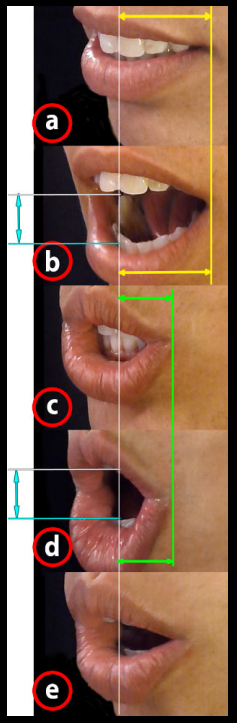
Traditional Phonetic sheet *Preston Blair '48*

One Phoneme = One Viseme

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Ventriloquist phonetic sheet

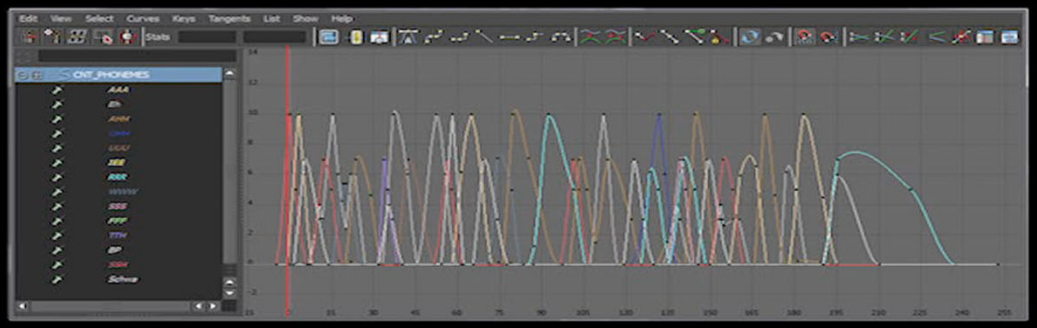
All Phonemes = One Viseme

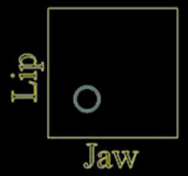


Real speech styles:
"ou" in "thought"

One Phoneme=Many Visemes

JALI: Five Jacks



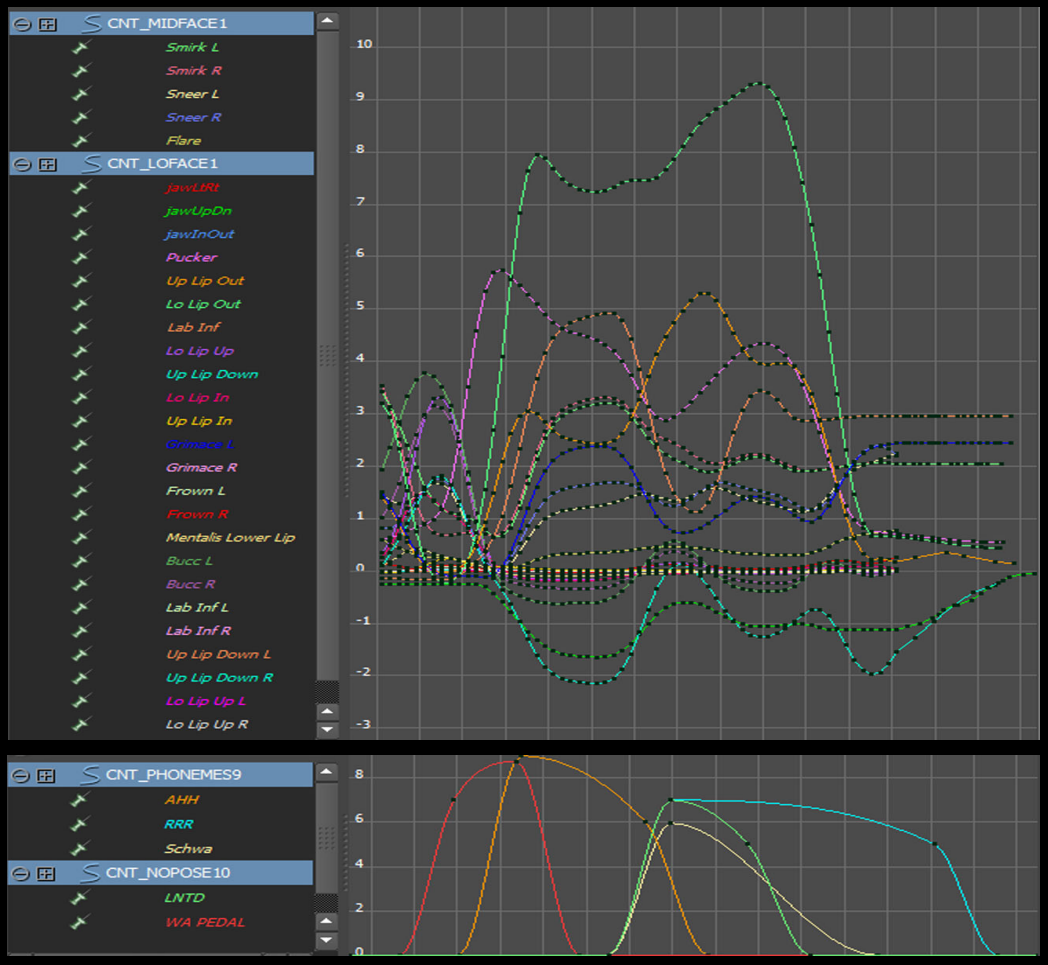


Normal conversation

JALI: Animation Curves

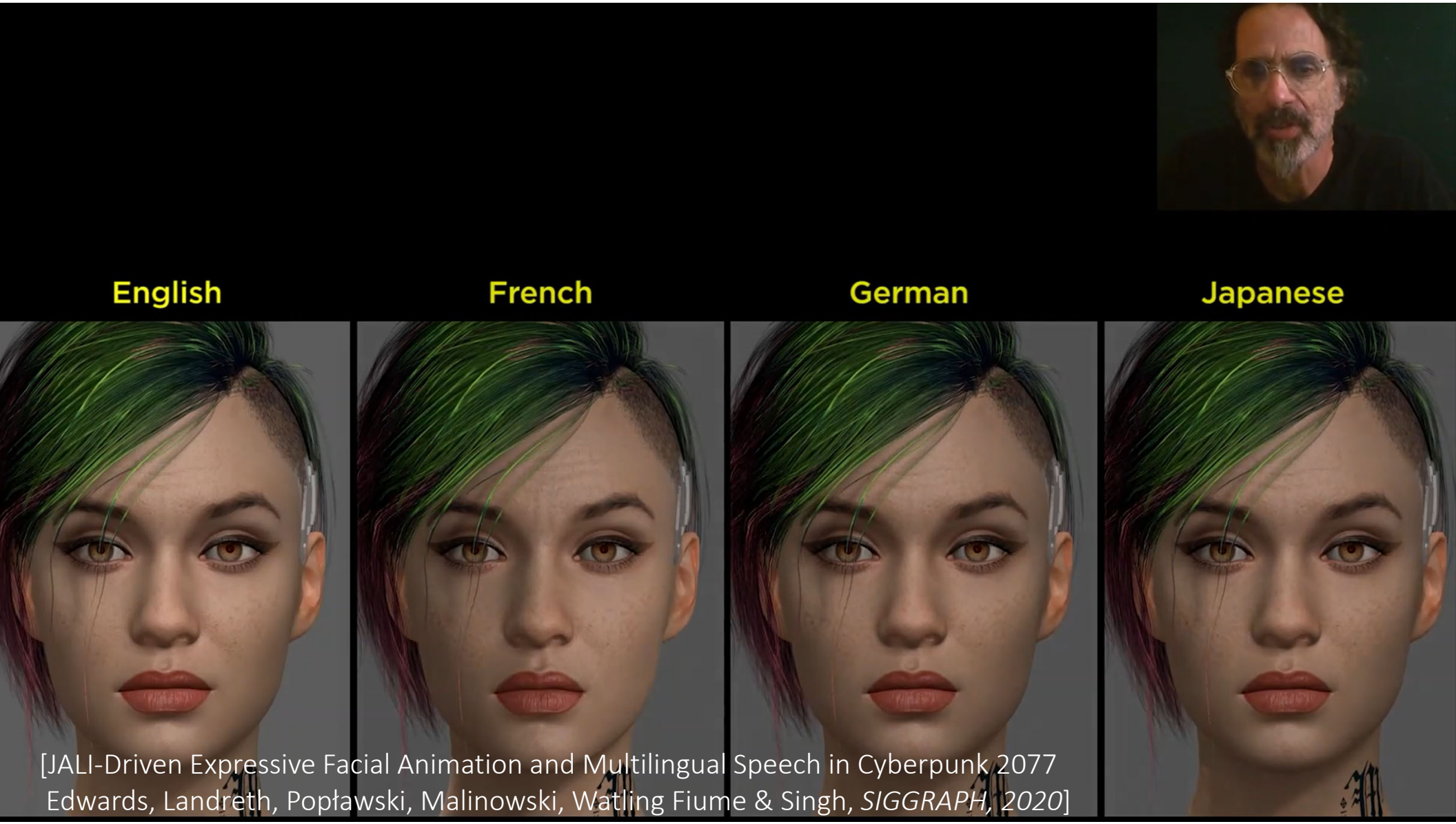
Performance Capture
29 curves, 2252 keyframes

JALI Animation
5 curves, 19 keyframes



CYBERPUNK 2077

"While it's home to never seen before systems, one of Cyberpunk2077's most impressive has to be JALI. JALI is software capable of complete automation of lip syncing and facial animation that offers developers complete control to fine tune the end result." — PC Gamer Dec 2020



[JALI-Driven Expressive Facial Animation and Multilingual Speech in Cyberpunk 2077
Edwards, Landreth, Popławski, Malinowski, Watling Fiume & Singh, *SIGGRAPH, 2020*]

Miasma Chronicles
The Bearded Ladies
Jali

Remember me

S GET DOW

I'M READY TO LEARN

Speech vs. Singing

Different roles of vowels and consonants in singing

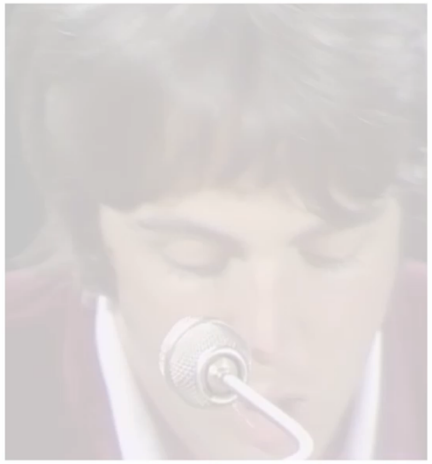
singing only vowels
to convey melody

layering consonant for
lyrical coherence and rhythm

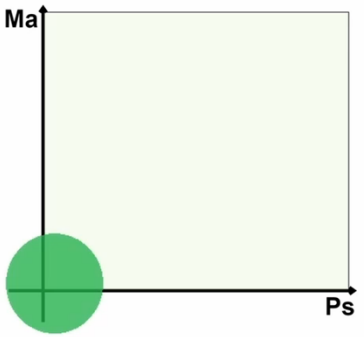
[VOCAL: Vowel and Consonant Layering for Expressive Animator-Centric Singing Animation, *SIGGRAPH Asia, 2022*]

VOCAL Insight: melodic accent + pitch sensitivity

percussive, speech-like consonants
(note enunciated "t"s)



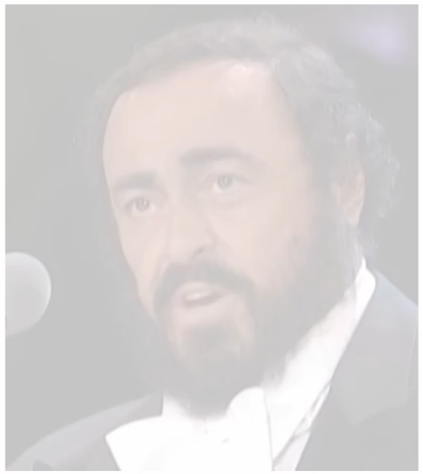
softly consonants, blended vowels
(note soft, silent "t"s)



video credit:
https://youtu.be/A_MjCqQoLLA
https://youtu.be/YlBlau59Piw

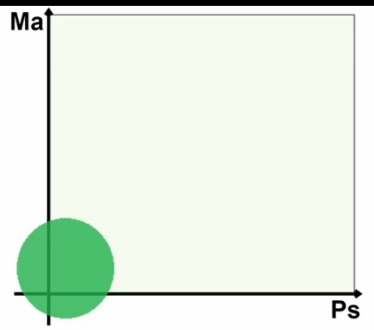
VOCAL Insight: melodic accent + pitch sensitivity

Pitch Sensitivity (Vowels)



lip is held **statically**
despite strong vibrato

lip moves **dynamically**
during vibrato



video credit:
https://youtu.be/ZATunybJm_4
https://youtu.be/Gg9u9hzFib0

[VOCAL: Vowel and Consonant Layering for Expressive Animator-Centric Singing Animation, *SIGGRAPH Asia, 2022*]

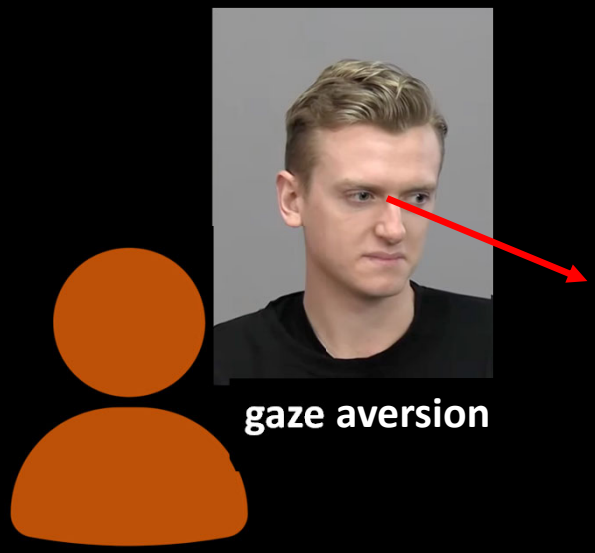
[VOCAL: Vowel and Consonant Layering for Expressive Animator-Centric Singing Animation, *SIGGRAPH Asia, 2022*]

W.I.P.
05/02/14
www.chrisj.com.au

Eye-mojis: Windows to the Soul

[S3: Speech, Script and Scene driven Head and Eye Animation, Pan, Agrawal, Singh, *SIGGRAPH 2024*]

S^3: conversational gaze



S^3 Insight: classify conversational gaze

Predict conversational gaze focus/aversion timing from **speech**

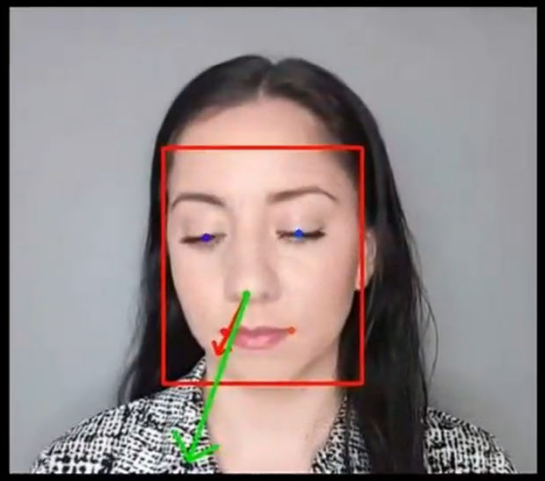
Predict gaze trajectories from script + **scene context**

Isolate and Predict rhythmic head motion from **speech**

audition dataset

we collected 111 actor audition videos totalling
379 minutes of uncut audiovisual data

dataset annotation - head



raw head motion is obtained using
mediapipe [Lugaresi et al . 2019]

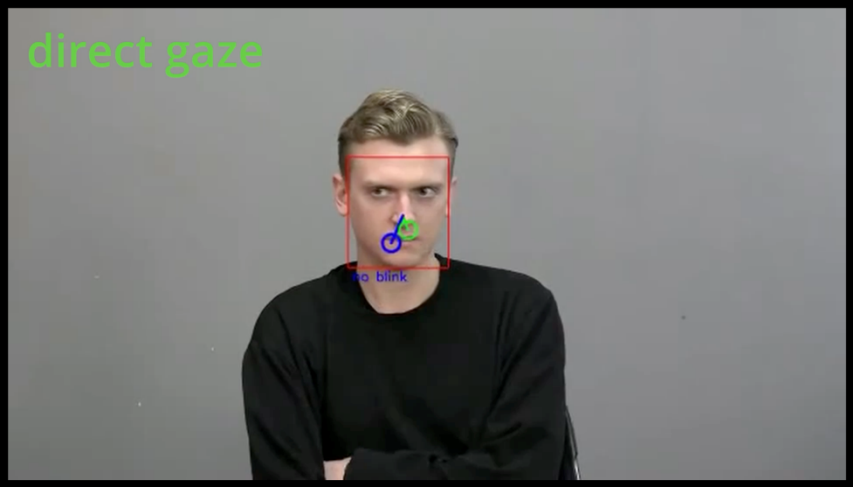
dear delores - the green book

https://youtu.be/eJdaeQswE4I

money laundering - breaking bad

https://youtu.be/RhsUHDJ0BFM

...about quantitative evaluation

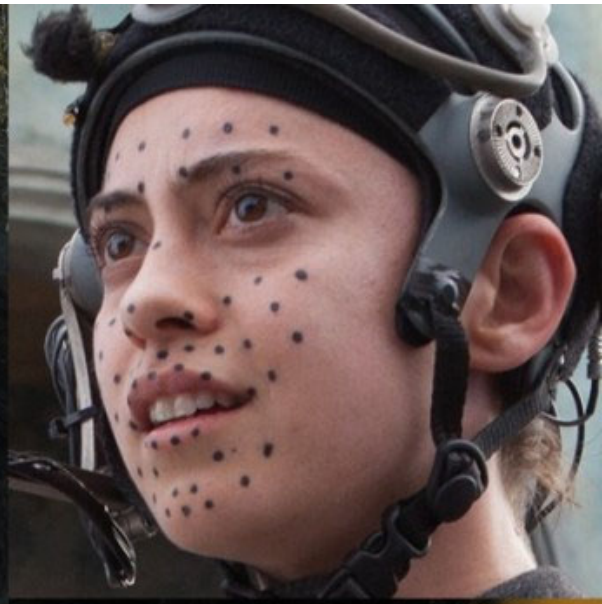


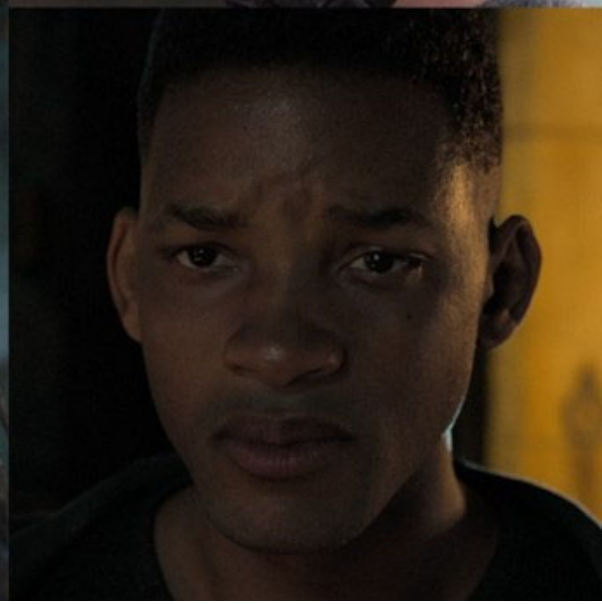
Model	Acc	IOU	Gaze-on Acc	Gaze-off Acc	Avert Instances
Stare	0.63	0.00	0.00	0.00	0.00
Statistical	0.47	0.23	0.31	0.33	**1.04**
S^3	**0.79**	**0.36**	**0.53**	**0.53**	1.08

Control

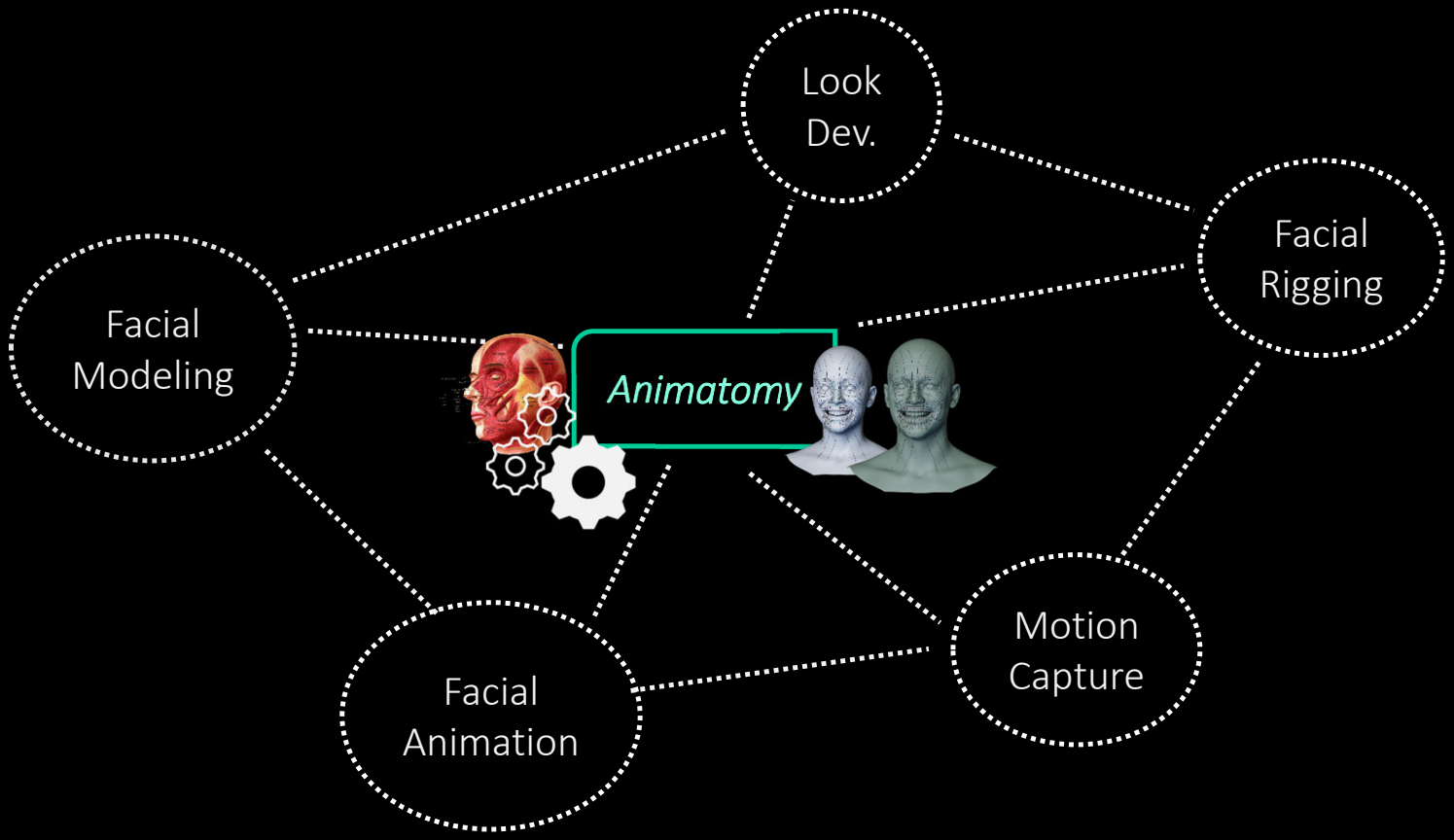
real-time hand-animated vocap **mocap** AI...

weta DIGITAL

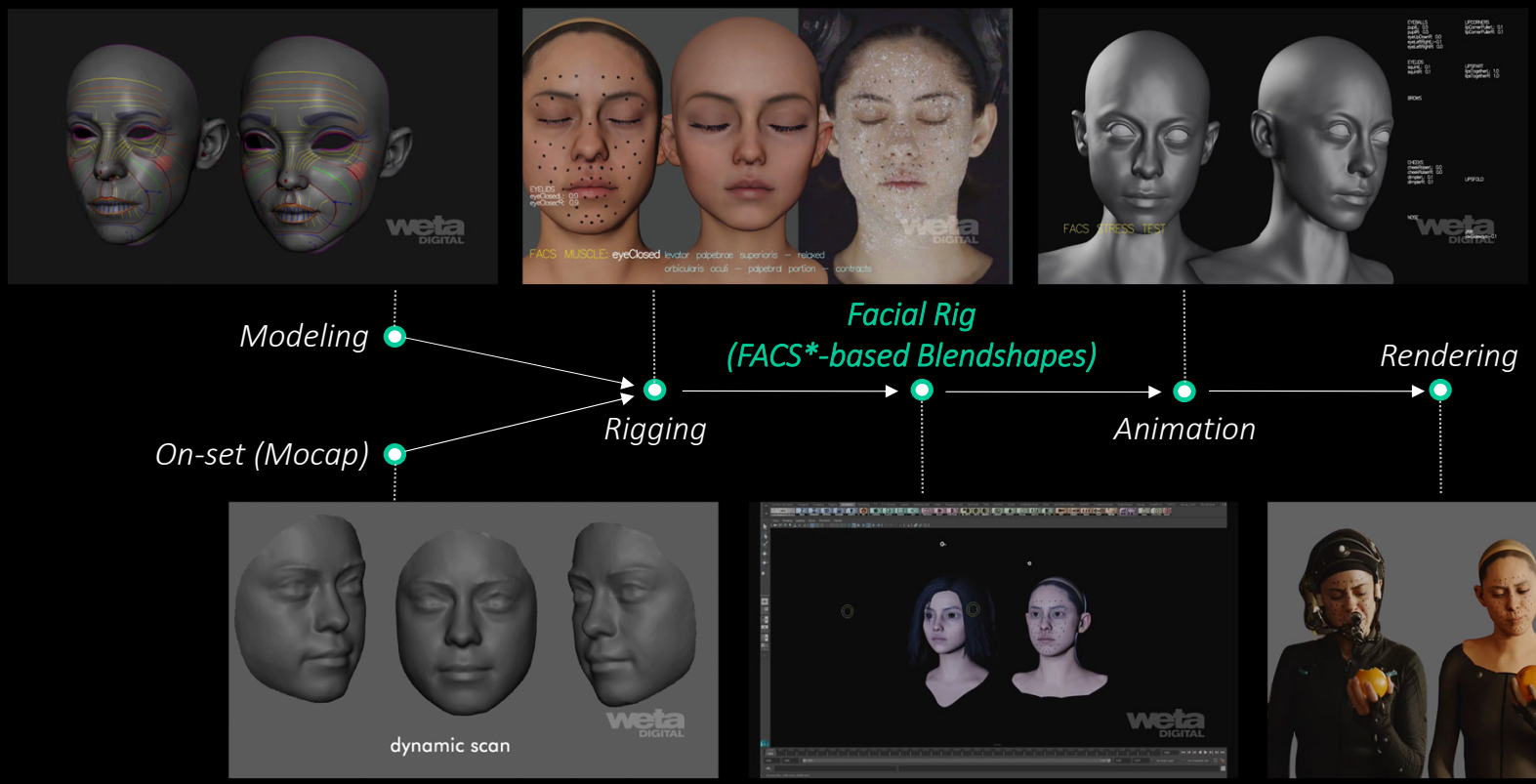




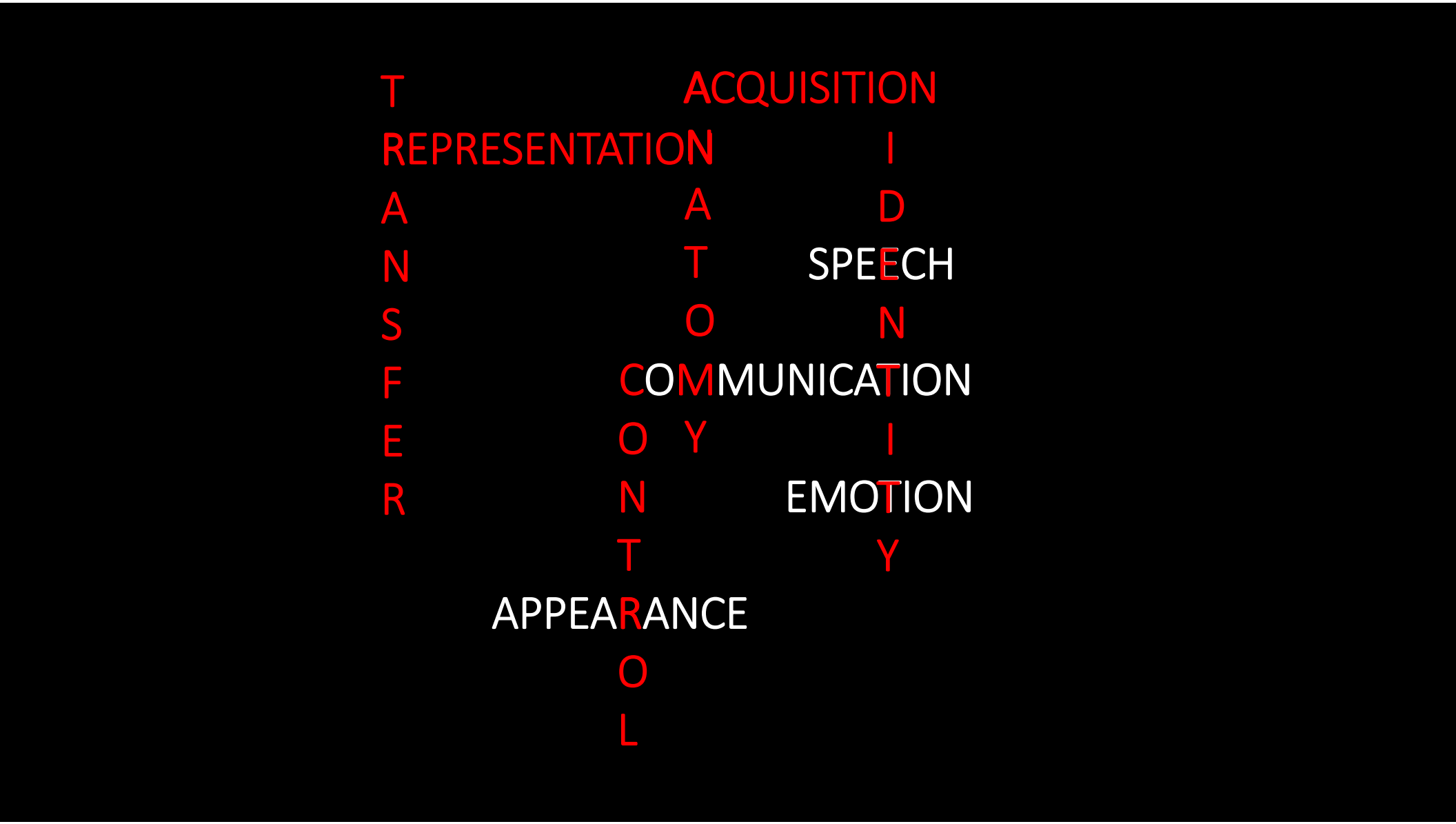
Facial System Design for VFX



FACS blendshape-based VFX



*FACS: Facial Action Coding System


TRANSFER
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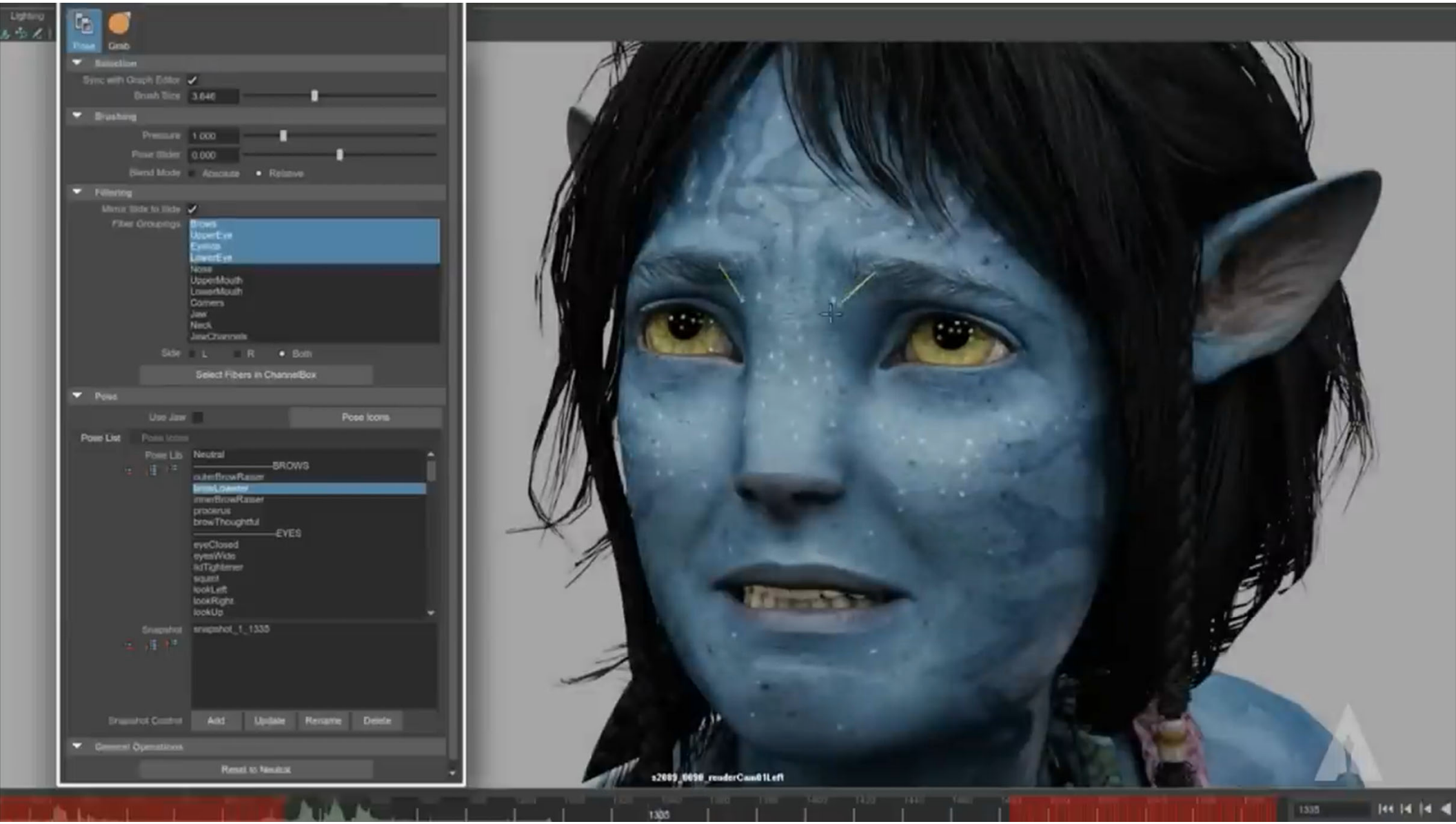
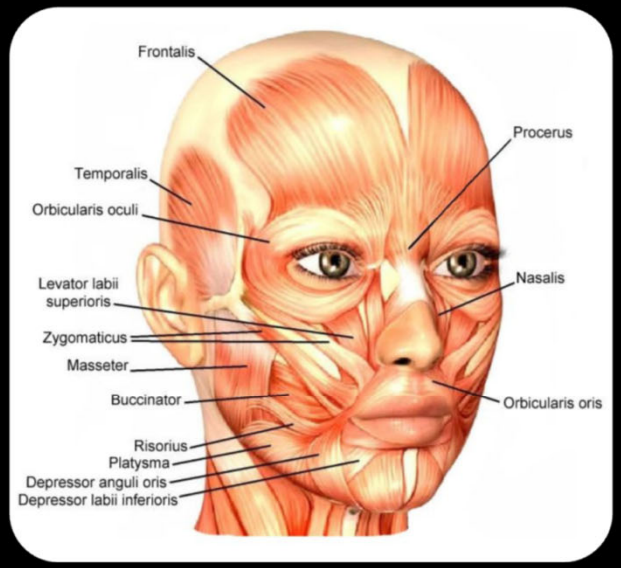
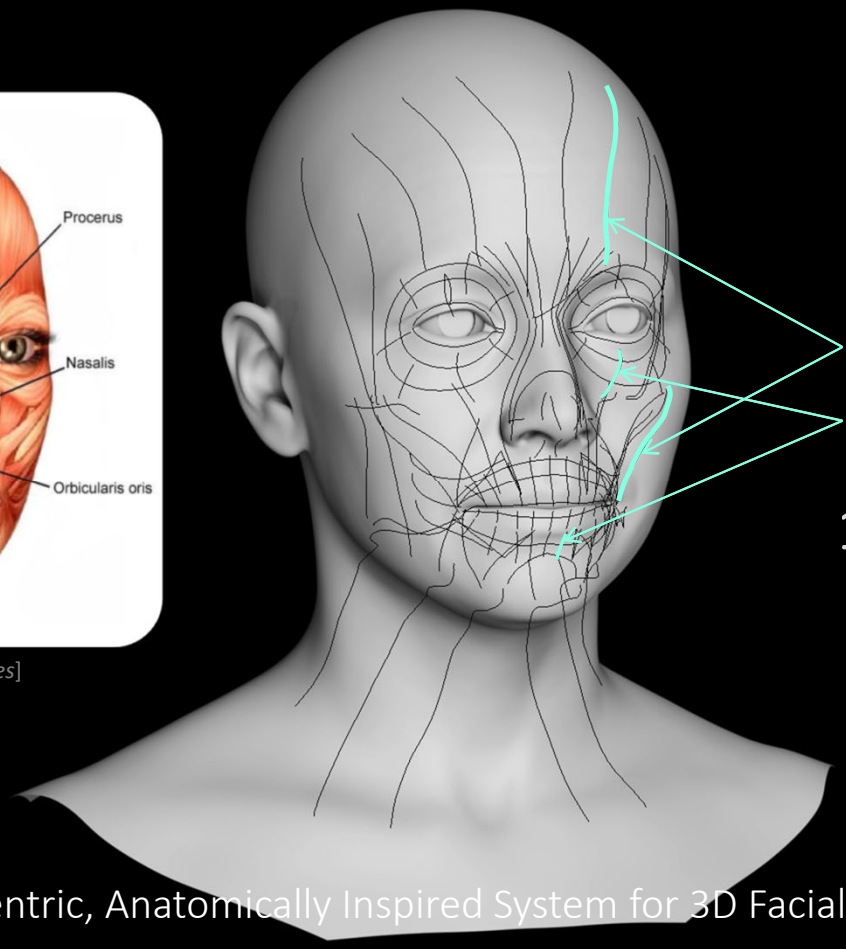

Lighting
Pose
Grab
Selection
Sync with Graph Editor
Brush Size
3.648
Brushing
Pressure
1.000
Pose Blider
0.000
Blend Mode
Absolute
Relative
Filtering
Mirror Side to Side
Fiber Groupings
Brows
UpperEye
Eyelids
LowerEye
Nose
UpperMouth
LowerMouth
Corners
Jaw
Neck
JawChannels
Side
L
R
Both
Select Fibers in ChannelBox
Poses
Use Jaw
Pose Icons
Pose List
Pose Lib
Neutral
----------BROWS
outerBrowRaiser
innerBrowRaiser
procerus
browThoughtful
----------EYES
eyeClosed
eyesWide
lidTightener
squint
lookLeft
lookRight
lookUp
Snapshot
snapshot_1_1335
Snapshot Control
Add
Update
Rename
Delete
General Operations
Reset to Neutral
s2009_0090_renderCam01Left
1335
1335

Animatomy Insight: Muscle Curves



[*anatomyinfo.com/facial-muscles*]

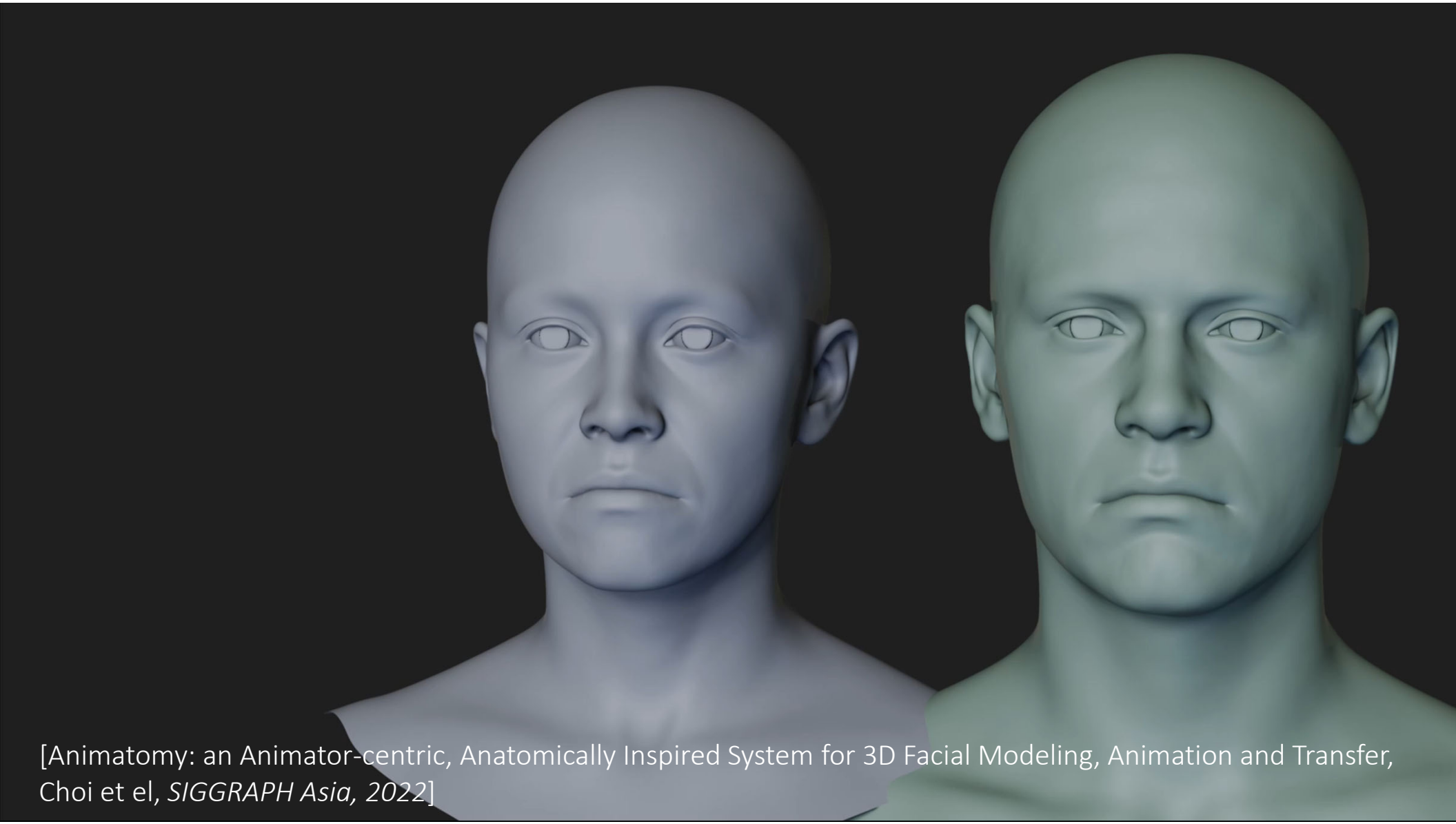


Muscles Strands: 108

Pseudo Muscles: 70

178 Muscle Curves in Total

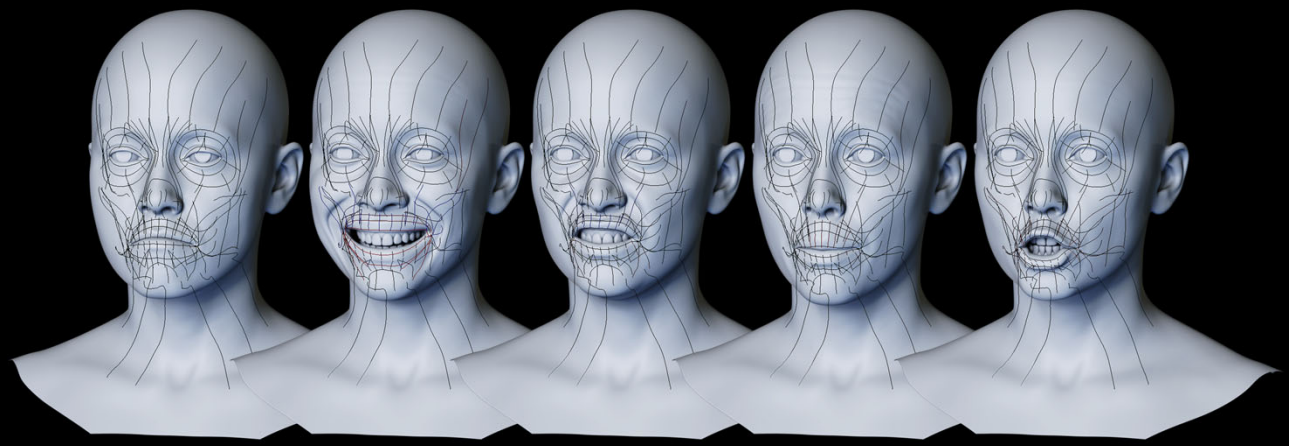
[Animatomy: an Animator-centric, Anatomically Inspired System for 3D Facial Modeling, Animation and Transfer *SIGGRAPH Asia, 2022*]



[Animatomy: an Animator-centric, Anatomically Inspired System for 3D Facial Modeling, Animation and Transfer, Choi et el, *SIGGRAPH Asia, 2022*]

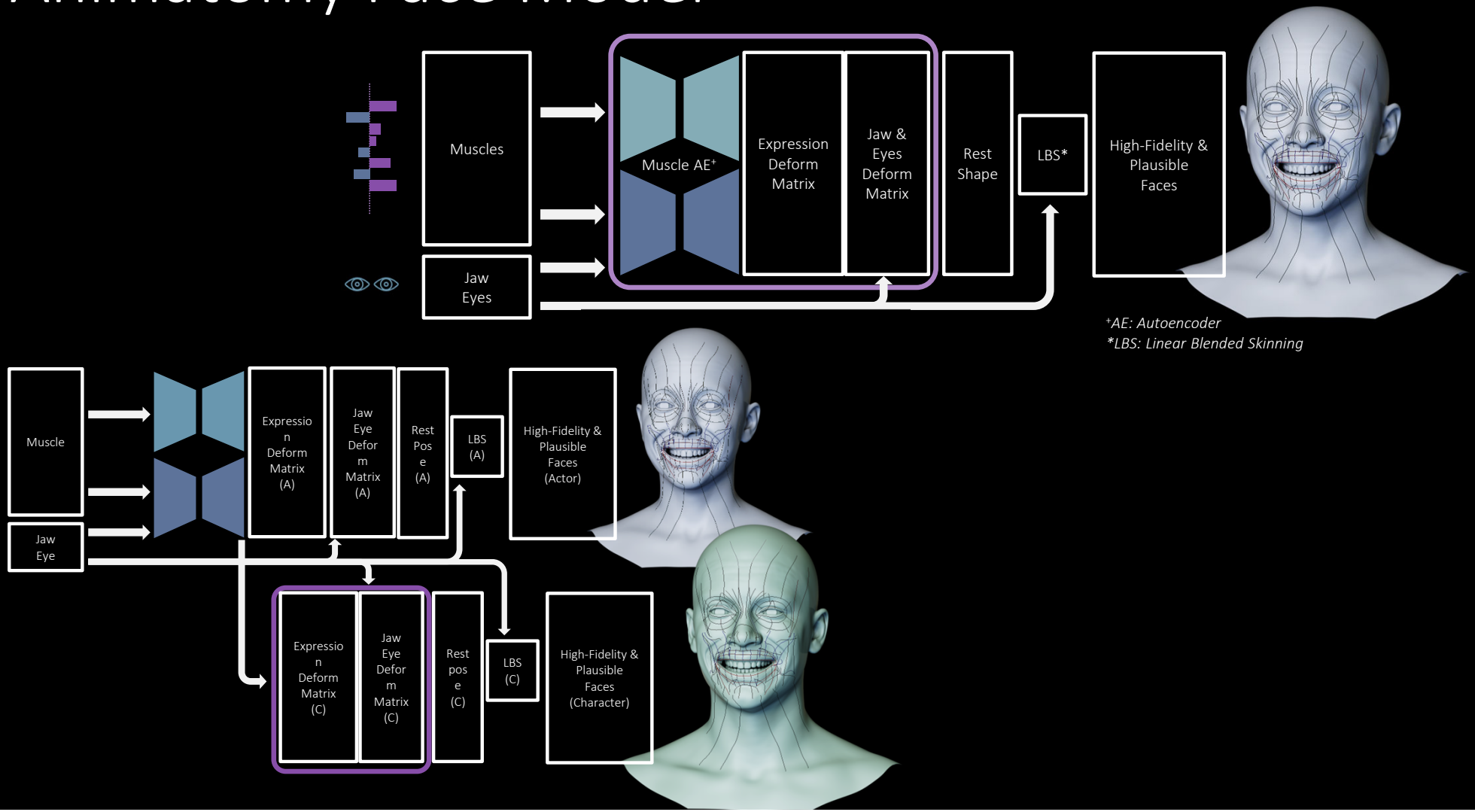
Actor Data-set

- Dynamic Skin (Scans)
- Skull, Jaw, Eyes
- Simulated Muscles



~7,000 frames: FACS actions, emotions, phonemes, Harvard sentences

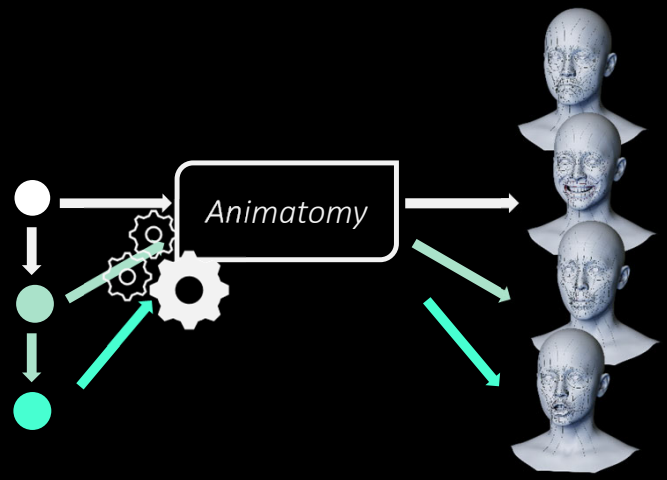
Animatomy Face Model



Facial Expression Solving & Editing

Forward Control of Muscle Values (Inside-Out)

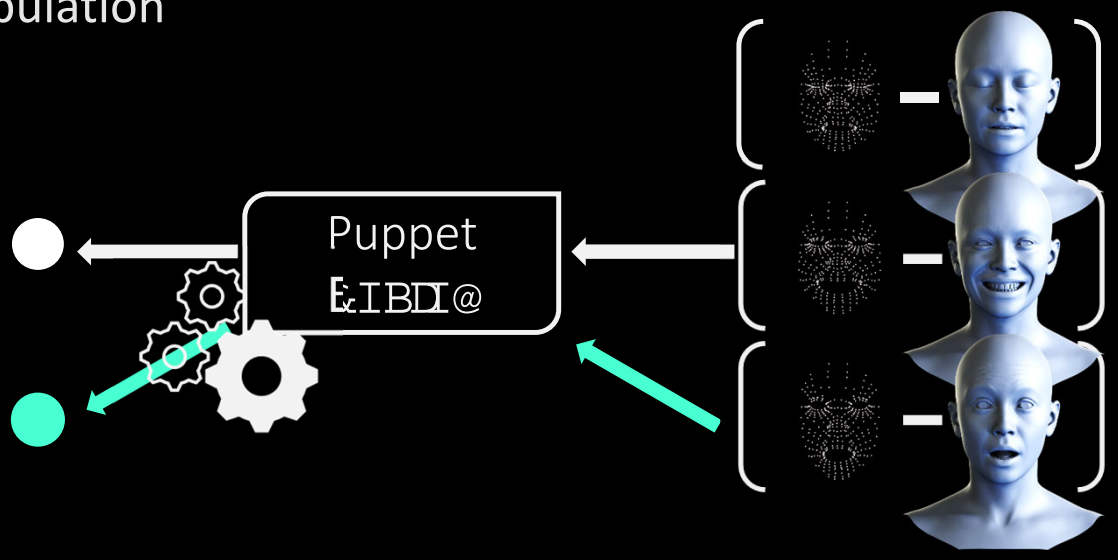
- Direct muscle strain controls
- Pose library



Facial Expression Solving & Editing

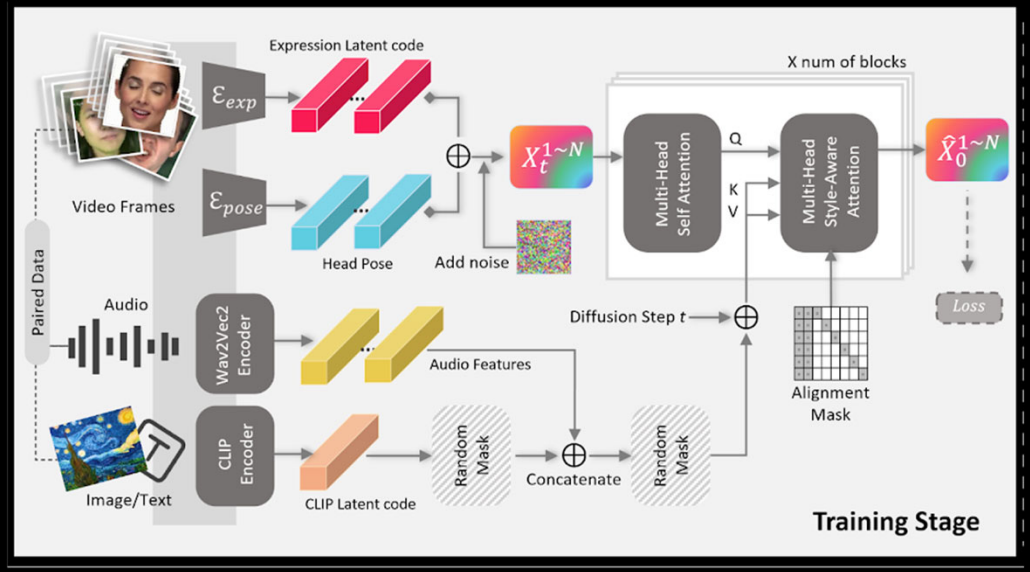
Inverse Control of Muscle Values (Outside-In)

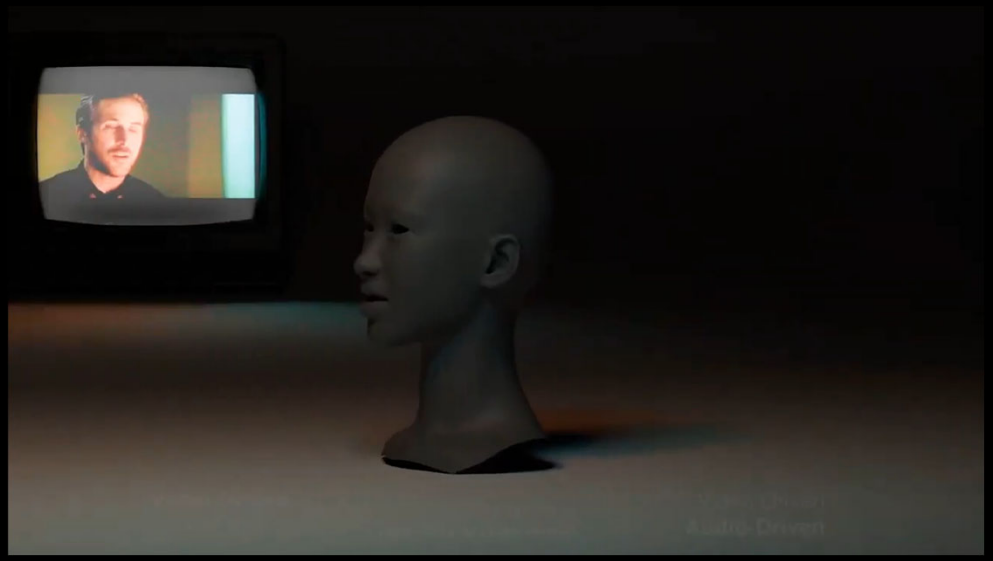
- Solving with performance markers
- Direct manipulation



Ground-truth
Animatomy
FACS Model

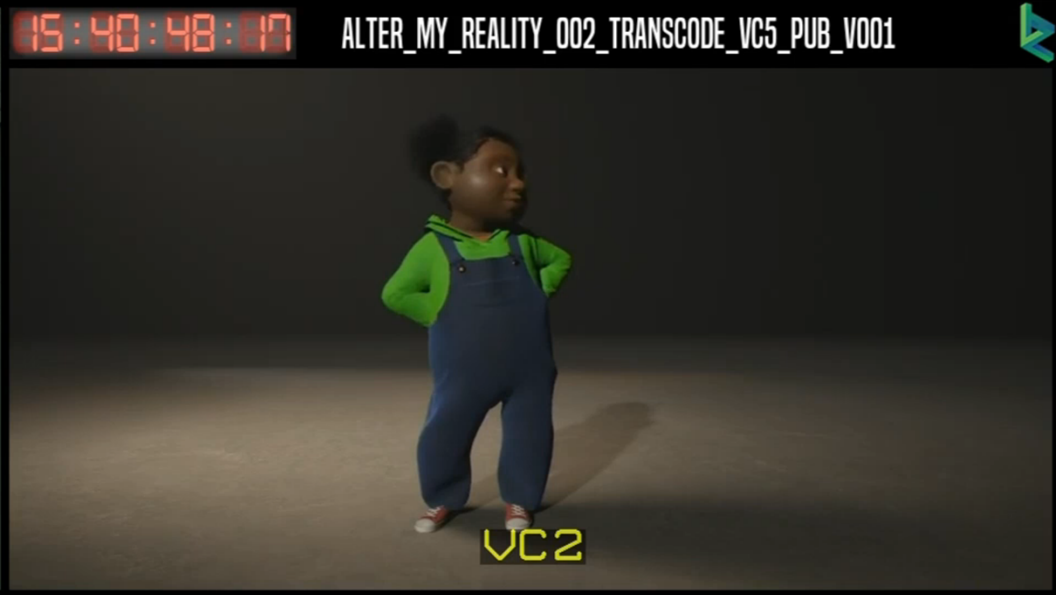
Generative AI





[Media2Face: Co-speech Facial Animation Generation With Multi-Modality Guidance, Zhao et al, *SIGGRAPH 2024*]

Facing Forward…



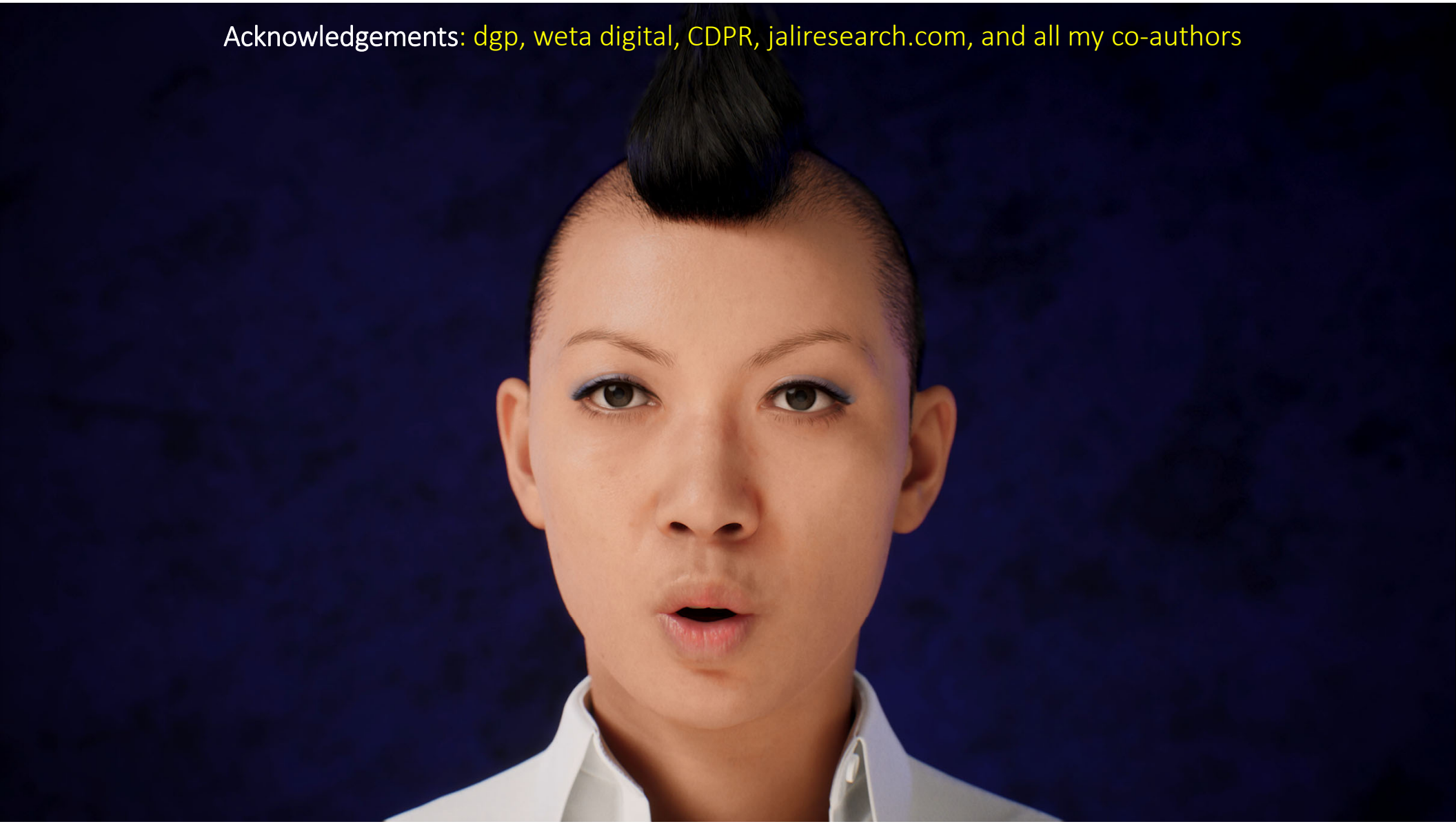
MOCAP + VOCAP

Jali

Facing Forward…

SILENCE IS GOLDEN

Facing Forward...

FINN (soulmachines.com)

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