# *What makes a Virtual Human Alive ?*

1. Avatar & Autonomous Virtual Humans
2. The complexity of expressive movements
3. From artificial to real: the uncanny valley
4. Motion capture is part of the solution (offline/online)
5. Perception of real-time animation
6. Core real-time VH believability factors
7. Other R&D efforts & exercises

*video2*

# 4. Motion capture is part of the solution for offline productions

High human-likeness can be recovered through motion capture provided that :

- Professional actors are hired for performance
- The actors learn text and performs as if they were filmed
- The actors are native speakers of the language
- Capturing **eye motions** is essential for the coherence of the synthesized behavior (http://www.mocaplab.com/services/eye-mocap/eye-tracker/)

[film «Renaissance»2006]

Capturing **micro-expression**s is a must for the expression of emotions [as formalized by Psychologist Paul Ekman]

- The mocap session is also video recorded - from many viewpoints - to recover subtleties that cannot be measured through marker-based motion capture

Check the TV series “lie to me” & the ref on micro-expressions

Very high mesh resolution is necessary for the micro expression deformation:

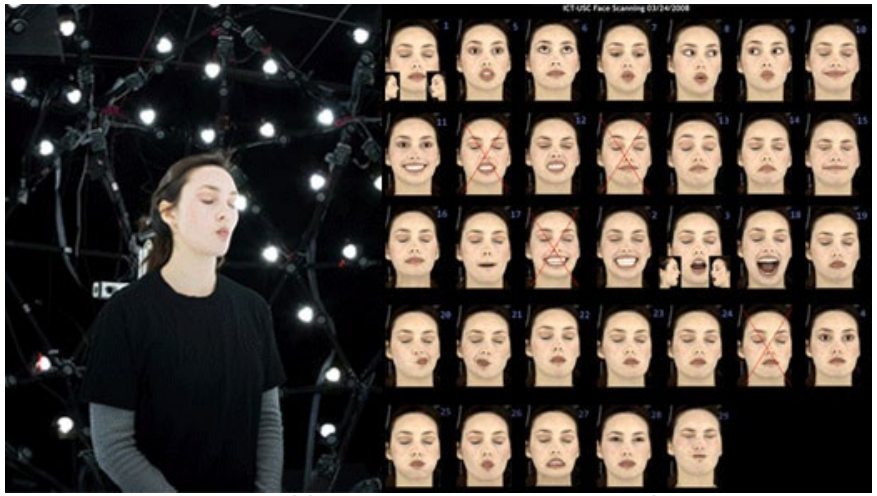
Micro-expressions:
02-03, 07-08, 11-12

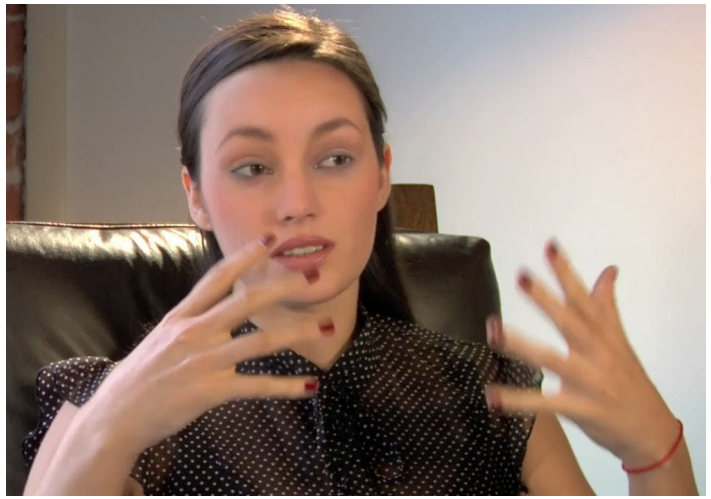
2010: Avatar(J. Cameron)

# 4. Motion capture is part of the solution for offline productions (2)

- Alternate motion capture technology based on Computer Vision :
  - Interview presenting Image Metrics technology (2008) [youtube / Emily / Advertizement]

Building a DB of facial expressions under controlled lighting

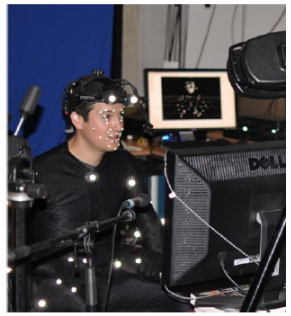


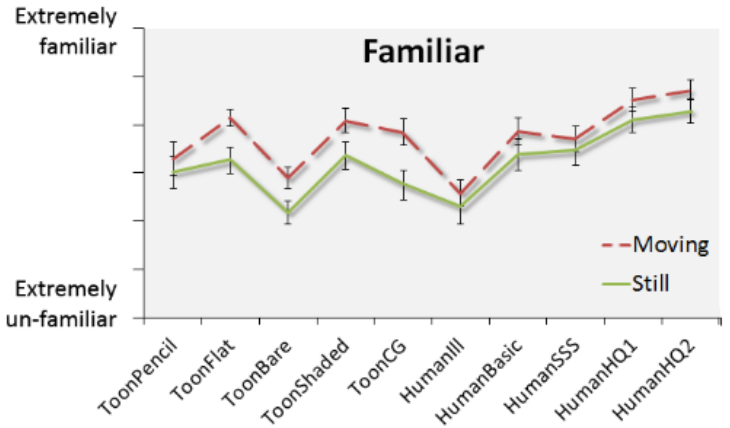


offline pipeline synthetizing new facial animation sequences

http://www.youtube.com/watch?v=JF_NFmtw89g&feature=fvwrel

- Numerous studies to assess the influence of rendering [McDonnell[2012]:

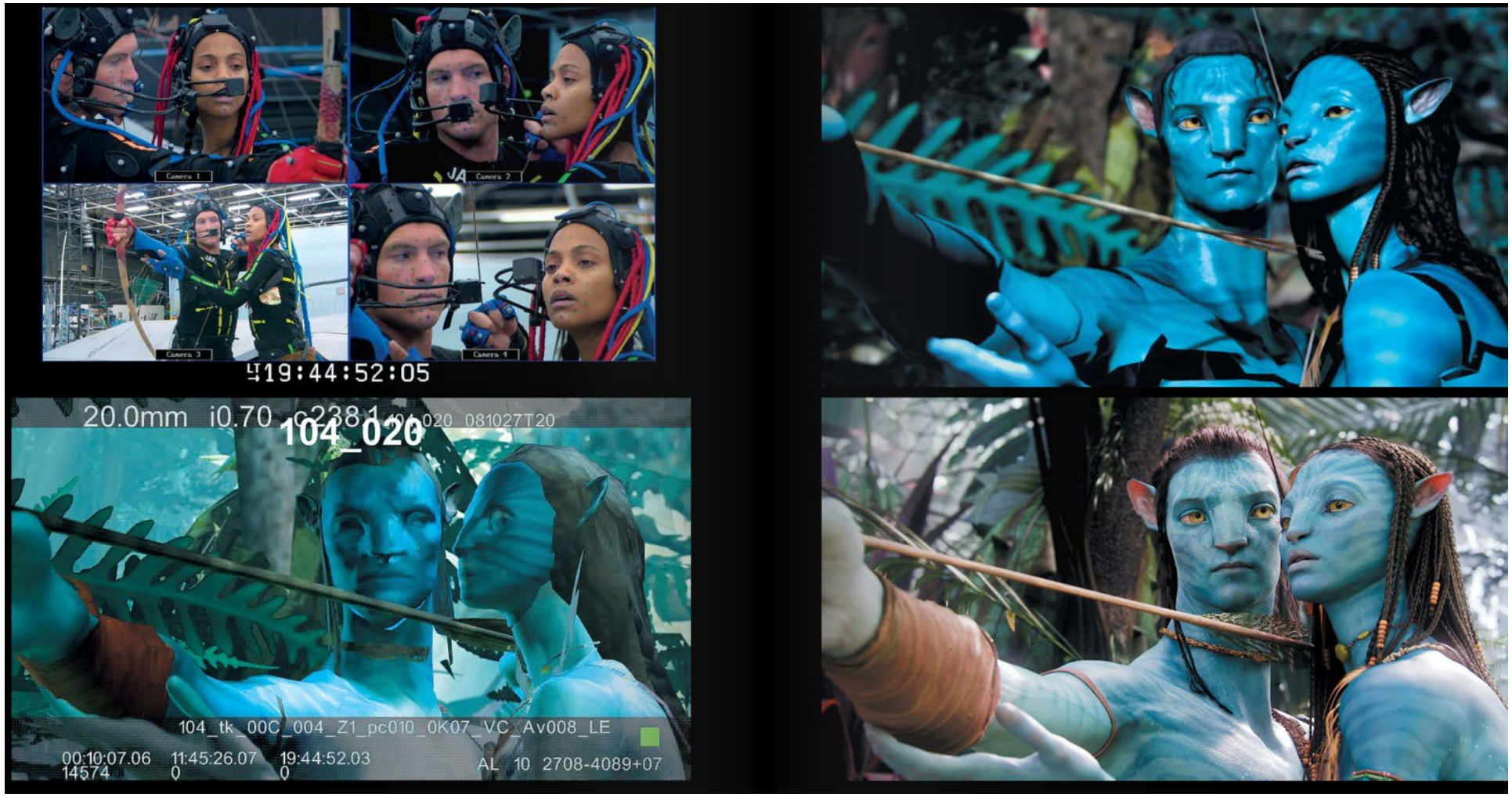





No simple mapping between the degree of realism and appeal/familiarity/friendliness

# 4. Motion capture is part of the solution for offline productions (3)

However, a very high resolution of facial meshes is not compatible with real-time display in VR, such as the *"swing cam"* concept introduced by James Cameron at the shooting stage to design camera trajectories.




[Cinefex on-line edition 2010]

# 4.1 Online Tracking systems

## *Camera based* *(mostly **outside-in** with static cameras)*

- *Marker based passive tracking*
- *Marker based active tracking*
  - *Active optical marker (LED) + IR cameras*
  - *HTC base-station emitter + embedded sensors*
- *Markerless tracking*
  - ***inside-out** CV viewpoint & hand tracking (e.g. Oculus Quest 2 carries four IR cameras)*
  - *CV Eye and face tracking (HTC Vive extensions)*

## *Pros*

- *Absolute position without drift over time*
- *relatively accurate devices*

## *Cons*

- *Occlusions*

## *Camera free :*

- *Mechanical capture (exoskeleton)*
- *IMU (accelerometers, giroscope)*
- *magnetic sensors*
- *Deformable gauges (mostly used in gloves)*

## *Pros*

- *No occlusions*

## *Cons*

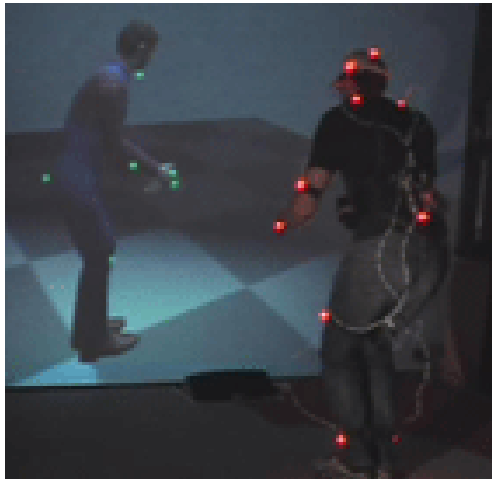
- *Lower accuracy (all)*
- *distortion induced by metallic objects (magnetic)*
- *Drifts (IMU)*

# 4.1 Online Tracking systems examples

*passive reflective markers*

*Optical mocap*

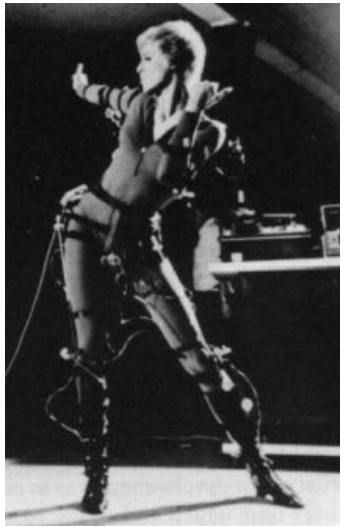
*active markers (red LEDs)*



*IMU-based products*

*magnetic sensors and gloves*

*exoskeleton*



*HTV-Vive basestation and sensors on HMD, tracker & controllers*

*HTC-Veve Eye-Pro*


Image: HTC

*HTC facial tracker*

# 5. Perception of real-time animation

The purpose of perception studies is to determine two tradeoffs regarding CPU/GPU use.

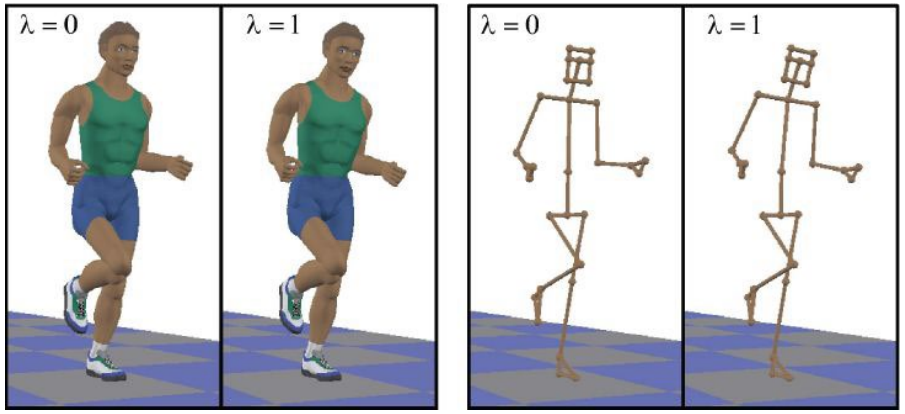
Context: a few **ms** to update the state of Virtual Humans

- **Uncanny valley:** matching animation quality with mesh resolution
  - Rationale: use only a VH degree of realism that can be supported by the available animation resources.
    - Don't add mobile accessories if they cannot be animated, such as long hairs, ear rings, floating pieces of cloth, etc…

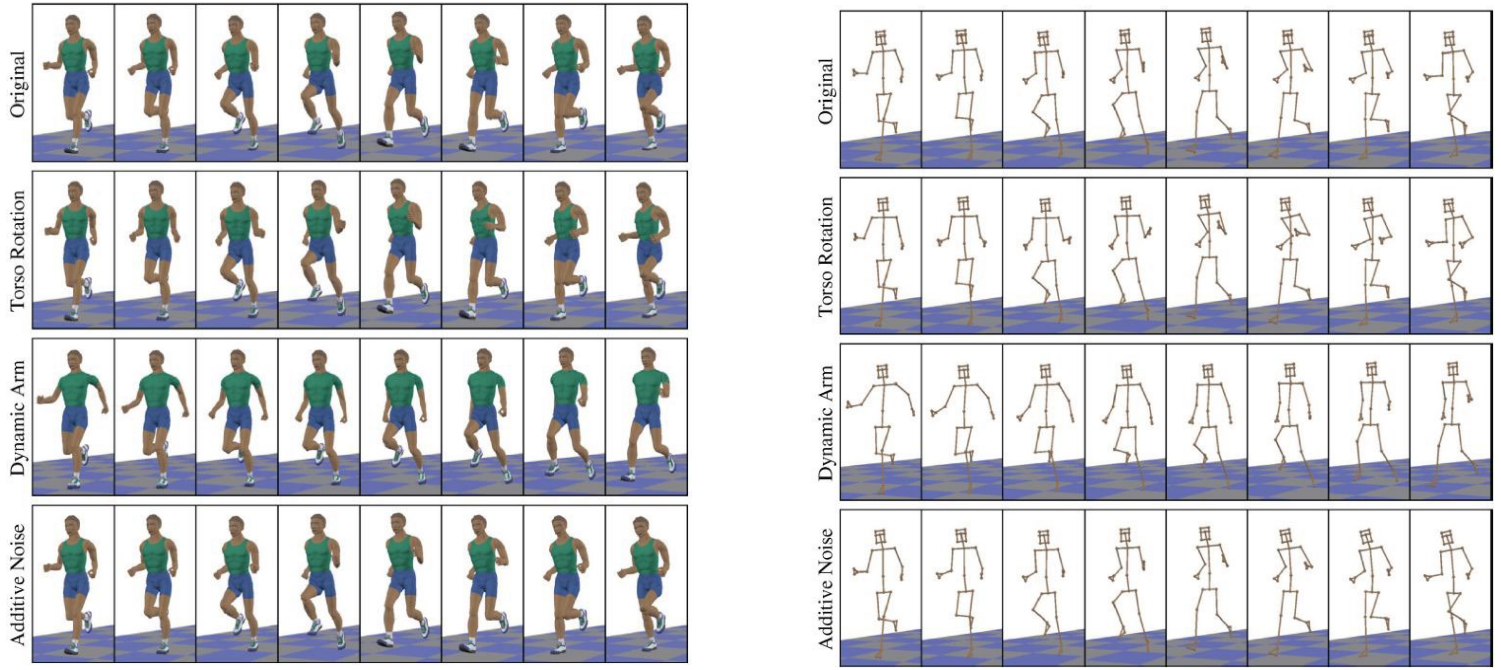
- **Compute what you see:**
  - Rationale: do NOT compute what is NOT perceived.
    - Levels of Details: decrease the resolution of human graphical models as distance increases to reduce display cost and simplify the movement to reduce animation cost.

# 5. Perception of real-time animation (2)

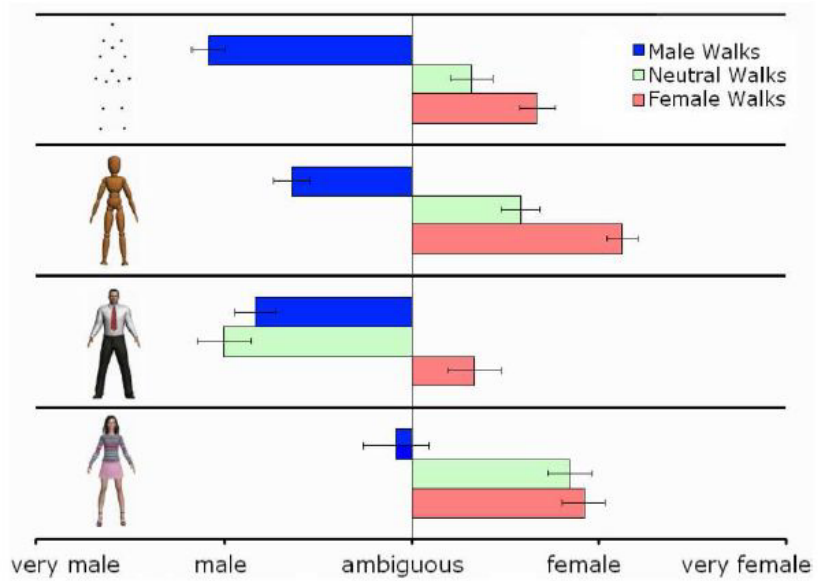
In 1998; Hodgins et al showed that the geometric model type used to represent the human affected people's ability to **perceive the difference between two human motions.**



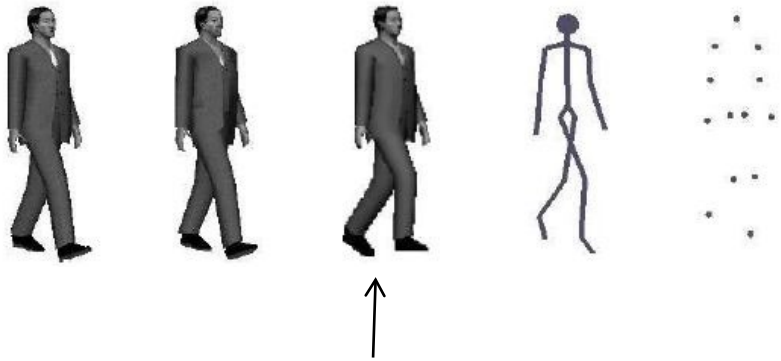

Subjects were more able to tell the difference between 2 motions when they were displayed on the polygonal character.



# 5. Perception of real-time animation (3)




• People are most sensitive to differences in human motions for high-resolution geometry (2022 pol) and *impostor* (i.e., image based rendering) representations, less sensitive for low resolution geometry (800 pol) and stick figures, and least sensitive for point-light representations [M 2005].



*Impostor = 17x8 precomputed texture from high resolution geometry*

Hodgins, O'Sullivan, Newell, McDowell found that:

• The graphical model may alter the perception of walking style (e.g. neutral).
• Gender-specific style should not be used for the other gender.

# 5. Perception of real-time animation (4)

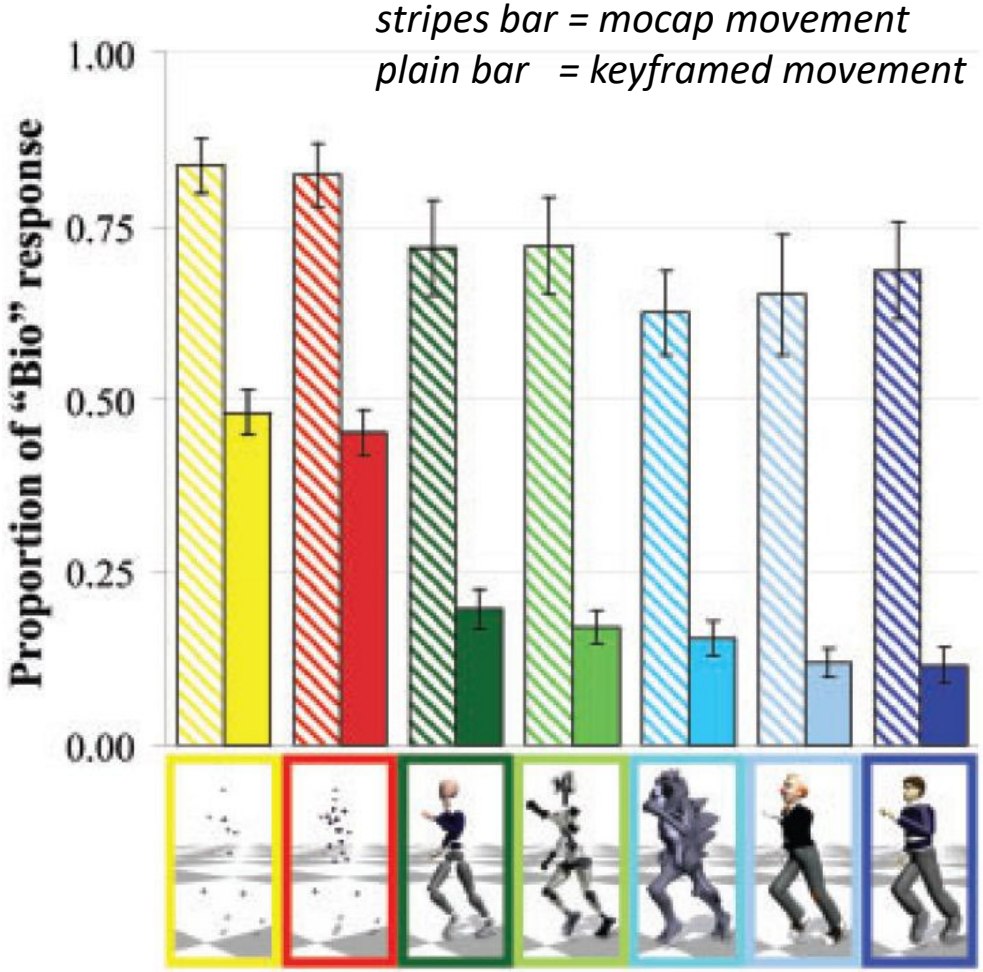
In [C2007], Chaminade et al. investigated how the appearance of computer animated characters influenced the perception of a running movement.

**Task:** indicate whether a running motion is ***biological*** or ***artificial***

**Setup**: 4 sessions (7 minutes) x 7 characters x 6 motions (1 s)

**Results:**

- Bias: subjects are more inclided to perceive a ***biological*** motion for simplified characters.
- Motion rendered with anthropomorphic characters are perceived as less natural.
- Emotion is not involved (fMRI)



# [References]


[C2007] T Chaminade, J Hodgins, M Kawato -Anthropomorphism influences perception of computer-animated characters' actions, Social cognitive and affective neuroscience, 2007

[H 1998] Hodgins et al.: Perception of Human Motion With Different Geometric Models, IEEE Transactions on Visualization and Computer Graphics, 4(4), 307-316

[ M 2005] R. Mc Donnell, S. Dobbyn, C O'Sullivan Optimising and Evaluating the Realism of Virtual Crowds: Perceptual Experiments and Metrics, in EG07 tutorial on crowd animation.

[M 2012] McDonnell, R., Breidt, M., Bülthoff, H. 2012. Render me Real? Investigating the Effect ofRender Style on the Perception of Animated Virtual Humans. ACM Trans. Graph. 31 4, DOI = 10.1145/2185520.2185587

[P 1995] K. Perlin, "Real Time Responsive Animation with Personality," IEEE Trans. Visualization and Computer Graphics, vol. 1, no. 1, pp. 5-15,Mar. 1995

[TRV 2006] Traité de Réalité Virtuelle, Ed. P. Fuch, vol 2, chap 17, Eds A. Berthoz & J.L. Vercher

[W 2009] van Welbergen, H., van Basten, B.J.H., Egges, A., Ruttkay, Z., Overmars, M.H.: Real Time Animation of Virtual Humans: A Trade-off Between Naturalness and Control. In: Eurographics - State of the Art Reports, Eurographics Association, pp. 45–72 (2009)

# [Web References]

http://en.wikipedia.org/wiki/Lie_to_Me : with Prof. Paul Ekman as consultant.

Doc on microexpressions : http://www.youtube.com/watch?v=k2rb7pAP7hk

Image Metrics: http://www.youtube.com/watch?v=JF_NFmtw89g&feature=fvwrel

Web site of Prof. Ken Perlin: http://www.mrl.nyu.edu/~perlin/
[PerlinNoise] : http://freespace.virgin.net/hugo.elias/models/m_perlin.htm