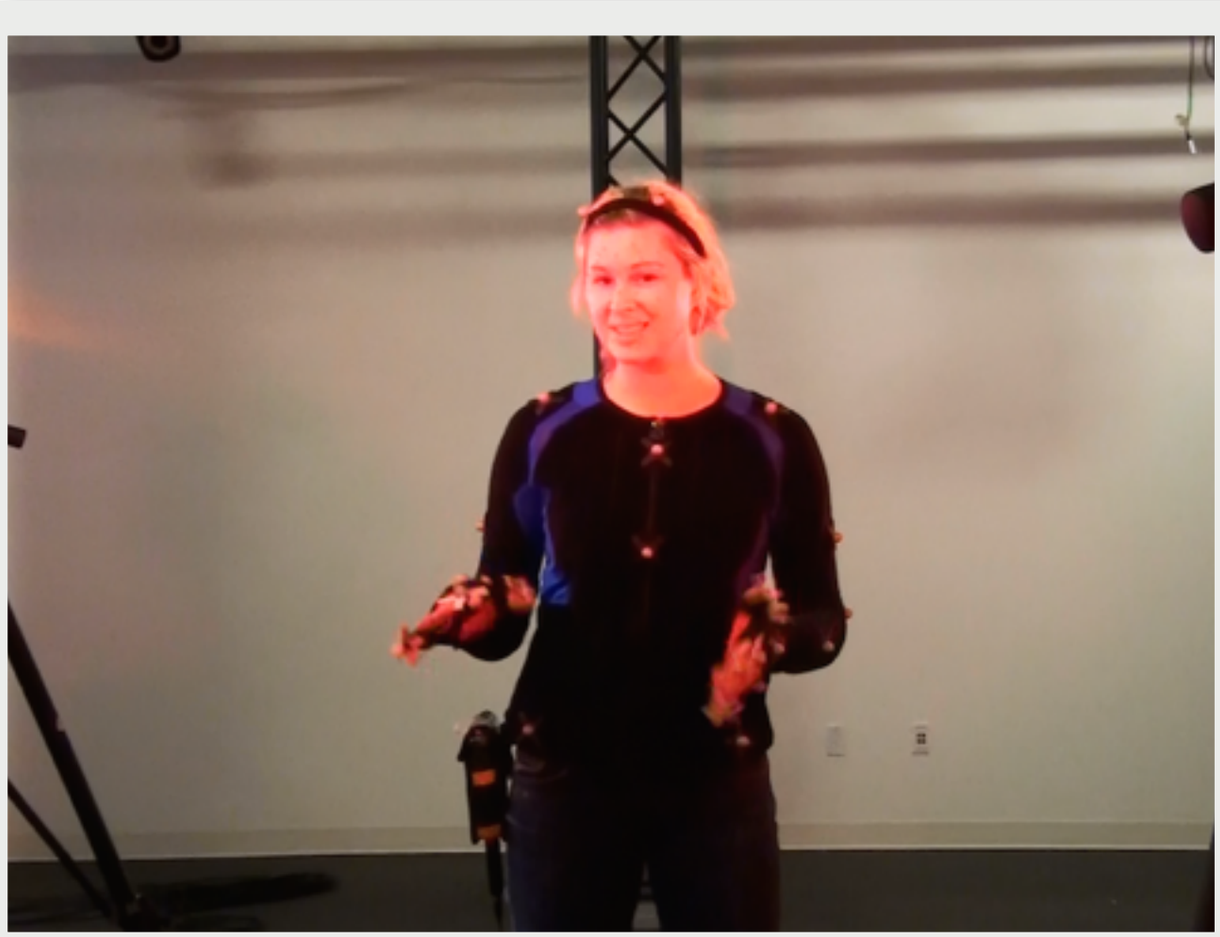
# MSP-AVATAR Corpus:

## Motion Capture Recordings to Study the Role of Discourse Functions in the Design of Intelligent Virtual Agents

NAJMEH SADOUGHI, YANG LIU AND CARLOS BUSSO



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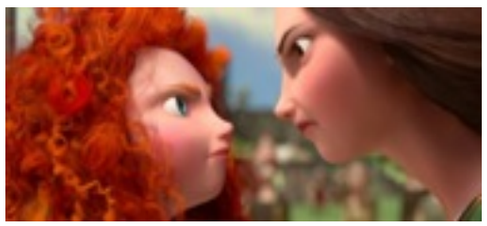
# Motivation

ICT-USC



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- Synthesizing human-like behaviors
  - Animation
  - Entertainment
  - Virtual reality
  - Tutoring/training systems
- Multiple verbal and nonverbal behaviors
  - Head motion, facial expressions, hand gestures, and body postures
  - Gesture coordinated, and synchronized with speech

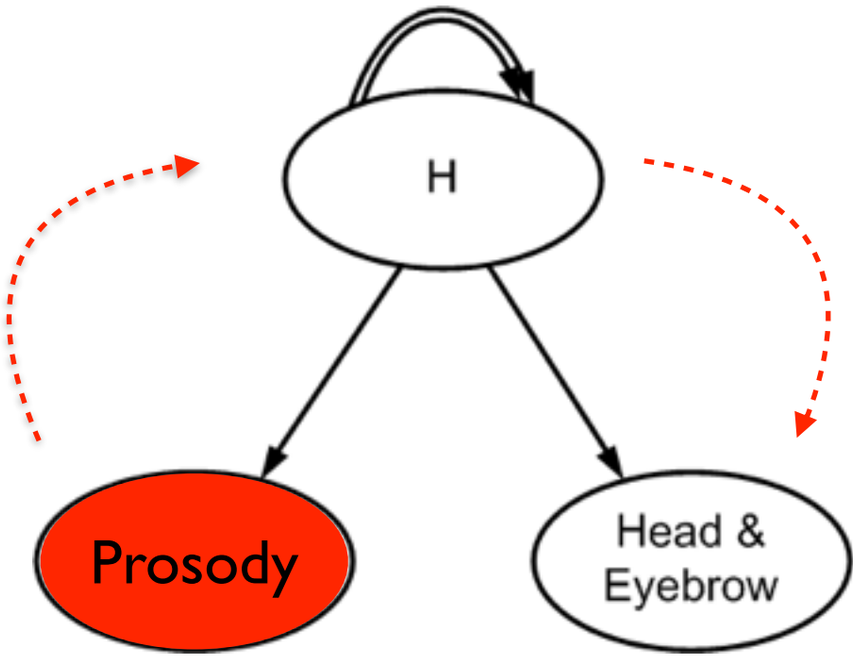
Complex relationship between gestures and speech has to be carefully considered

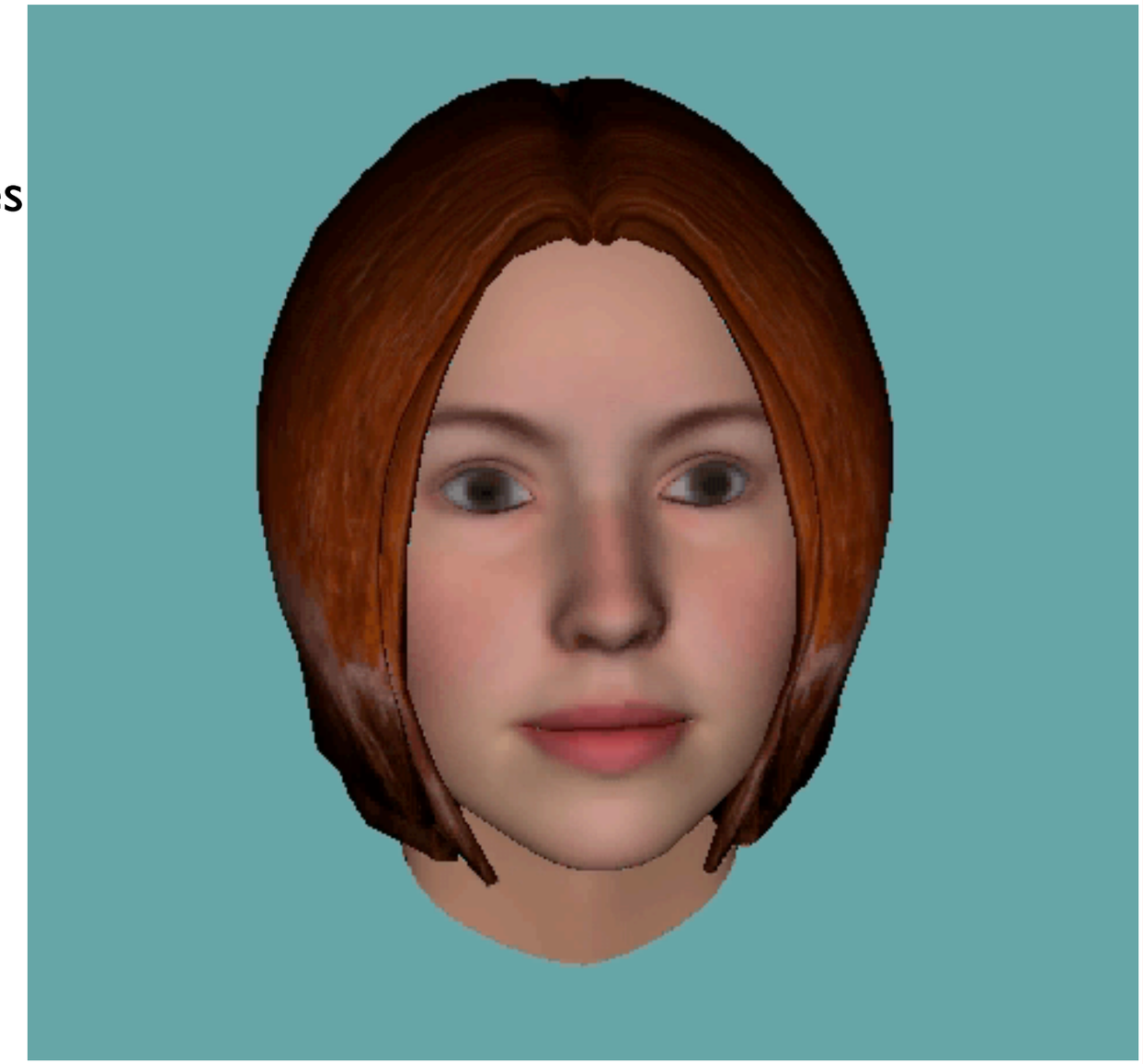
# Previous Studies on Talking Faces

- Rule-based systems [Cassell et al., 1994; S. Kopp 2006]
  - \+ Semantic meaning of behaviors (nodding)
  - \- Repetitive behaviors for a given gesture
- Data-driven methods [Levine et al., 2010; Busso et al. 2007]
  - Prosodic features are effective modalities to synthesize nonverbal human-like behaviors

# Speech-Driven Animation

- Dynamic Bayesian Models (DBNs)
  - Joint head-eyebrow discrete state variables
  - Joint continuous nodes for head and eyebrow



S. Mariooryad and C. Busso, "Generating human-like behaviors using joint, speech-driven models for conversational agents," IEEE Transactions on Audio, Speech and Language Processing, vol. 20, no. 8, pp. 2329-2340, October 2012.

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  - Prosodic features are effective modalities to synthesize nonverbal human-like behaviors
  - \+ Capturing more variability, and synchrony
  - \- Behaviors may not convey the semantics

# Our Vision

Rule-based systems

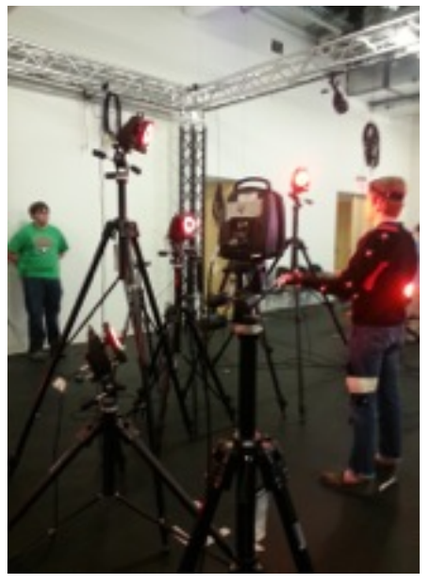
Data-driven systems

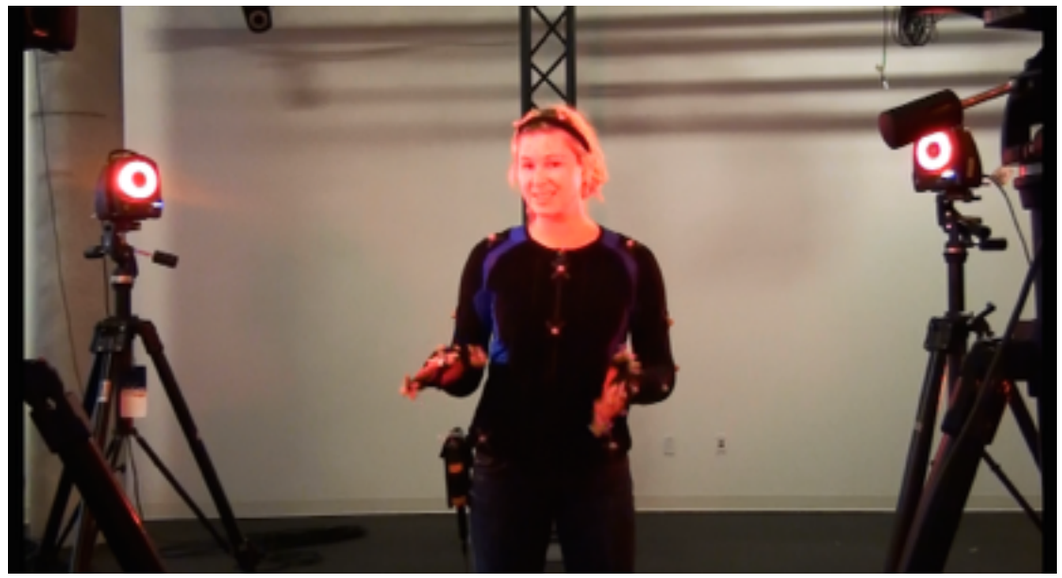
- Considering the underlying discourse function to bridge the gap between data driven and rule-based systems.
  - Synthesizing behaviors that are timely aligned with speech
  - Synthesizing behaviors that convey the right meaning

Data driven approach requires a corpus rich in discourse functions

# MSP-AVATAR Corpus

- Multimodal database comprising:
  - Motion capture data
  - Video camera
  - Speech recordings

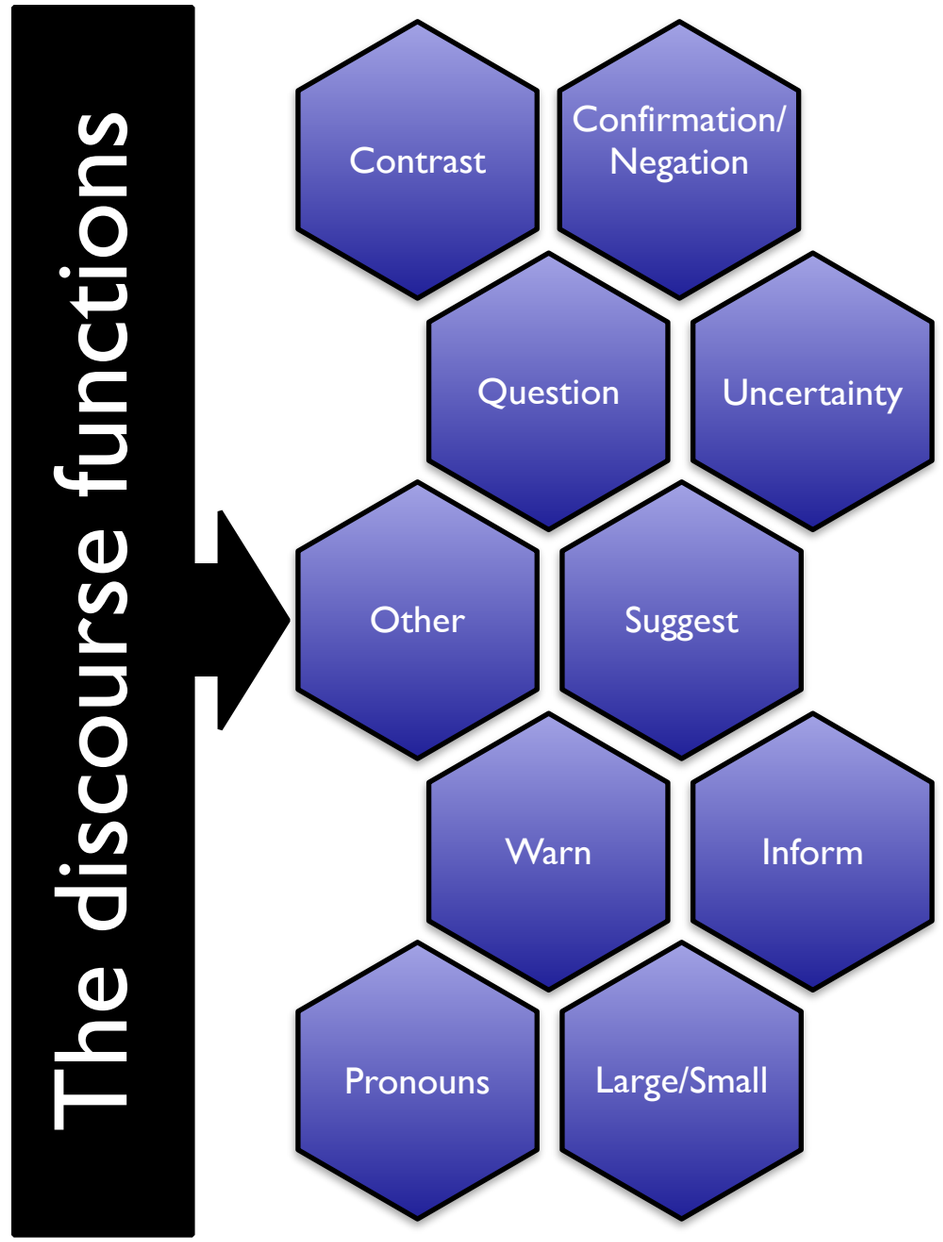




- Four dyadic interaction between actors
  - We motion captured one of the actors
- Database rich in terms of discourse functions
  - There are no corpora available to explore the role of discourse functions

# Selection of Discourse Functions

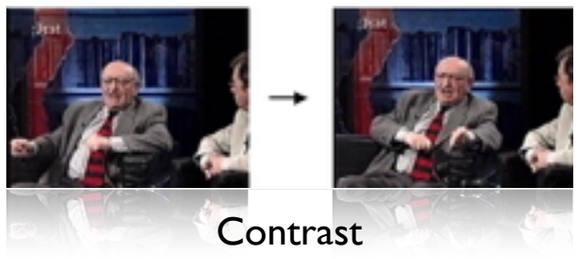
- We look for discourse functions that elicit specific gestural behaviors
- Selection guided by previous studies
  - Poggi et al [2005]
  - Marsella et al. [2013]
- 2-5 scenarios per discourse function



# Discourse Functions

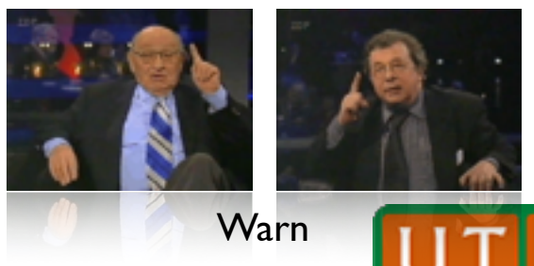
| | |
|---|---|
| CONTRAST | Contrasting two ideas, usually accompanied with contrast conjunctions such as *but, nevertheless, as, and as opposed to* |
| CONFIRMATION/ NEGATION | Showing agreement and disagreement, usually accompanied with phrases such as *Yes, No,* and *I don't think so* |
| QUESTION | Asking a question of any type: *Yes-No and Wh-questions* |
| UNCERTAINTY | Showing uncertainty in making a decision, might be accompanied by sentences such as *I really don't know what to do!* |
| SUGGEST | Suggesting ideas to the listener, e.g., *How about the new Japanese restaurant?* |
| GIVING ORDERS | Ordering any type of service, e.g. *ordering food in a restaurant* |
| WARN | Warning the listener of a danger, e.g. *Be careful about …* |
| INFORM | Inform something to the listener |
| LARGE/SMALL | The act of referring to something as small or large during speaking. These scenarios target iconic gesture usually accompany these two words or any of their synonyms |
| PRONOUNS | The act of referring to any pronoun (I/You/She/He/They). These scenarios target deictic gestures |


Pronouns


Contrast

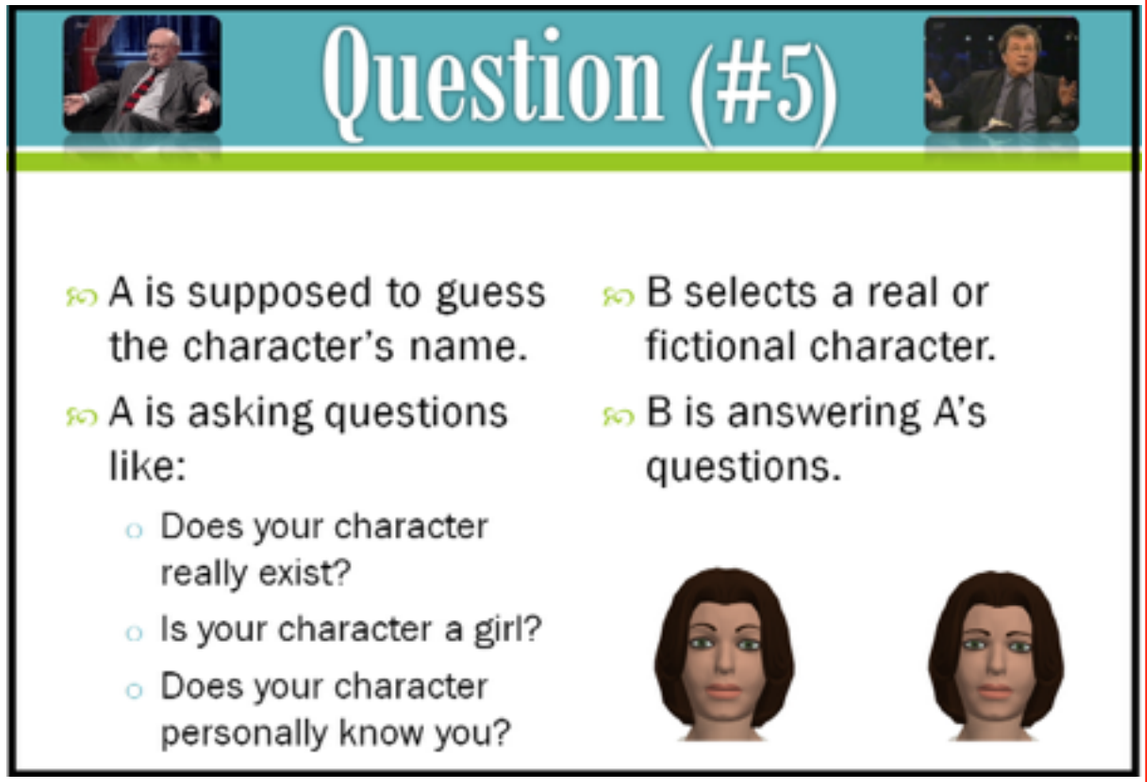

Question


Small/Big


Warn

# Scenarios

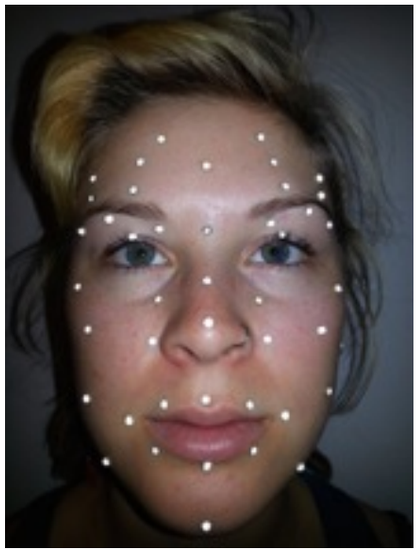
- Scenarios designed to elicit characteristic behaviors
  - Description of the scenario
  - Prototypical behaviors associated with target discourse function

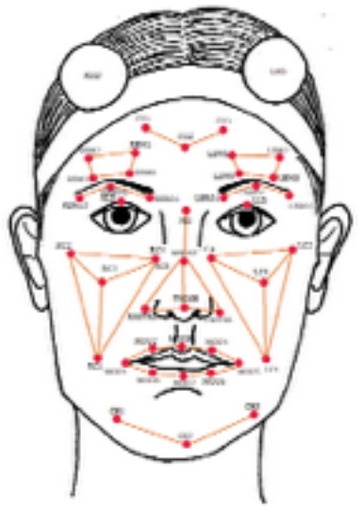


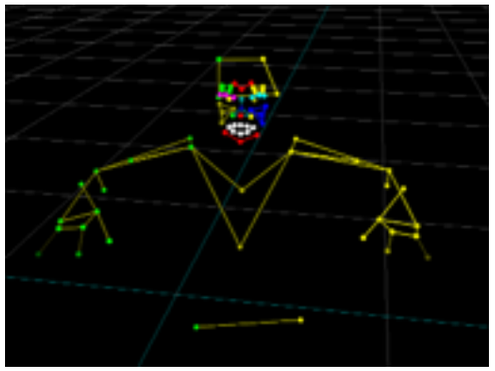

- Duration of the recorded scenarios:
  - MEAN = 143.1 sec, STD = 74.7 sec.
  - 21, 15, 22, and 16 scenarios (74 in total), based on pace of the actors

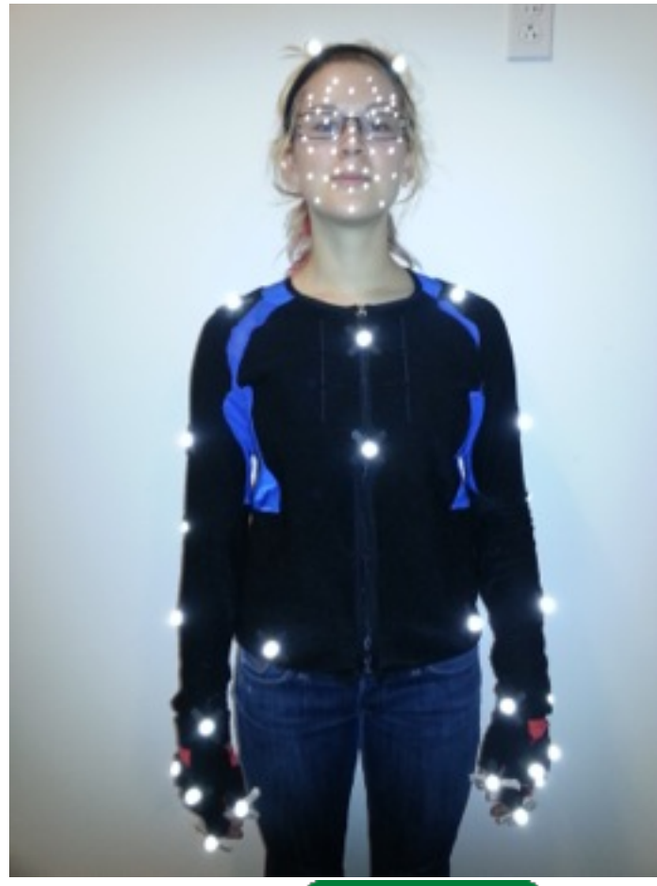
# Motion Capture

- 16 VICON cameras
- Face:
  - 43 reflective markers
- Upper-body joints:
  - Headband with 4 markers
  - Suite with 28 marker







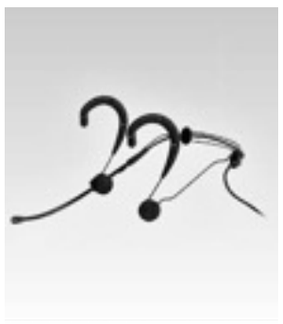


Recording "upper-body", and "facial"!

# Audio

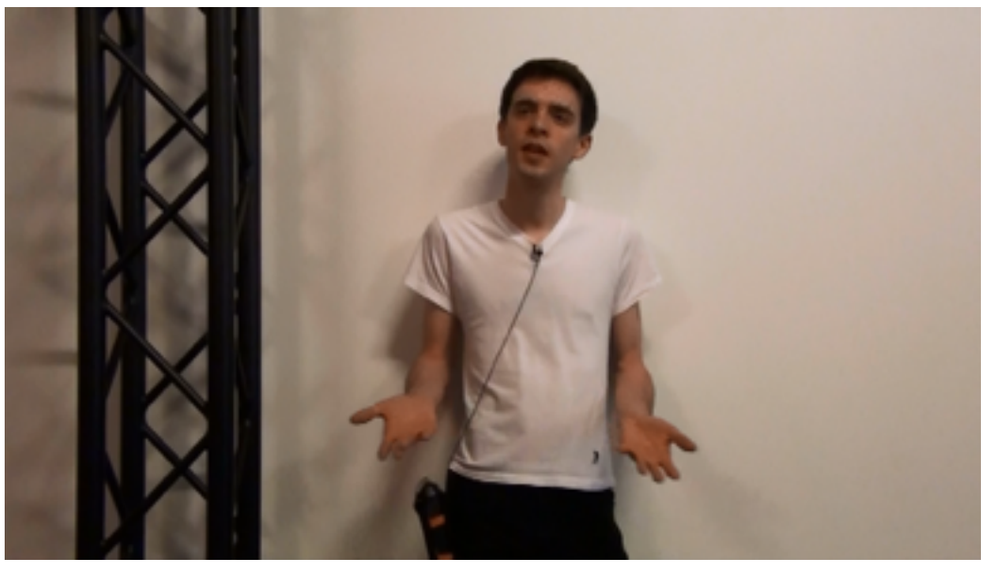
- Audio-visual data for all actors (6 people)
- Microphone connected to a digital recorder (TASCAM DR-100MKII)
  - 16 bit resolution
  - Sampling rate of 44.1 kHz

- First session: head-worn microphone (SHURE BETA 53)
  - Occluded some of the facial markers
  - Making the post-processing more difficult



- Next two session: lavalier microphone (SHURE MX150)

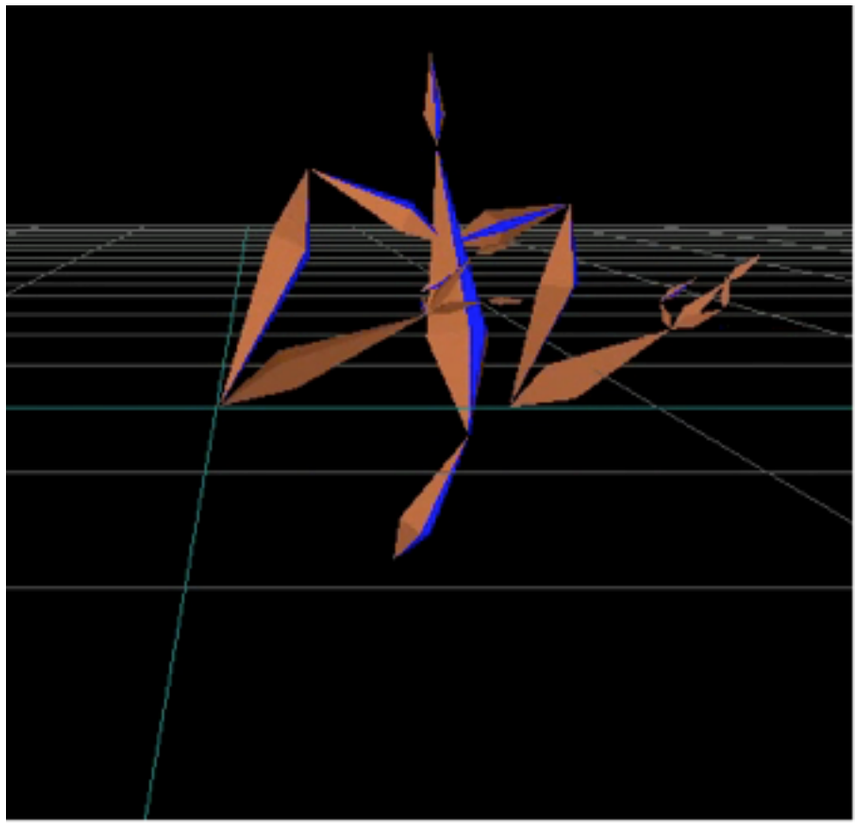
# Video

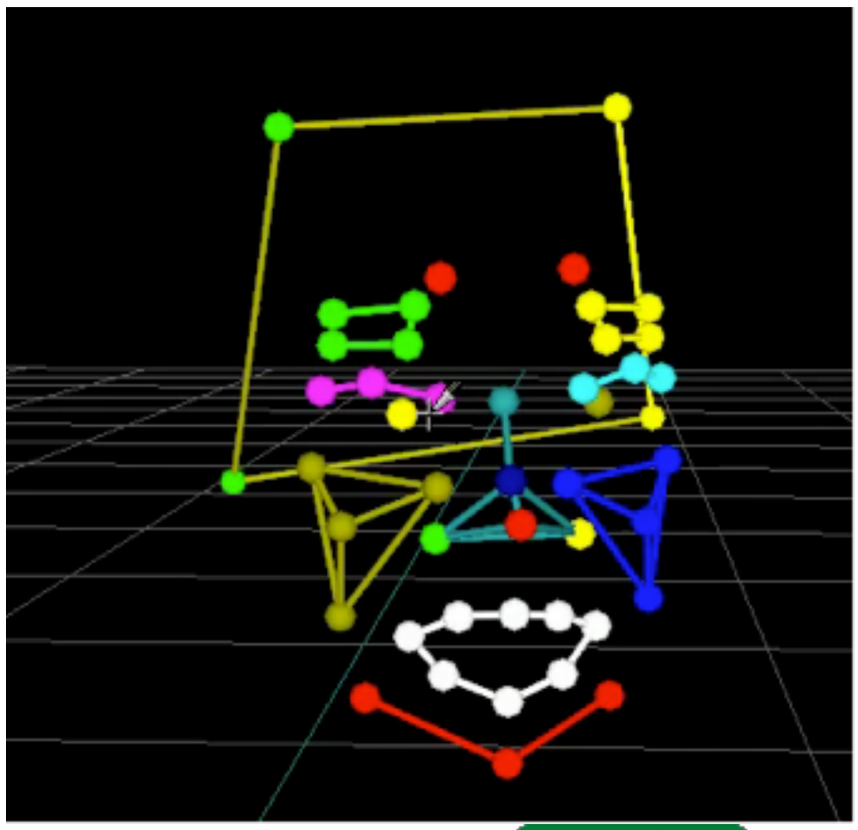


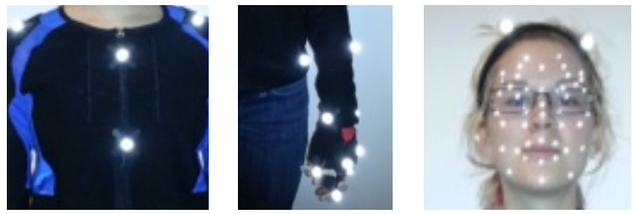
- Frontal view of both actors
- Two Sony Handycams HDR-XR100
  - 1920x1080 resolution in Full HD
- We use these videos to annotate the behaviors
- They can be used in extracting visual features from both actors
- We use a clapboard with two reflective markers to synchronize audio, video and motion capture data

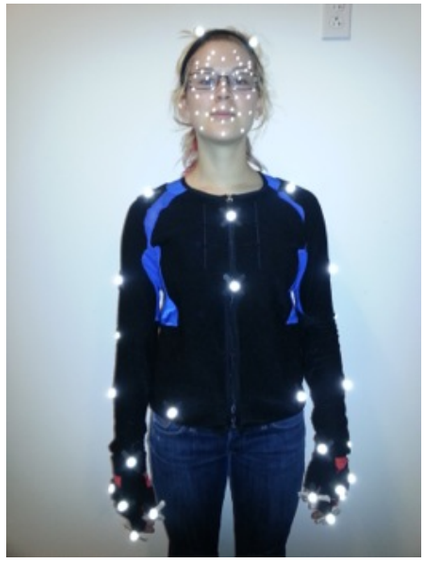
# Post Processing

- Cleaning the motion capture data
  - Blade (VICON)
- Skeleton personalized for each actor
- Upper-body skeleton
  - 74 scenarios (all sessions)
- Facial markers
  - Only 3 scenarios



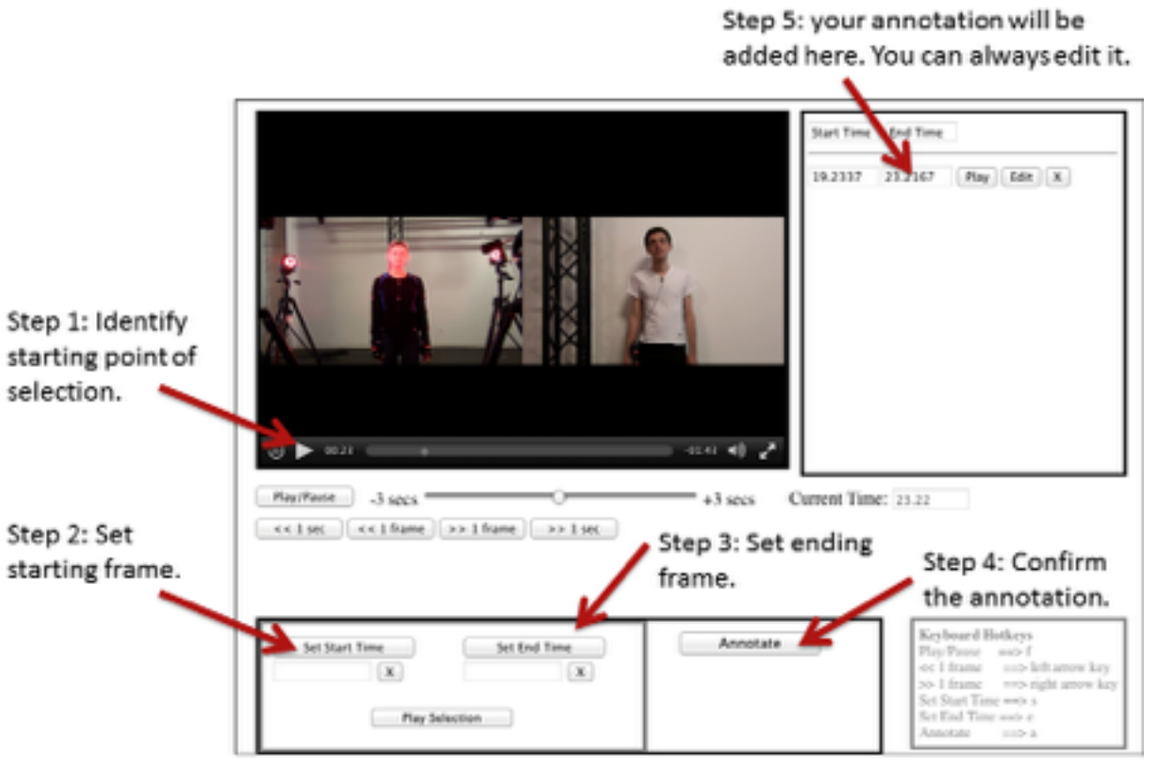






# Discourse Functions

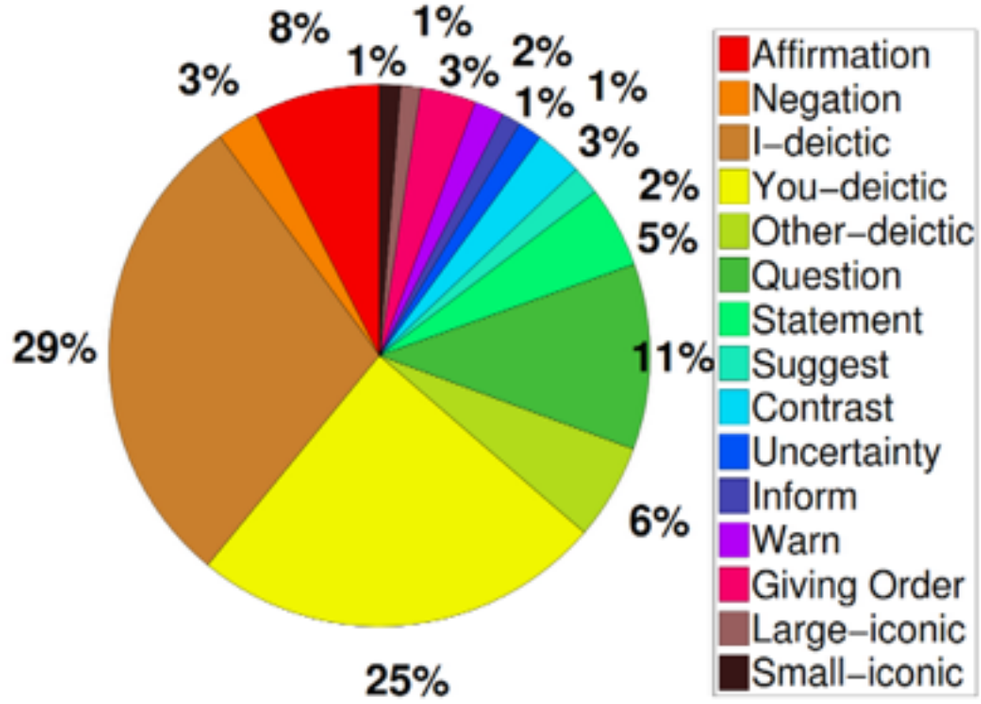
- Annotate discourse functions within speaking turns
- All annotations are done by one person, using Audacity
- We have 1751 samples
  - UPDATE: We are currently getting annotations by more people using AMT with OCTAB [Sunghyun et al., 2014]




1 . Park, Sunghyun, Philippa Shoemark, and Louis-Philippe Morency. "Toward crowdsourcing micro-level behavior annotations: the challenges of interface, training, and generalization." *Proceedings of the 19th international conference on Intelligent User Interfaces*. ACM, 2014.

# Discorse Functions in MSP-AVATAR

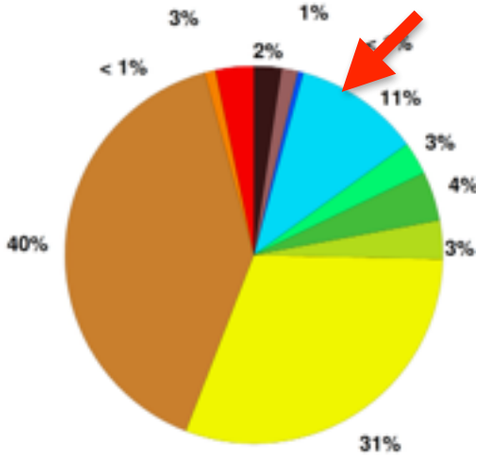
- Some discourse functions appears in most scenarios
  - I-deictic
  - you-deictic
  - questions



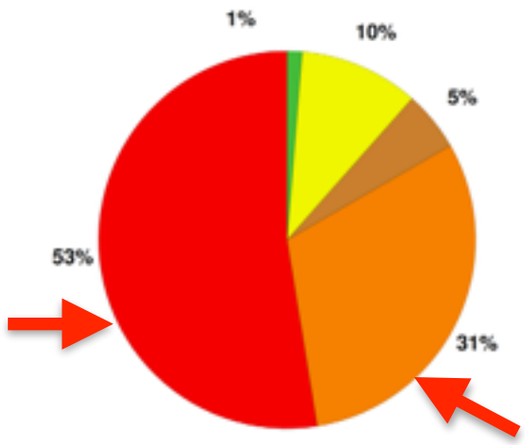

- We have multiple instances of the most relevant discourse functions

# Discorse Functions in MSP-AVATAR

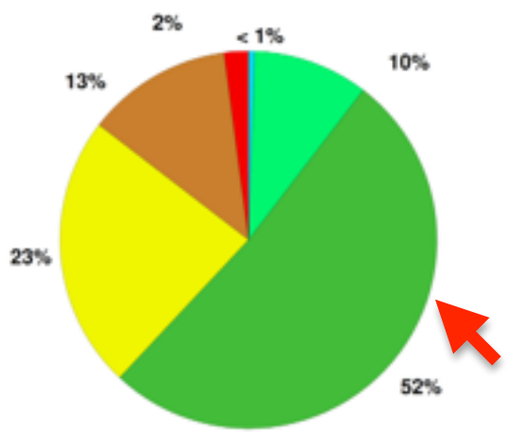
- The scenarios successfully elicited the target discourse functions



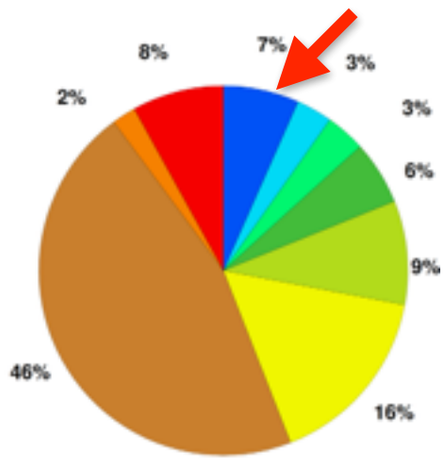

(a) Contrast



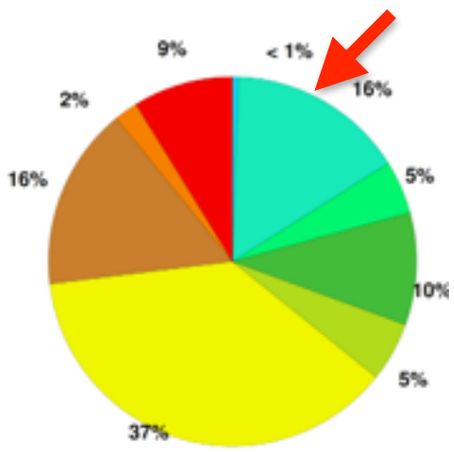

(b) Affirmation/Negation



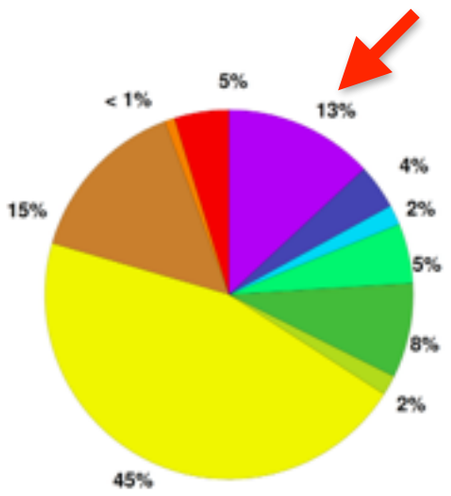

(c) Question




(d) Uncertainty



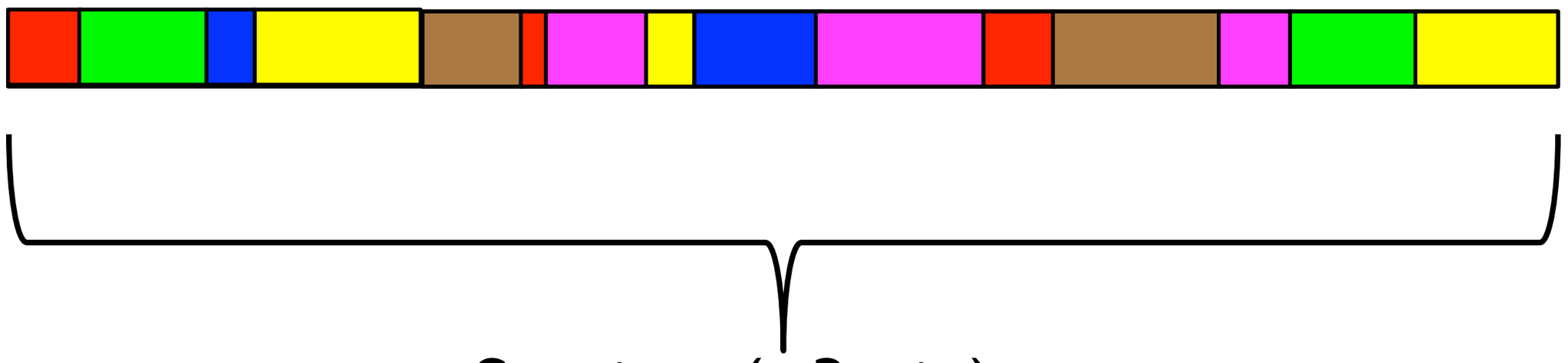

(e) Suggest




(f) Warn

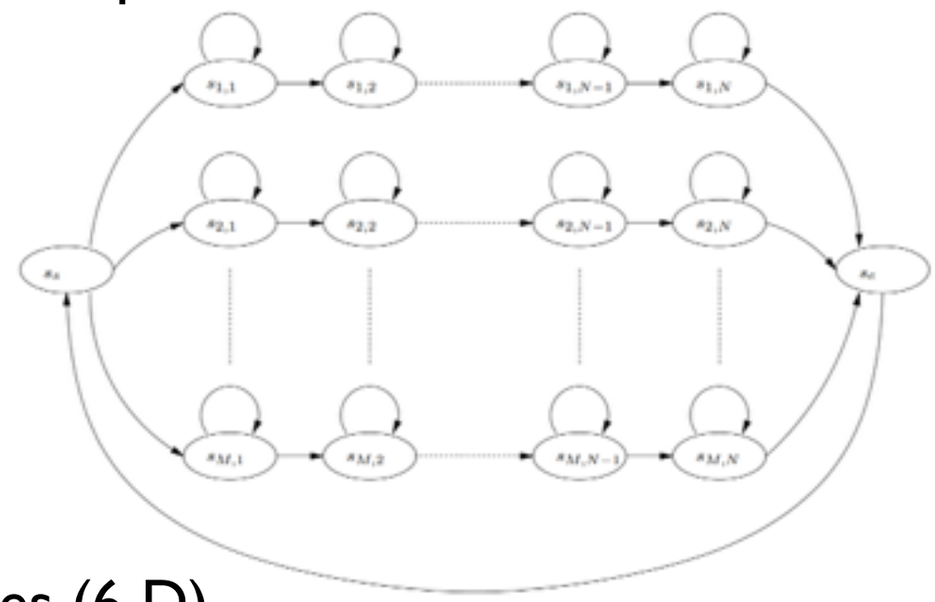
# Analysis of body movements

- Are the gestures different across discourse functions?
- We focus on hand and head gestures
  - We only have facial features of 3 sessions
- We rely on automatic unsupervised segmentation of gestures
  - Data-driven mid-level classes



# Parallel Hidden Markov Models

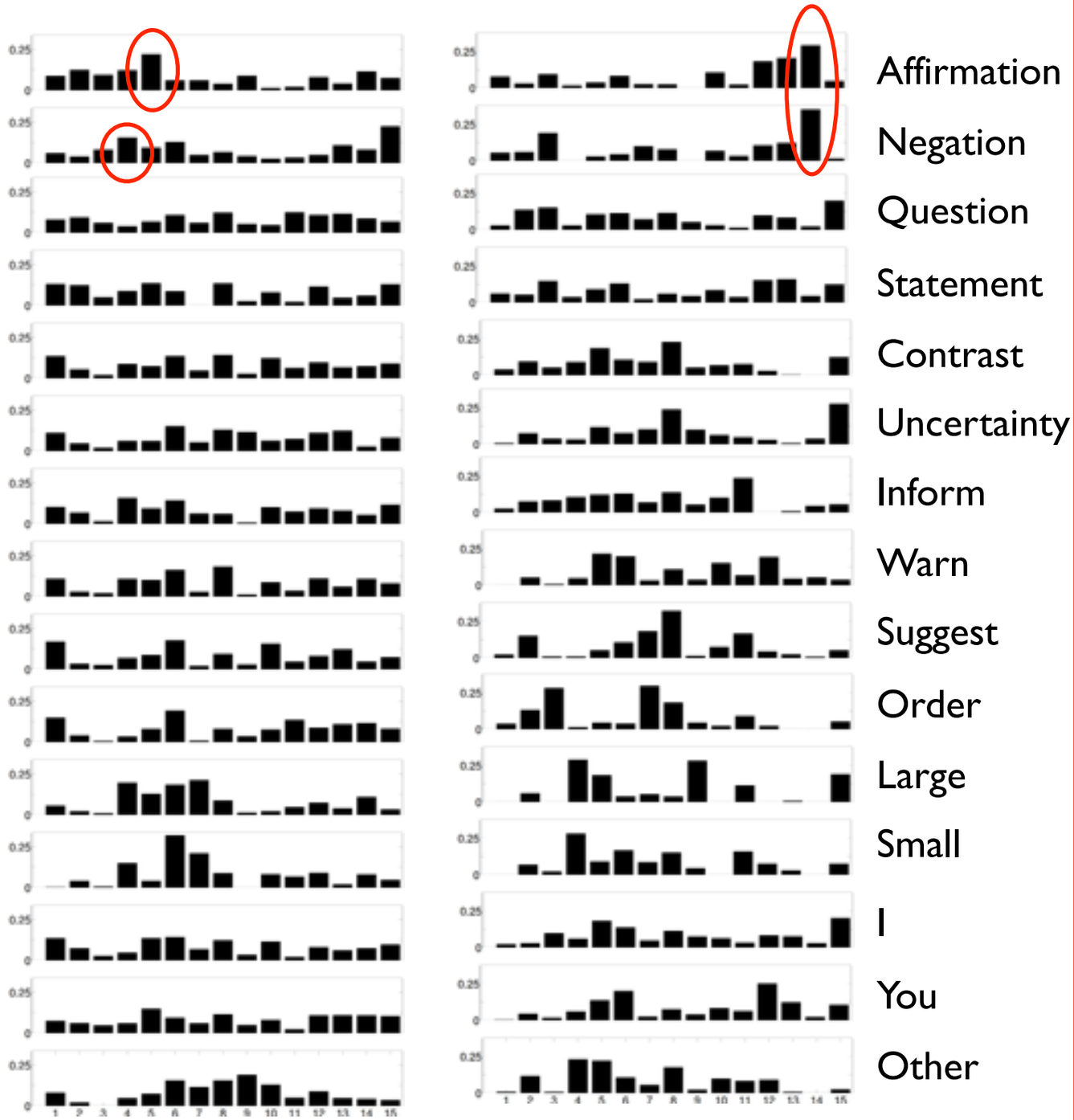
- Cluster the behaviors using PHMM
  - Individual left-to-right HMMs
  - States within the branches have self transitions
  - Model dynamic behaviors having different temporal durations
- #states per branch = 15
  - Minimum duration: 125 ms
- 15 branches for both head and hand
- Analysis on head, and arms movements
  - Head: three angular rotations + derivatives (6 D)
  - Arms: angular rotations + derivatives (20D)



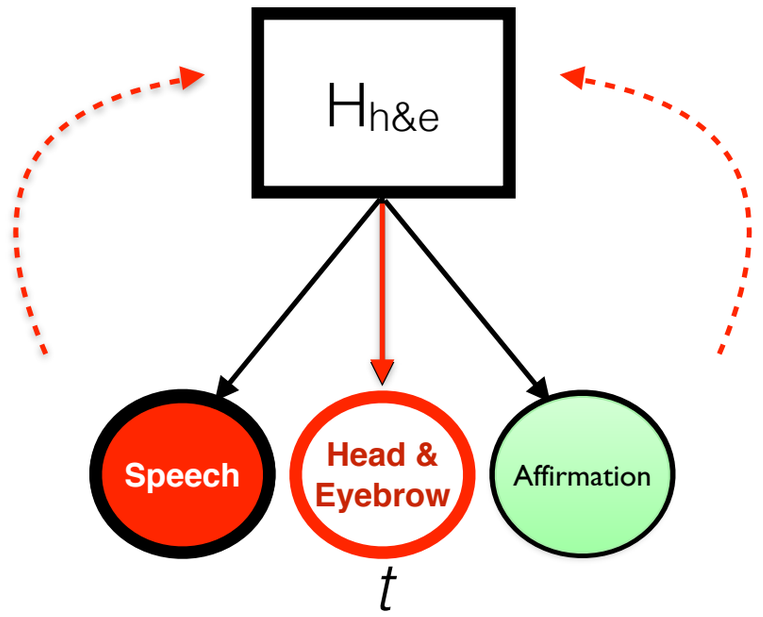
M. E. Sargin, Y. Yemez, E. Erzin, and A. M. Tekalp. Analysis of head gesture and prosody patterns for prosody-driven head-gesture animation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 30(8):1330–1345, 2008.

# Analysis of Head Motion and Hand Gestures

- Different gestures across discourse functions
- Hand: *affirmation* and *negation* have a distribution with a peak in cluster 14
  - Hand gesture less active
- Head: peak in *affirmation* relate to head nod (cluster 5)
- Head: *negation* include head shakes (cluster 4)



# Constraining DBNs with Discourse Functions




Constrained on Affirmation

# Conclusions

- This paper introduces the MSP-AVATAR database
- This corpus comprises video and audio of 6 actors and motion capture recording of 4 actors in dyadic conversations
- Scenarios are designed such that they elicit the behaviors associated with discourse functions
- One drawback of this corpus is small number of subjects that were motion captured
- We expect to release the database after finishing the correcting process of motion capture recordings

http://ecs.utdallas.edu/research/researchlabs/msp-lab/MSP-AVATAR.html

# Multimodal Signal Processing (MSP)

- Questions?


**http://msp.utdallas.edu/**