Sociable Robots

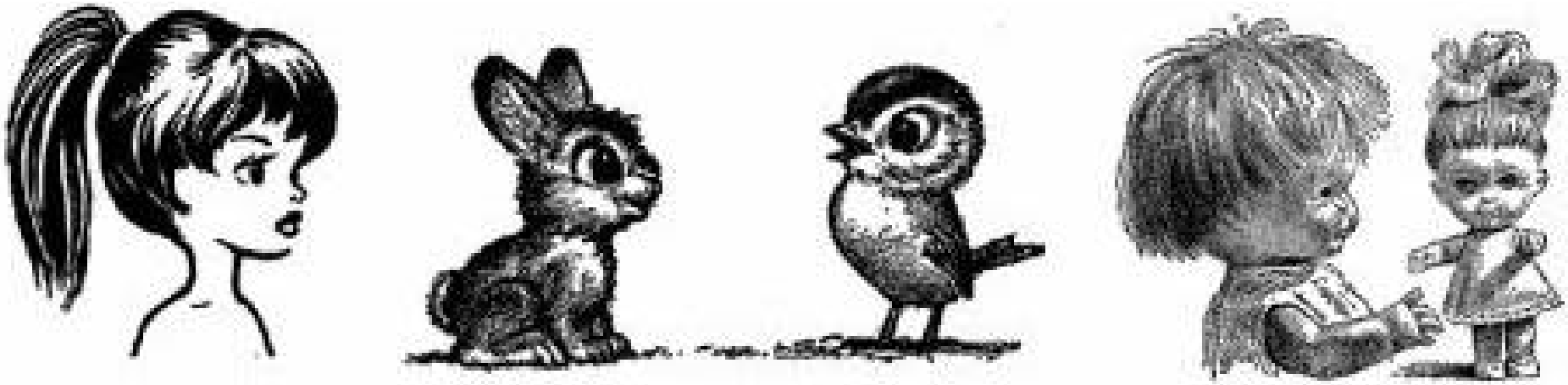
Peeping into the Human World

An Infant's Advantages

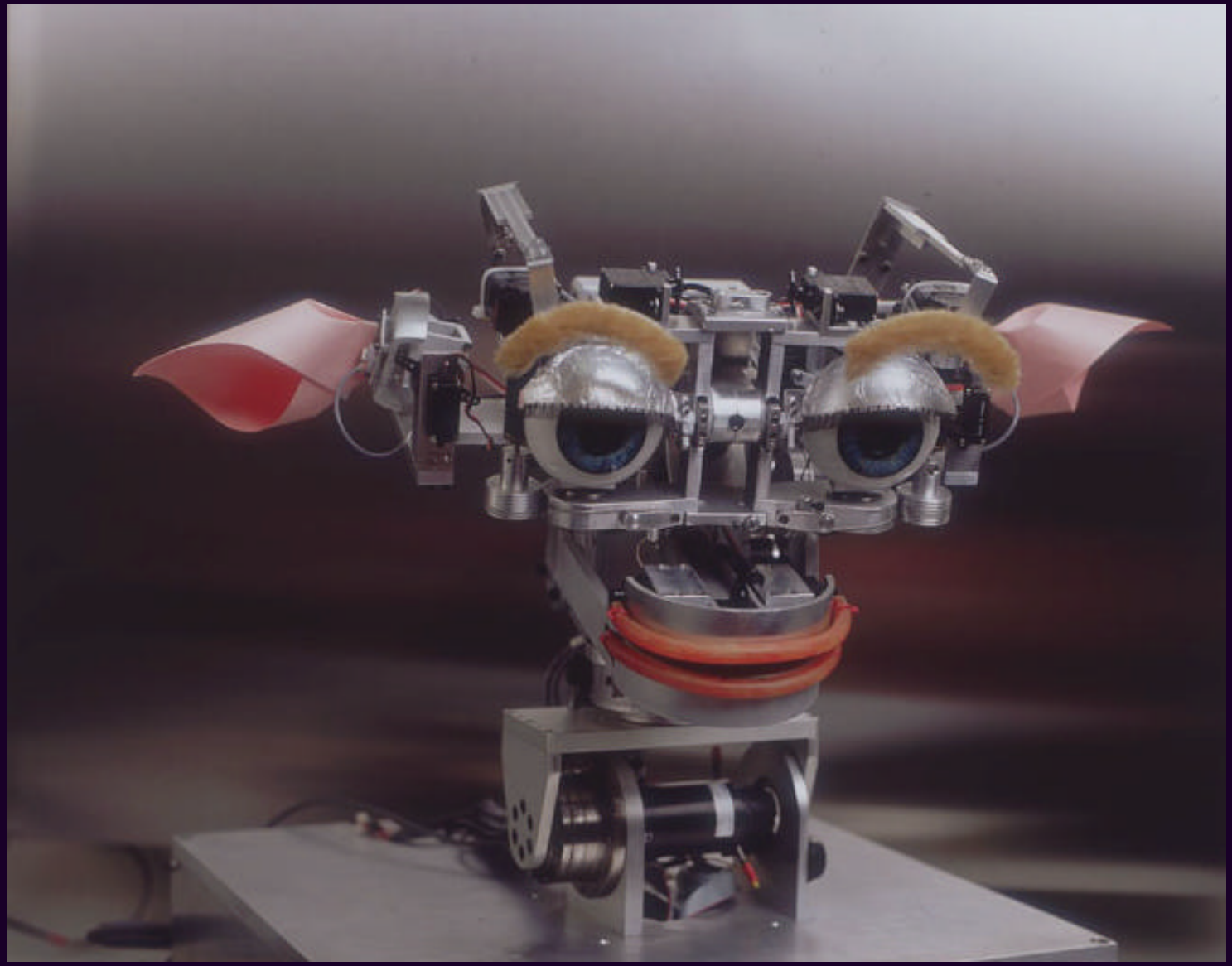
- Non-hostile environment
- Actively benevolent, empathic caregiver
- Co-exists with mature version of self

Baby Scheme

- Physical form can evoke nurturing response
- Caregiver exaggerates voice, gestures



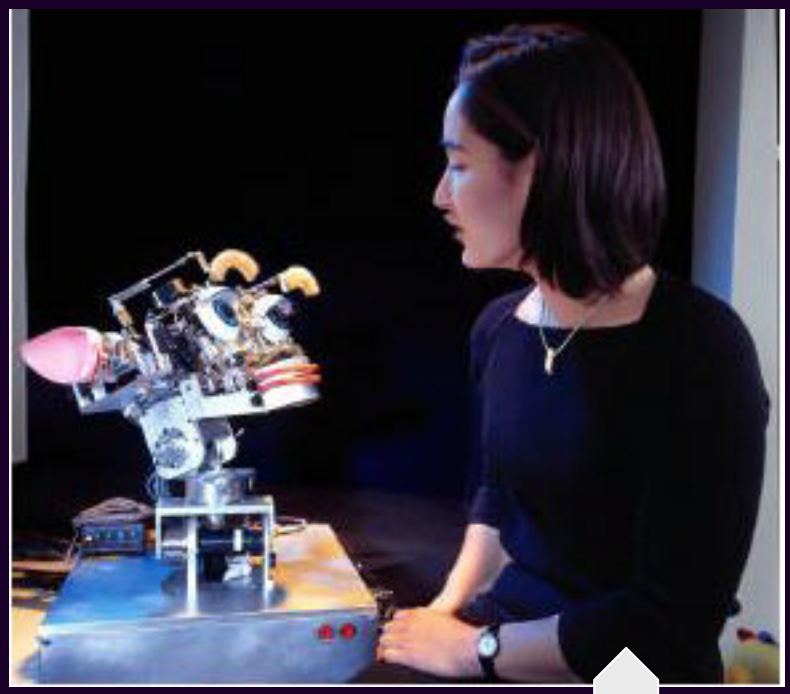
Kismet – a Baby Robot



Requirements

- Robot needs to perceive human state
  - Computer vision, speech processing
- Human needs to perceive robot state
  - Animatronics, speech generation
- Closed loop interaction requires both directions

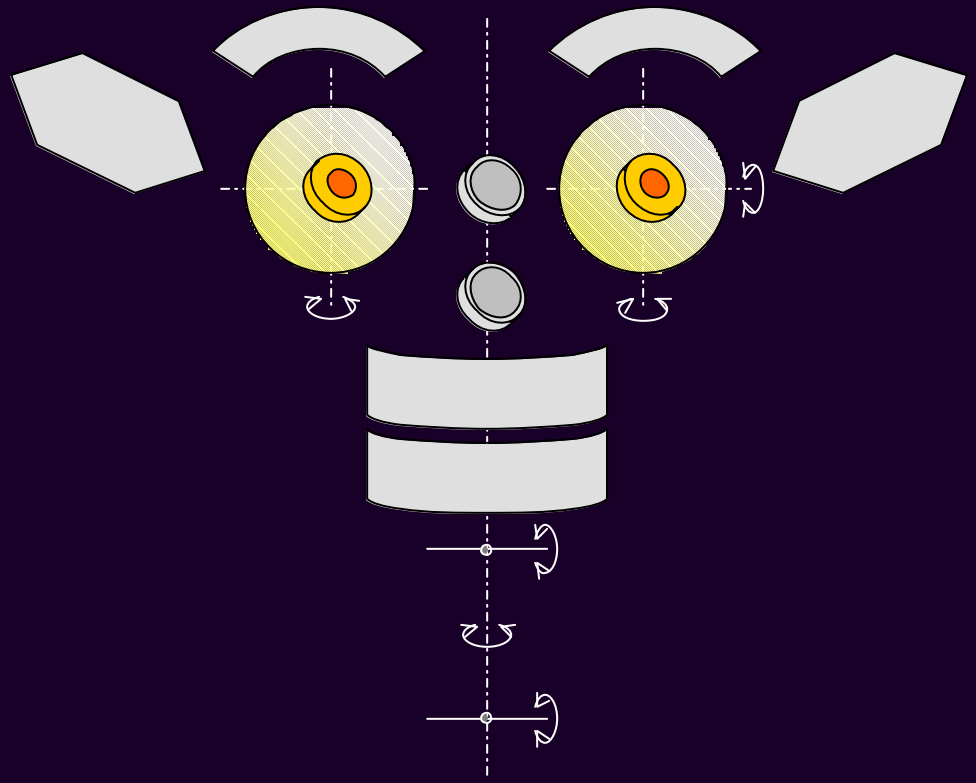
Readable locus of attention



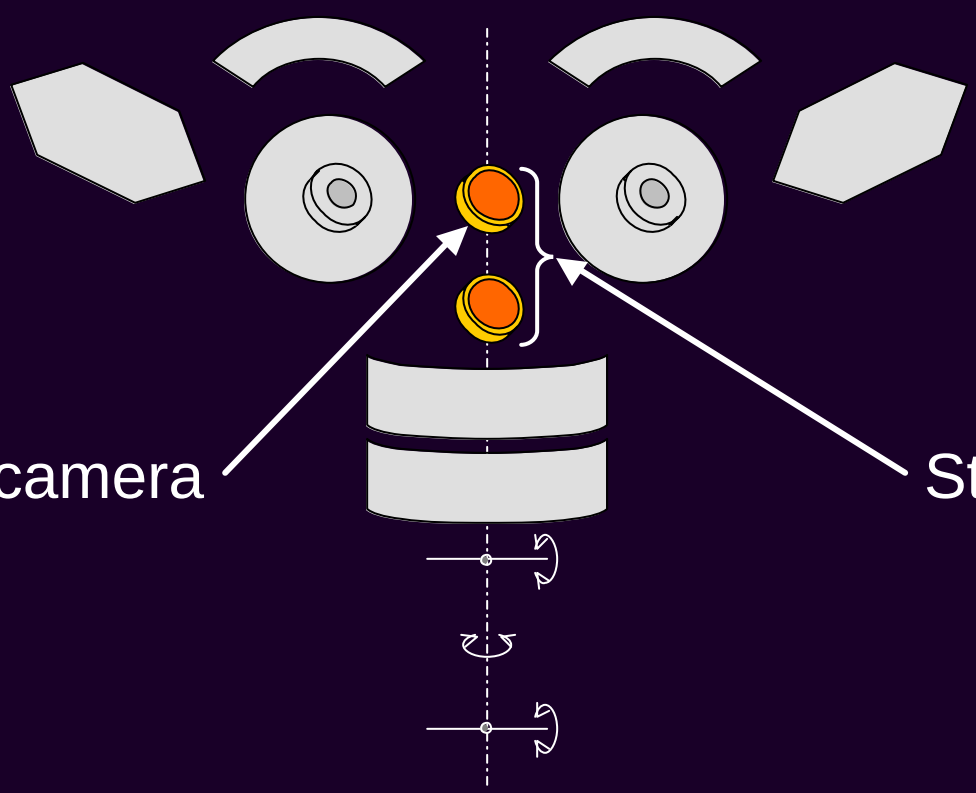
Attention can be deduced from behavior

Or can be expressed more directly

Expressing locus of attention



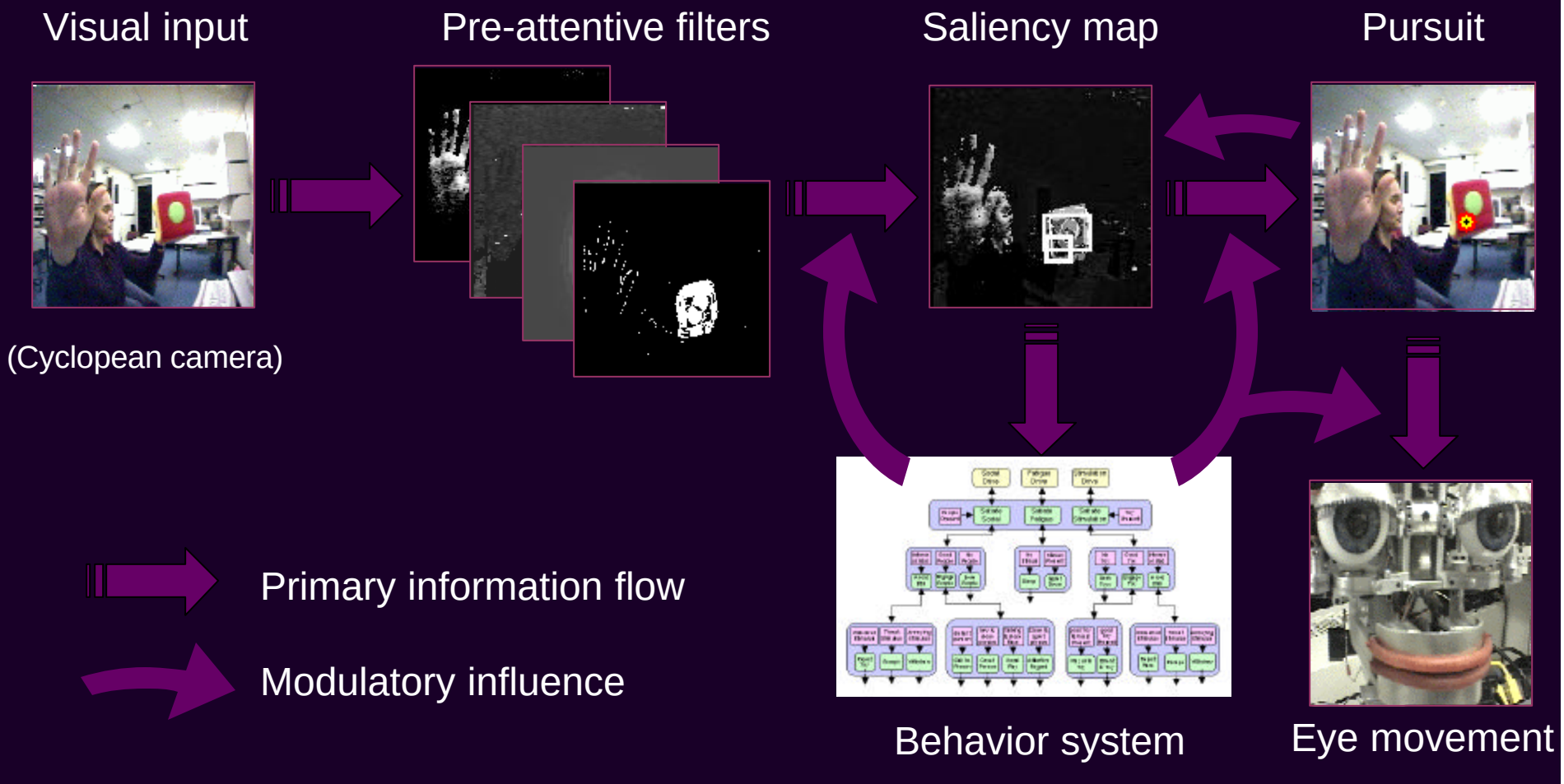
Computing locus of attention



“Cyclopean” camera

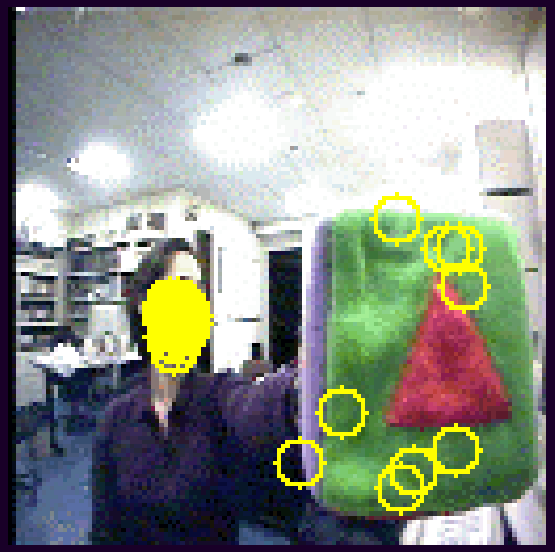
Stereo pair

Computing locus of attention



Looking Preference

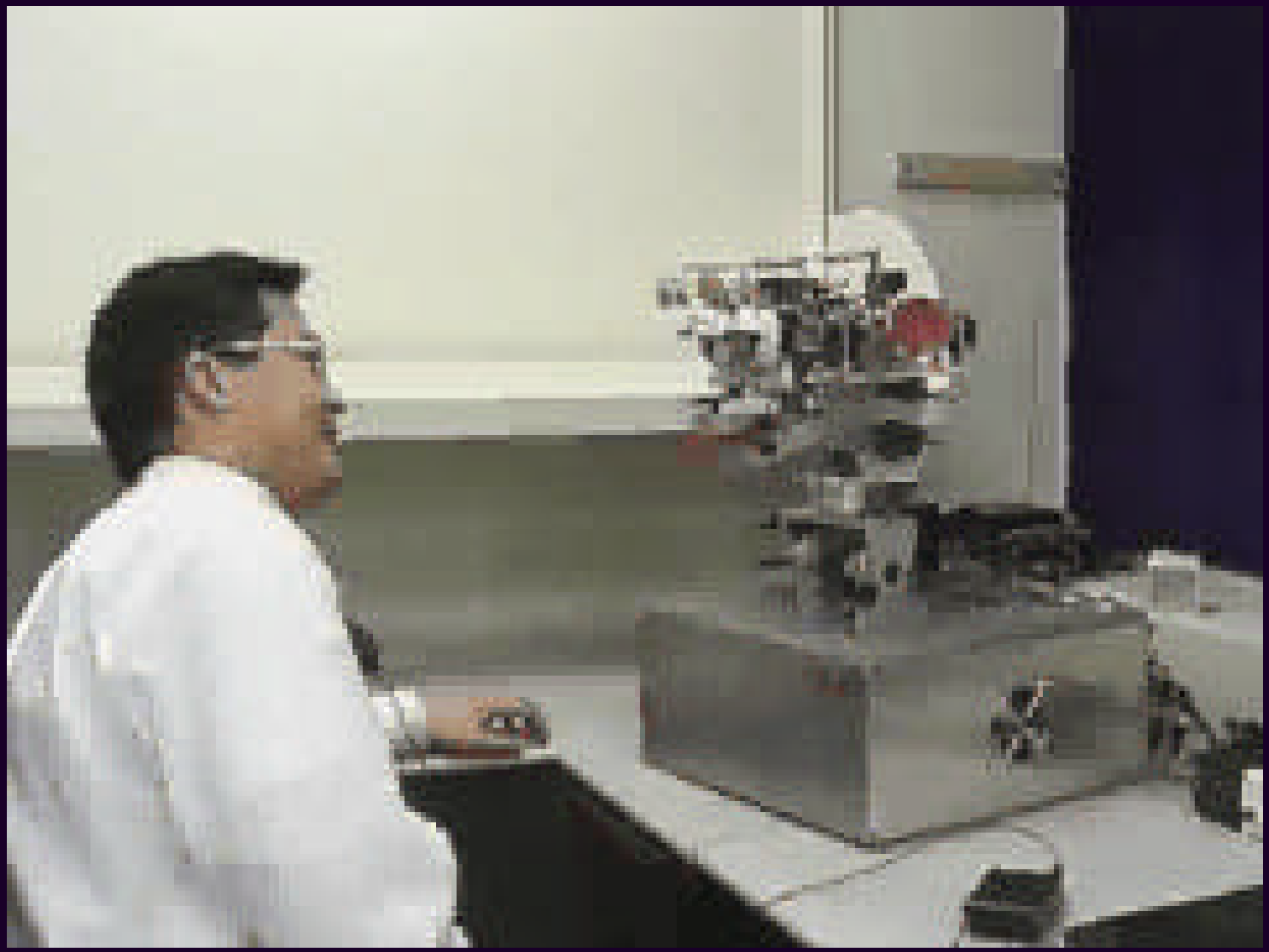
“Seek toy” –
low skin gain, high saturated-color gain
Looking time 28% face, 72% block



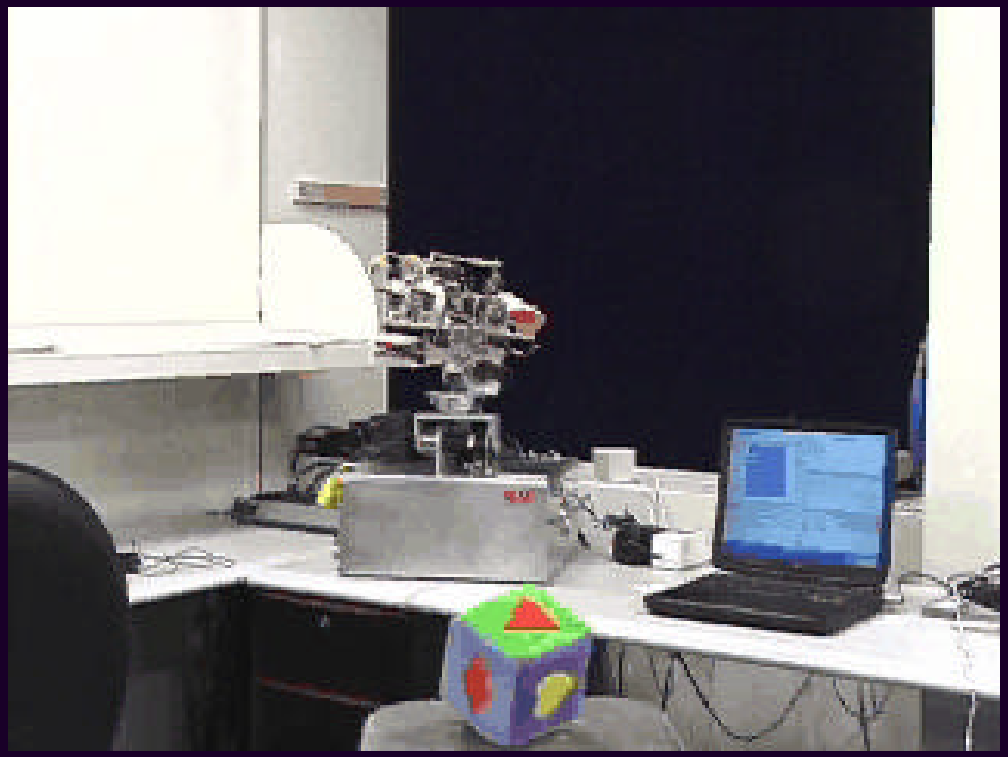
“Seek face” –
high skin gain, low color saliency gain
Looking time 80% face, 20% block

- Internal influences bias how salience is measured
- The robot is not a slave to its environment
- Prefers behaviorally relevant stimuli

Example (video)



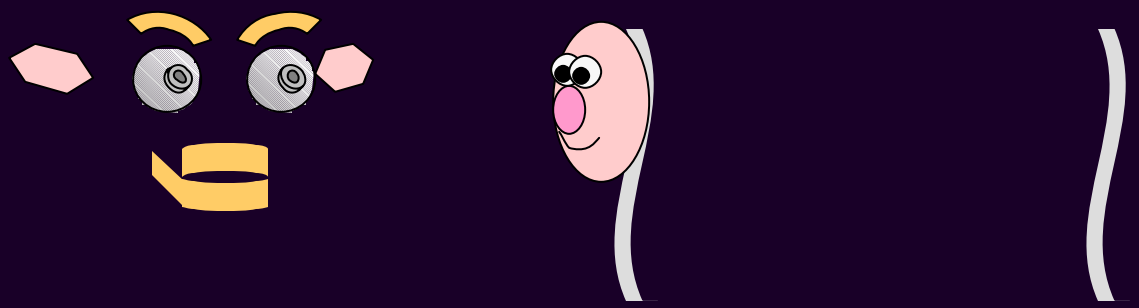
Example (video)



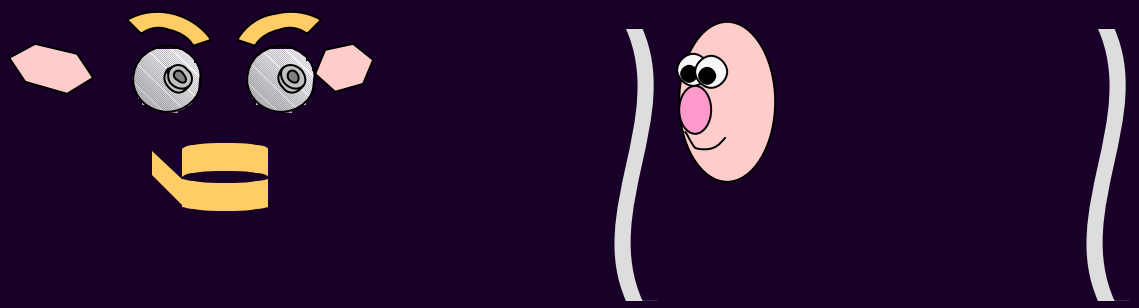
- Robot's search is task-specific
- Still opportunistic when appropriate
- Visual behavior conveys degree of commitment
- Gaze direction, expression conveys interest

Interpersonal Distance

Interpersonal Distance

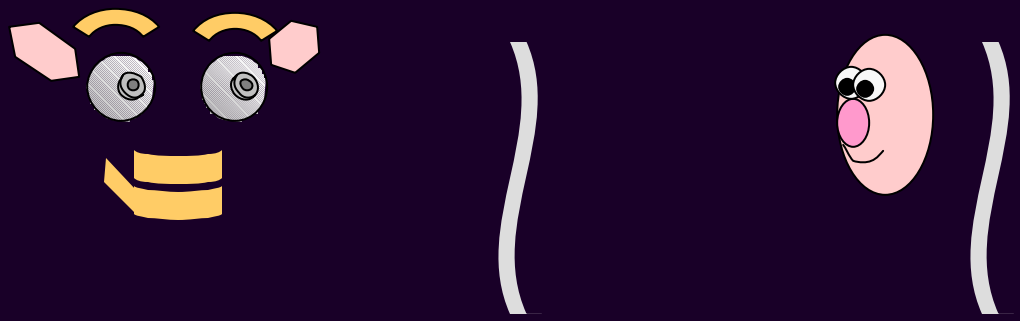


Interpersonal Distance



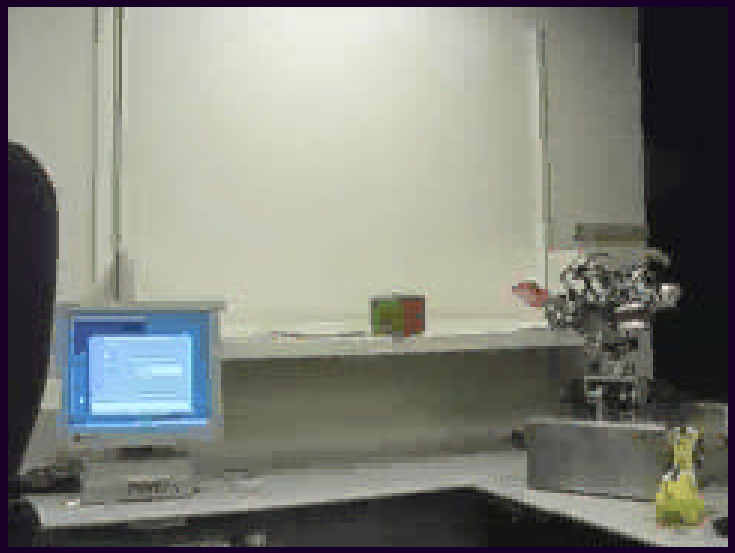
Interpersonal Distance

Interpersonal Distance



Examples (video)

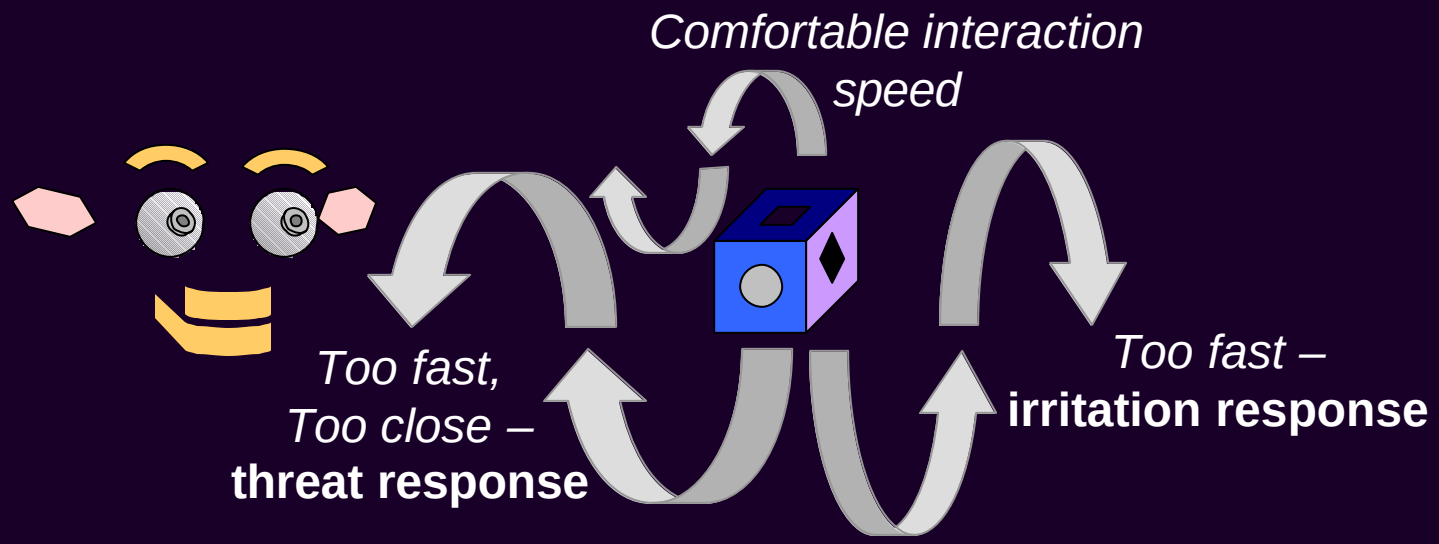
“Back off buster!”



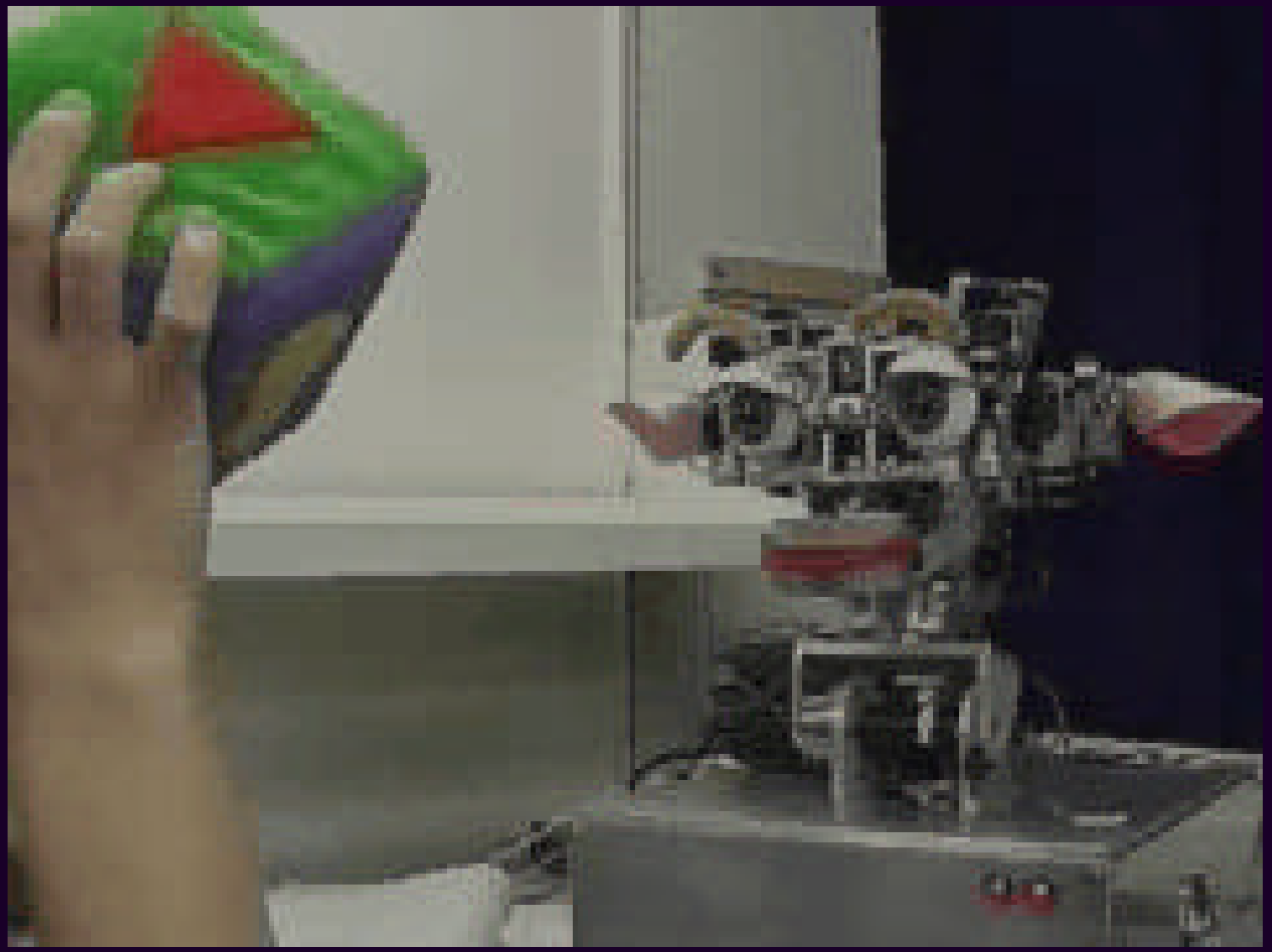
“Come hither, friend”

- Robot backs away if person comes too close
- Cues person to back away too – social amplification
- Robot makes itself salient to call a person closer if too far away

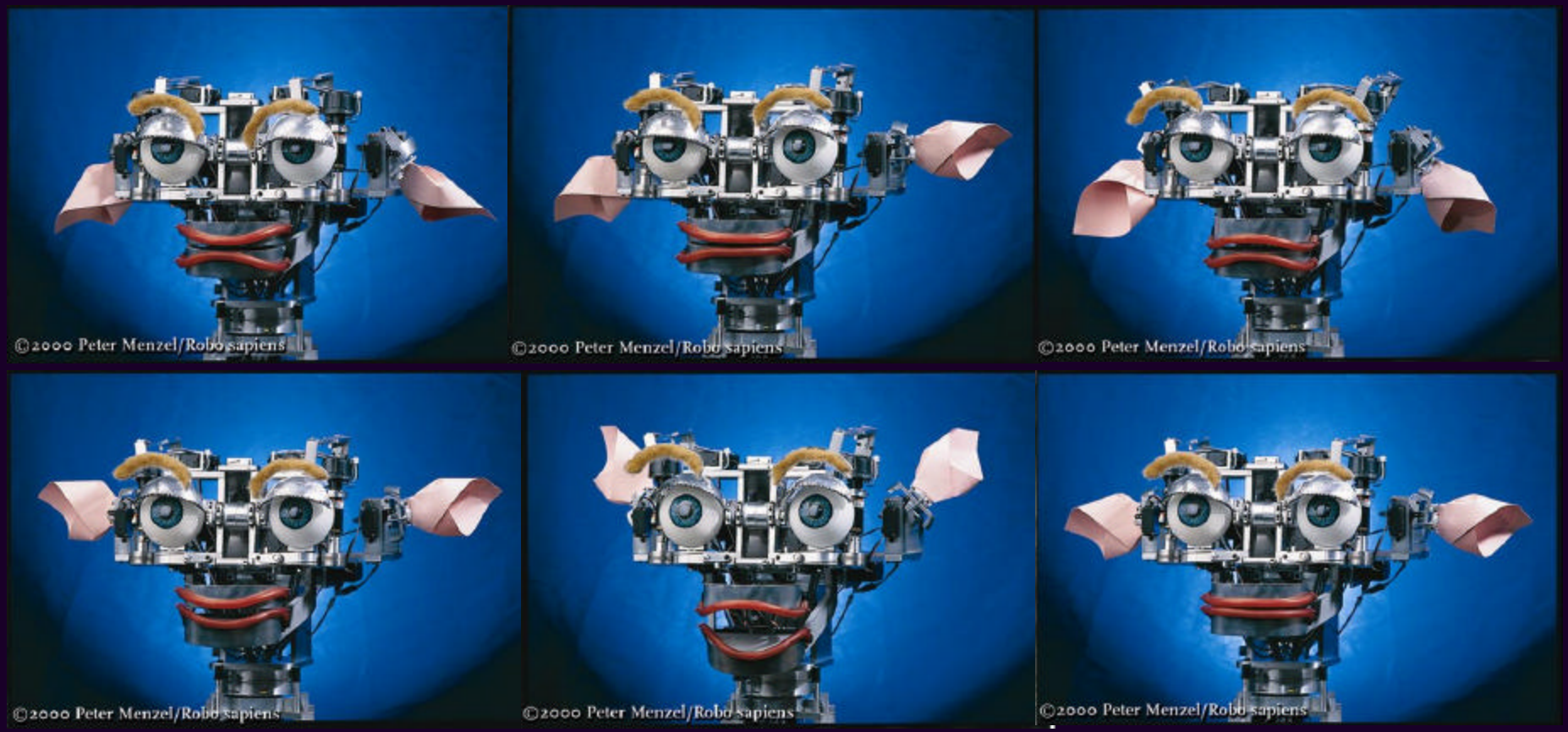
Negotiating object showing



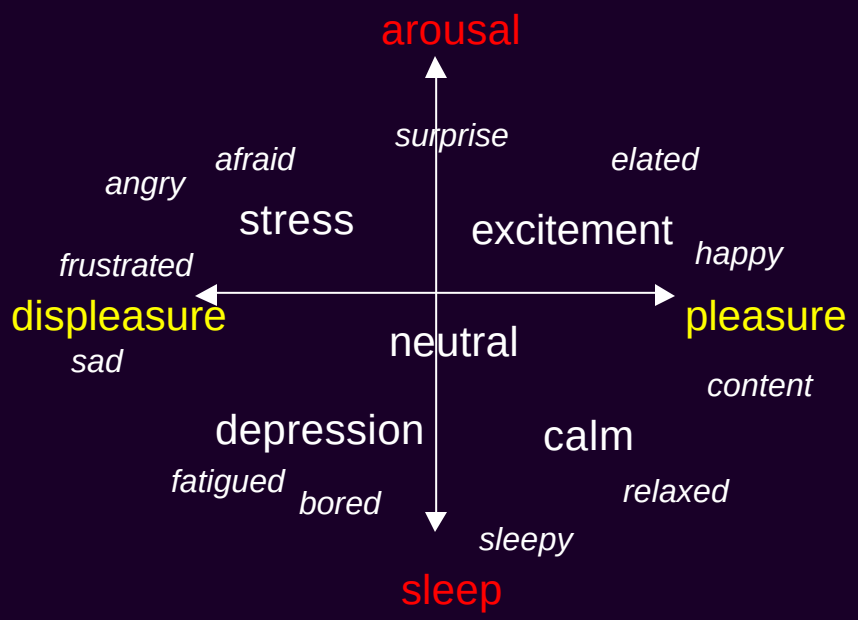
Example (video)



Facial expressions

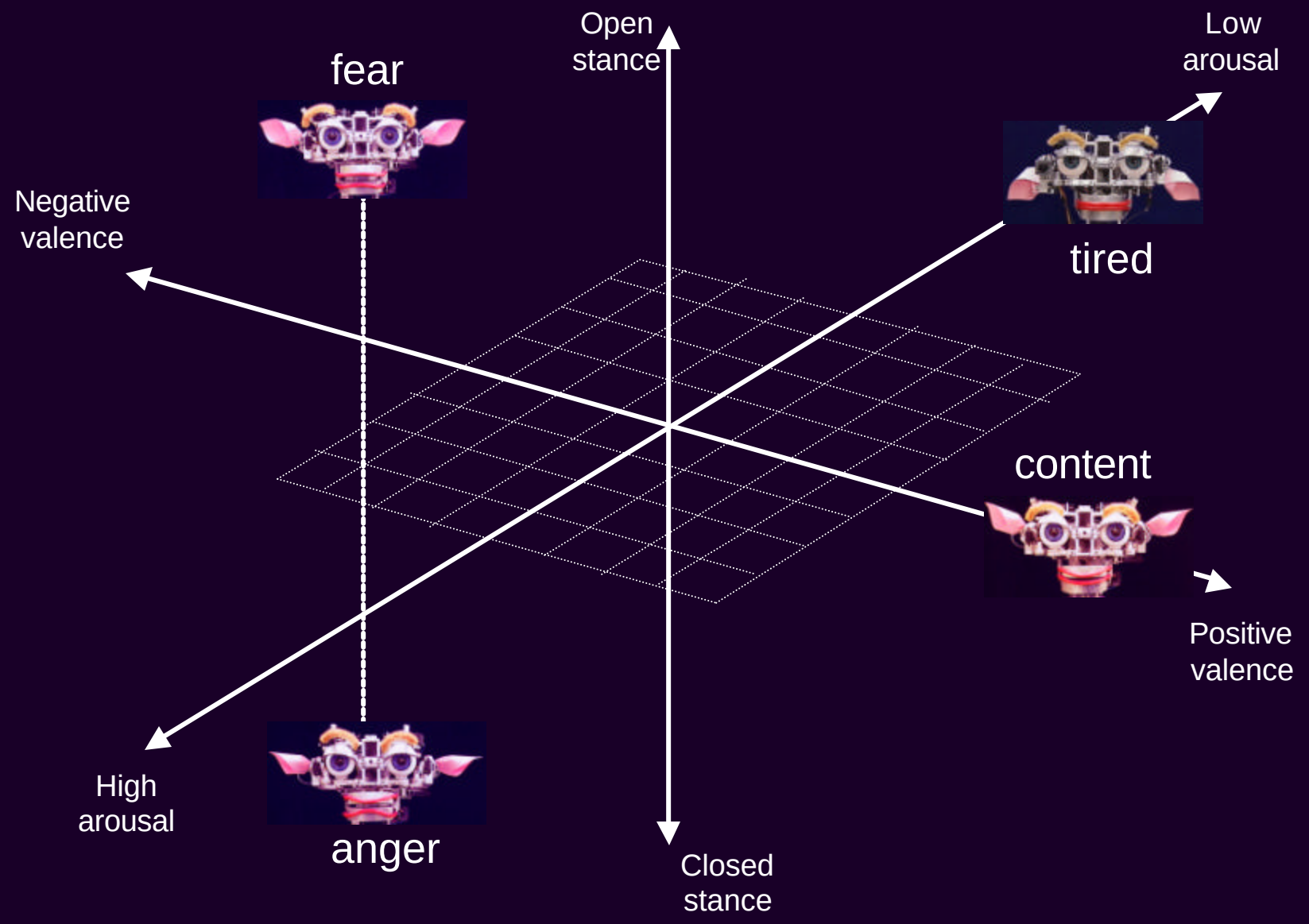


Facial Expressions
(Russell, Scott&Smith)

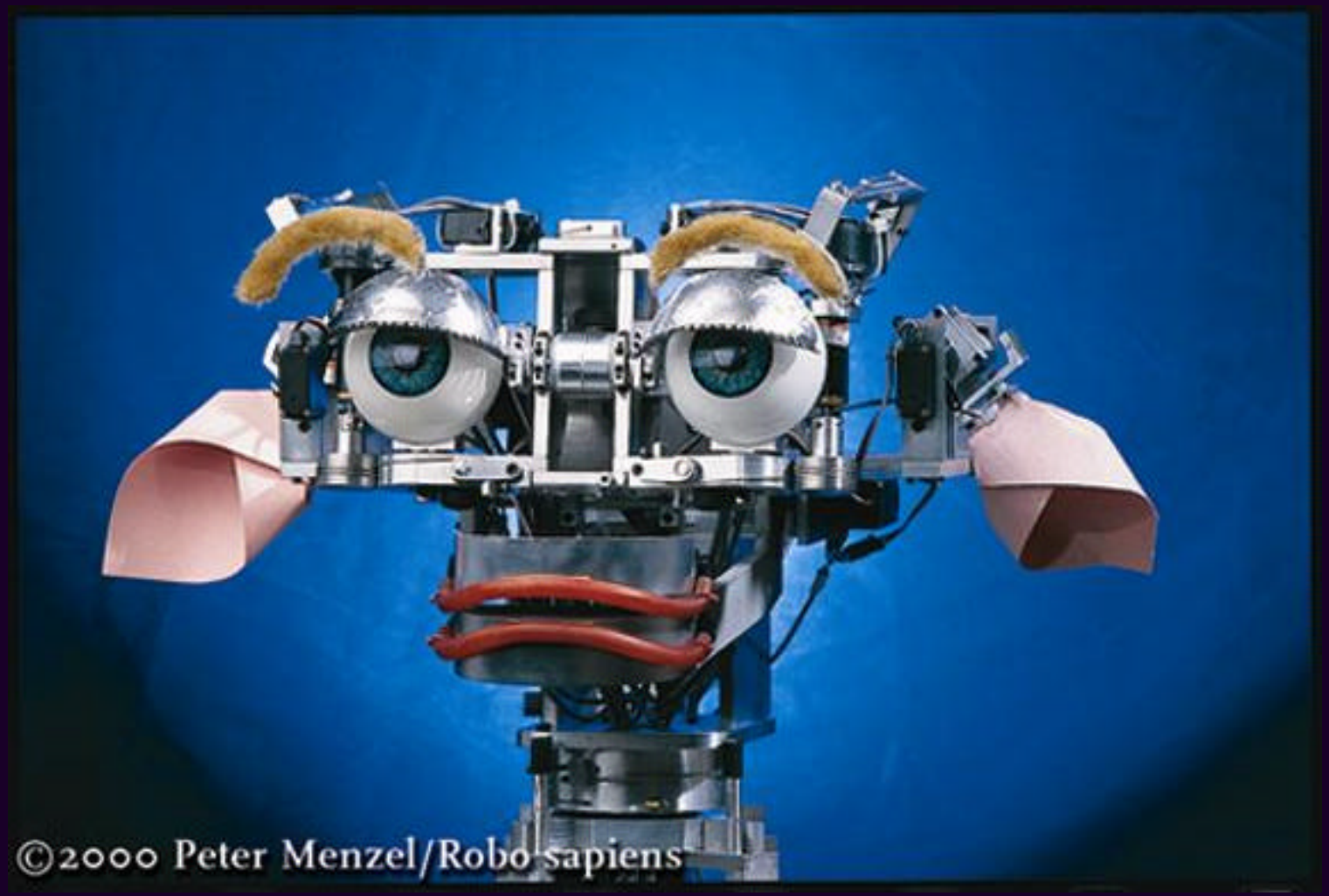


- **Emotions can be mapped to affect dimensions (Russell)**
- **Facial postures are related in a systematic way to these affective dimensions (Smith & Scott)**

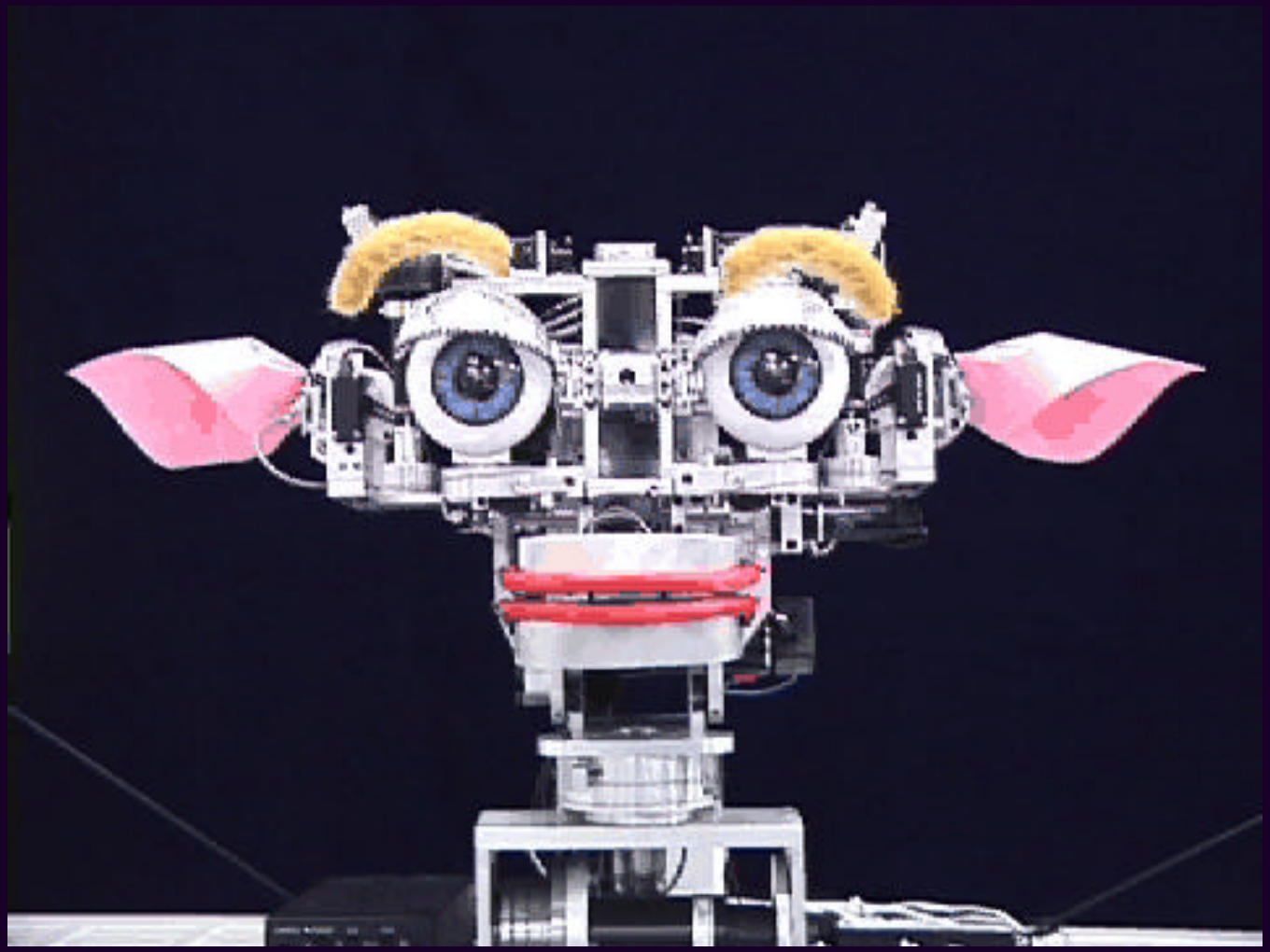
Generating Posture, Expressions



Example Facial Expression



With Posture (video)

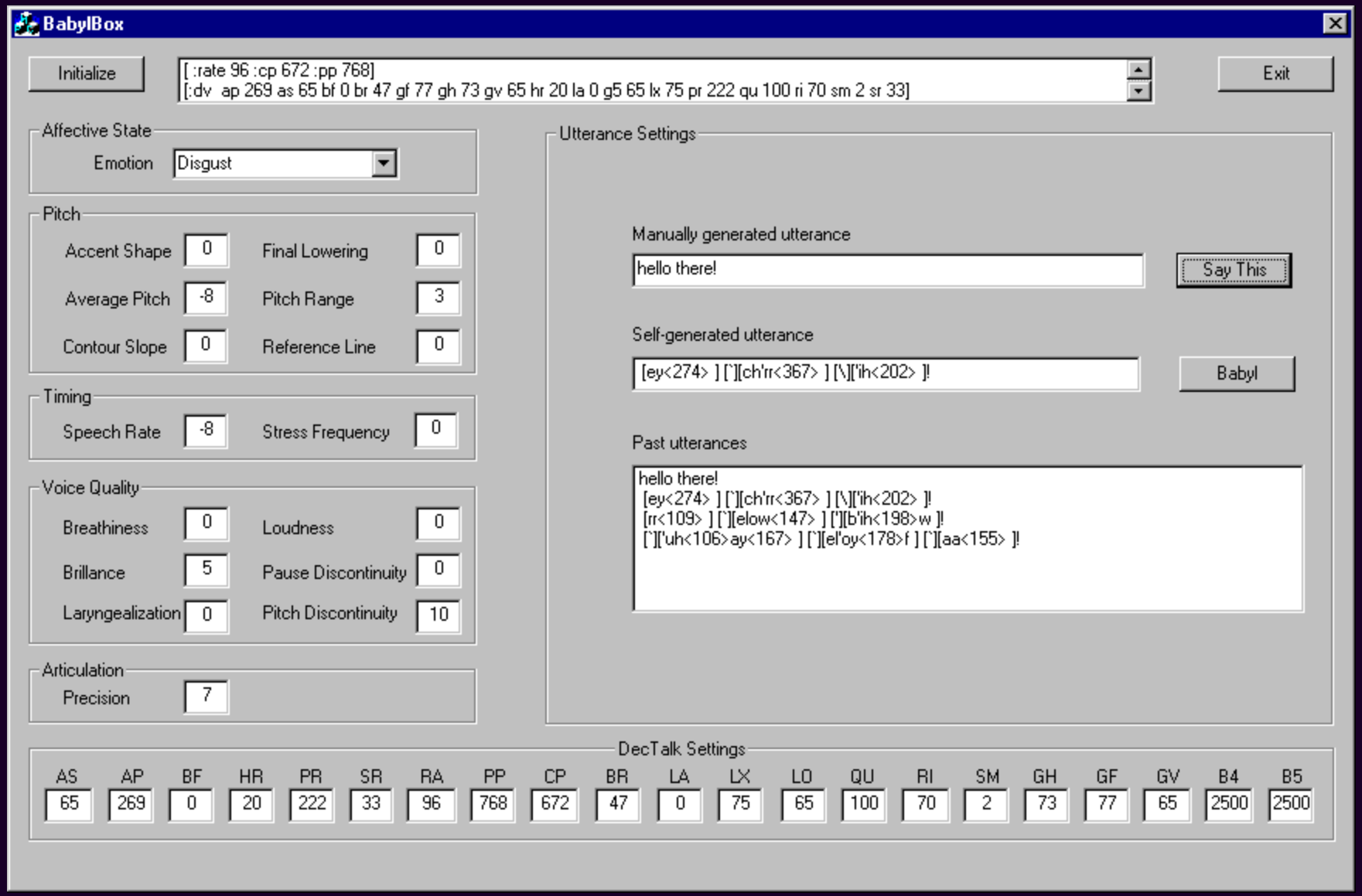


Emotive Voice Quality

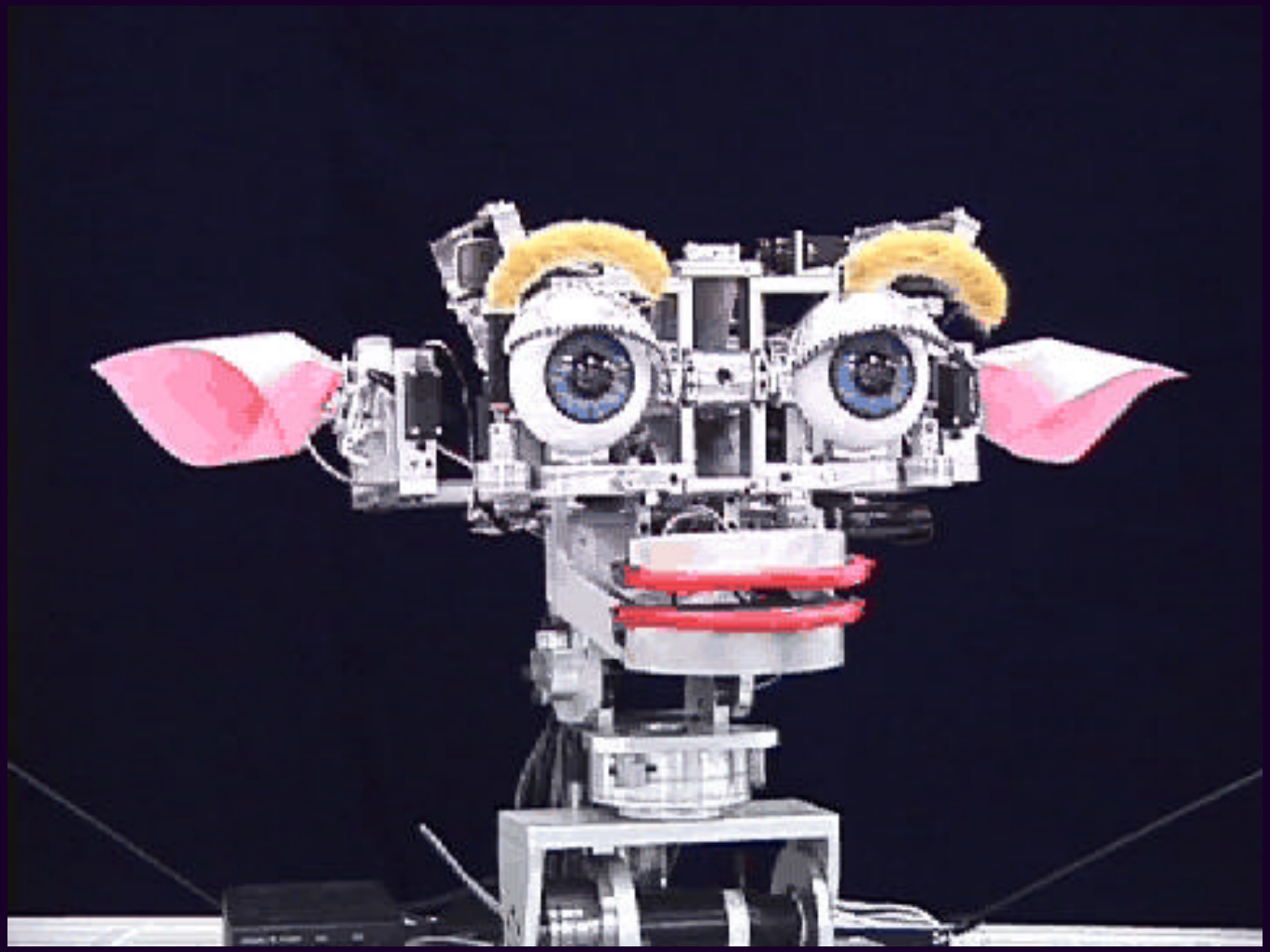
The effect of emotions on the human voice

	fear	anger	sorrow	joy	disgust	surprise
speech rate	much faster	slightly faster	slightly slower	faster or slower	very much slower	much faster
pitch average	very much higher	very much higher	slightly lower	much higher	very much lower	much higher
pitch range	much wider	much wider	slightly narrower	much wider	slightly wider	
intensity	normal	higher	lower	higher	lower	higher
voice quality	irregular voicing	breathy chest tone	resonant	breathy blaring	grumbled chest tone	
pitch changes	normal	abrupt on stressed syllable	downward inflections	smooth upward inflections	wide downward terminal inflections	rising contour
articulation	precise	tense	slurring	normal	normal	

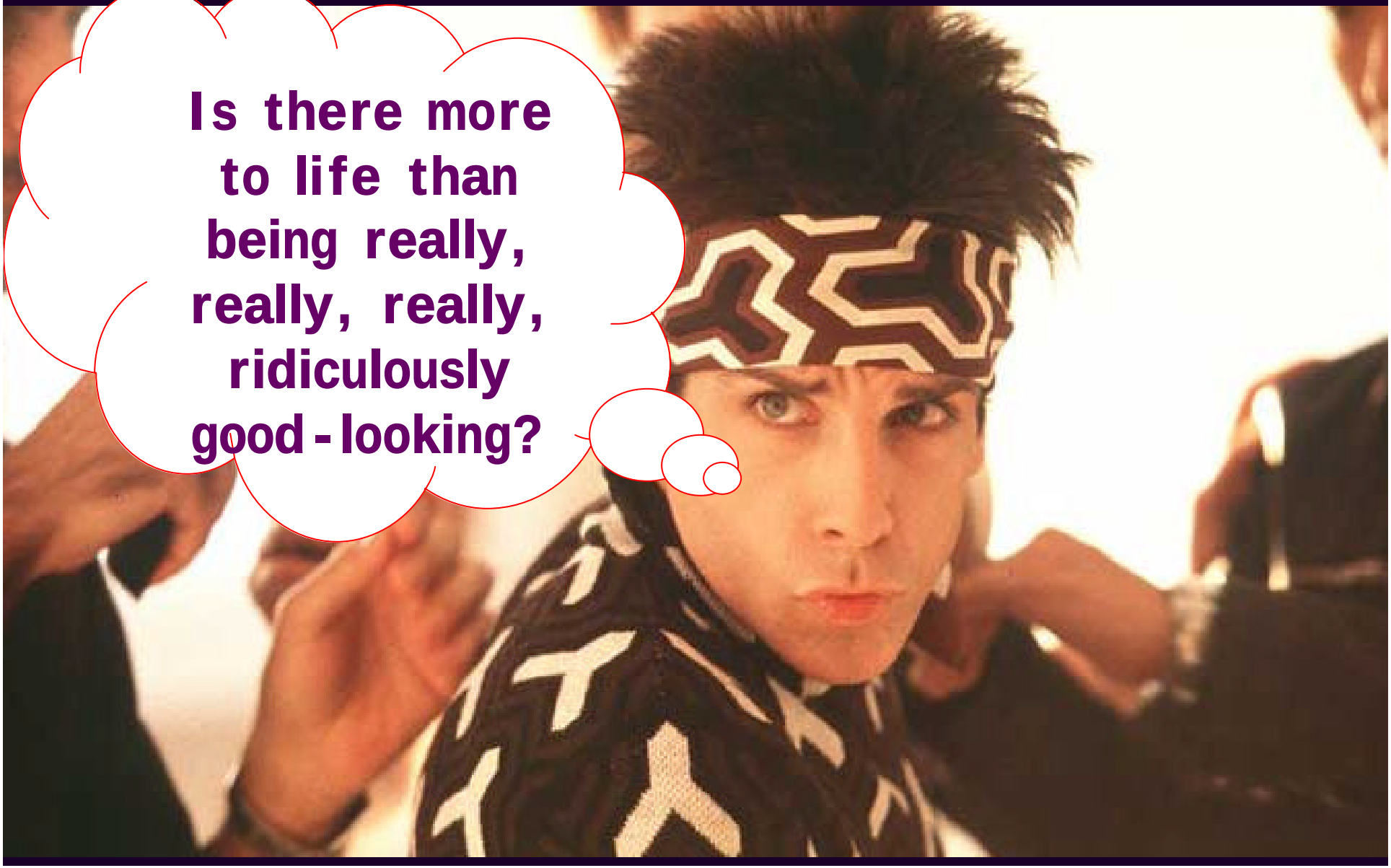
Synthesized Emotive Speech



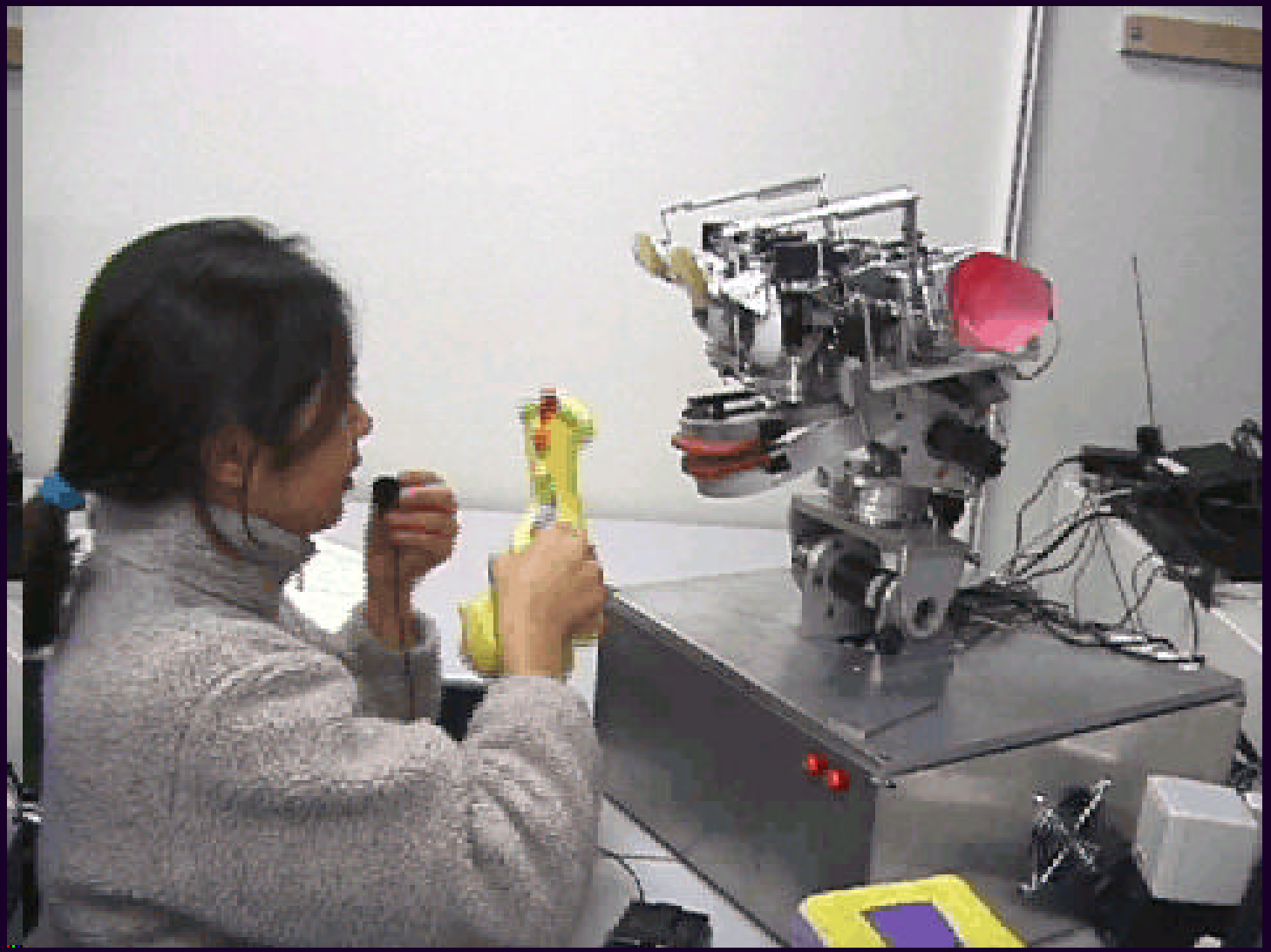
With Vocalizations (video)



But…


Is there more to life than being really, really, really, ridiculously good-looking?

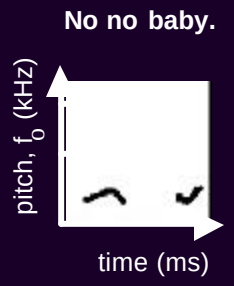
Affective Intent (video)



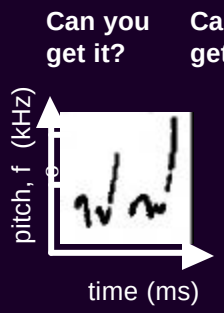
Fernald's Results

- Four cross-cultural contours of infant-directed speech
- Exaggerated prosody matched to infant's innate responses

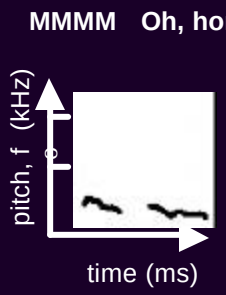
approval



prohibition



attention



comfort

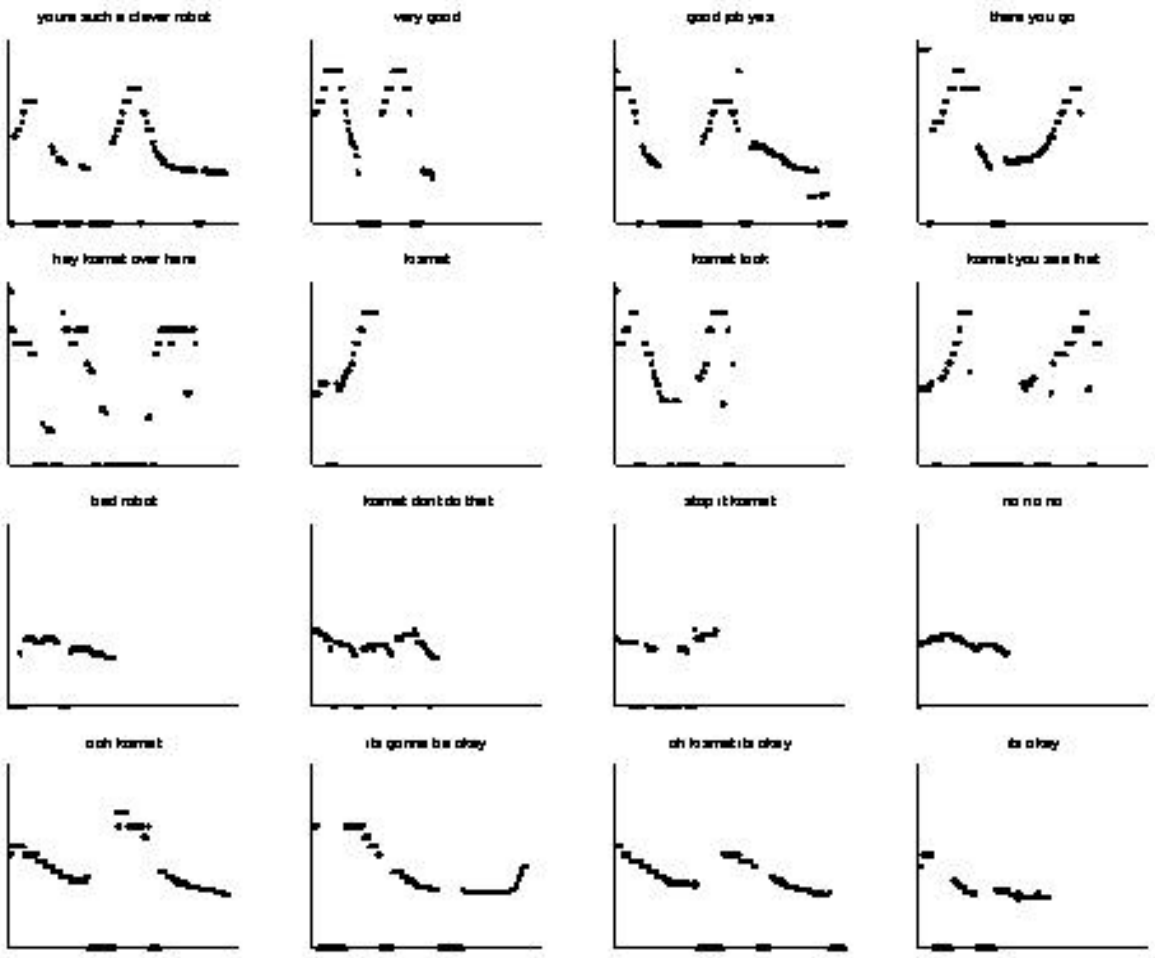
Evidence for Fernald-like Contours

Approval

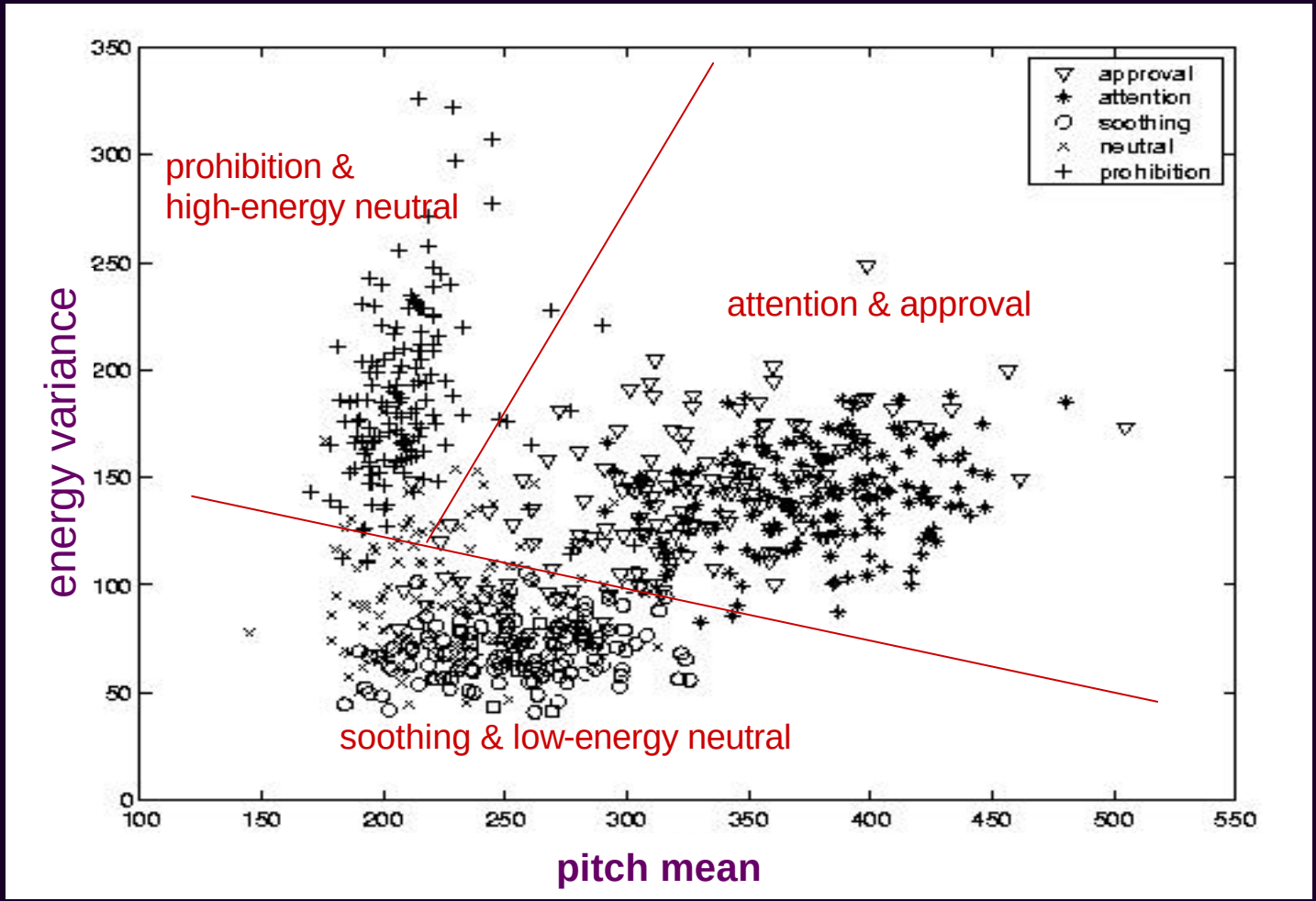
Prohibition

Attention

Soothing



Performing Recognition



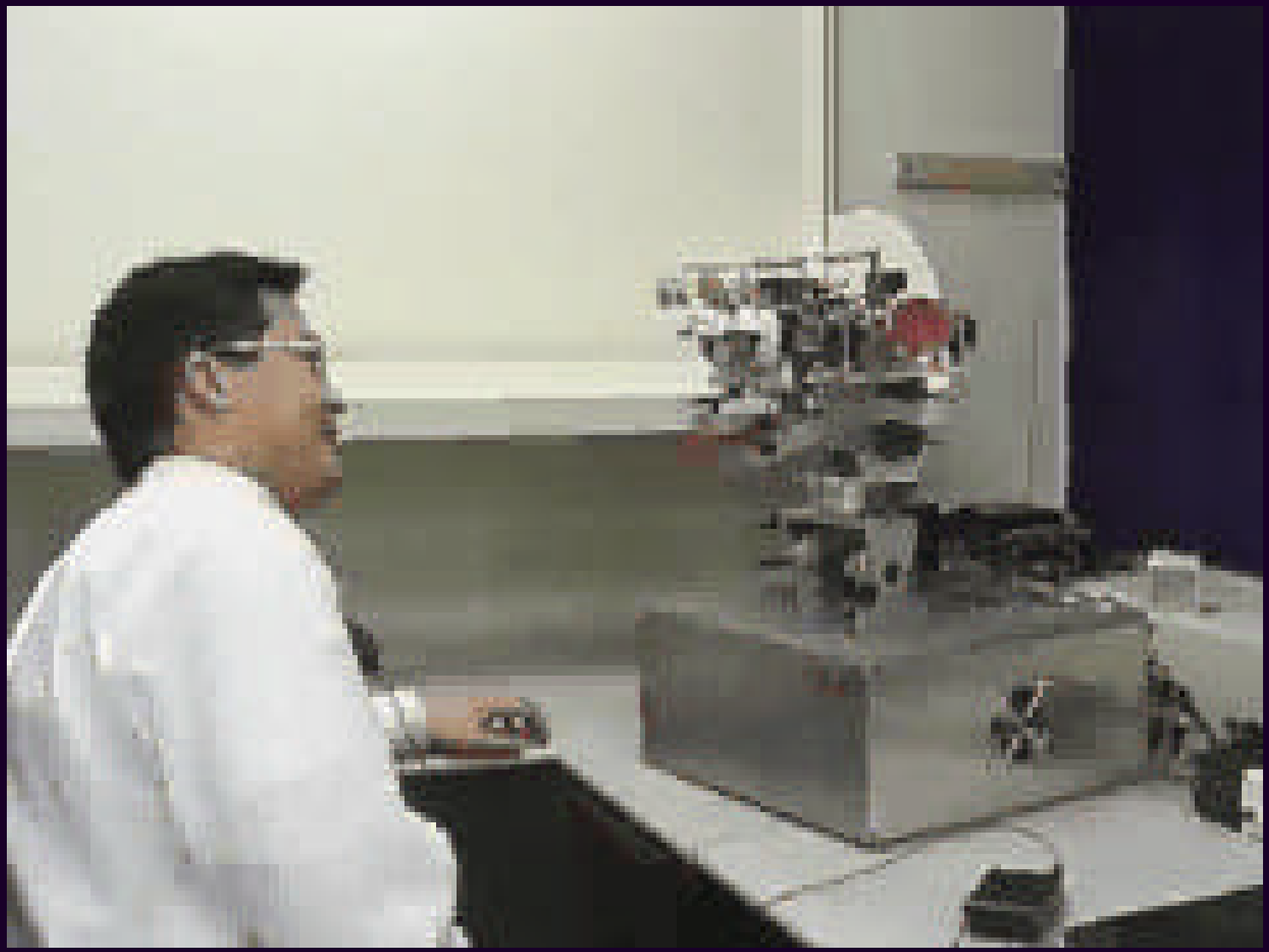
Breazeal & Aryananda, Humanoids 2000

Examples (video)

Turn-Taking

- Cornerstone of human-style communication, learning, and instruction
- Four phases of turn cycle
  - relinquish floor
  - listen to speaker
  - reacquire floor
  - speak
- Integrates
  - visual behavior & attention
  - facial expression & animation
  - body posture
  - vocalization & lip synchronization

Example (video)



Conclusions

- Robots can partake in “infant-caregiver” interactions
- These interactions are rich with scaffolding acts
- Prerequisite for socially situated learning

Kismet’s really, really, ridiculously detailed web-pages:

http://www.ai.mit.edu/projects/kismet/