# Interacting with Socially Interactive Agents


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# Social Interactive Agents

Virtual characters that can:

- simulate cognitive and expressive human capabilities
- communicate using verbal and nonverbal  means
- display a wide range of socio-emotional behaviors
- be socially aware and emotionally competent
- be capable of holding multi-modal social interactions

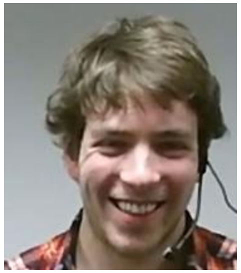
# Nonverbal Behaviors

Nonverbal behaviors:

- have a communicative function
- have different meanings; context dependent
- are socially shared
- may be intentional or not  (scratching one's head because it hitches is not a NVB)

They are dynamic, multimodal, transient

- Facial expression, Gesture
- Gaze, Posture
- Voice, Touch





# Metaphoric gestures

GESTURE GENERATION FROM IMAGE SCHEMAS

BRIAN RAVENET, CHOÉ CLAVEL, CATHERINE PELACHAUD

# Metaphoric Gesture

Metaphoric gestures: convey abstract concepts through the physical behavior of a gesture, its form and motion.

Communication of message

- Build from concrete elements, the properties of those elements and actions on them.

Eg:

*Anything* = set of items

Hands and head → delineate space of items

# Metaphoric Gestures

Autonomously generate meaningful and coordinated verbal and nonverbal behaviors:

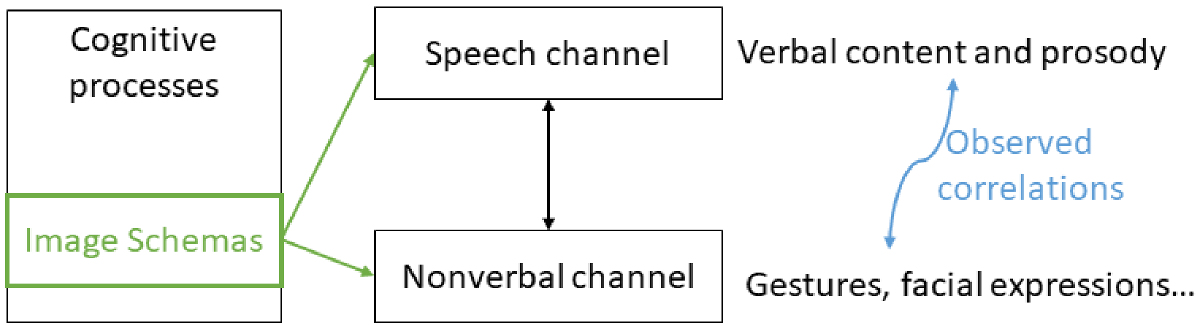
- From the textual surface discourse of the agent augmented with prosodic information (e.g. pitch accents), compute:
  - timing (when to place a gesture)
  - shape (which gesture form and movement)
- Capture mental imagery from text and map it into gesture

# Image Schemas

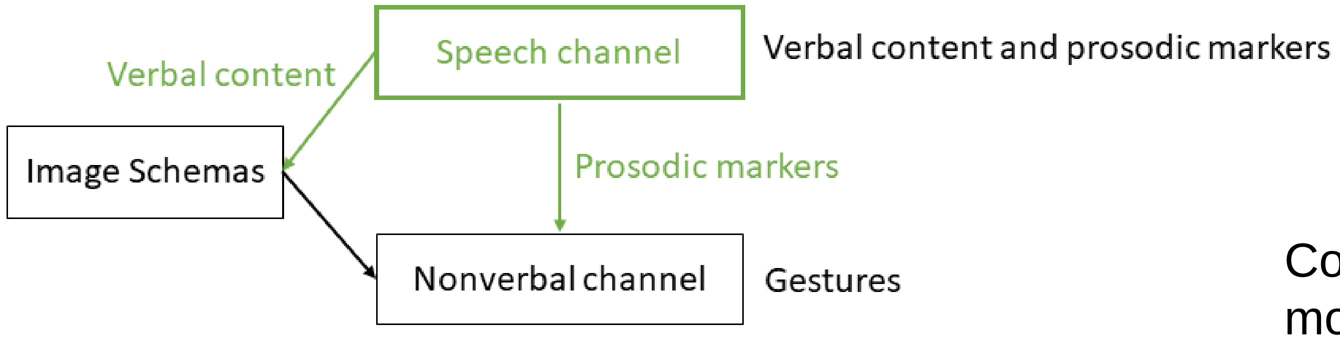
Image Schemas: allows for manipulation of spatial, temporal and compositional concepts (container vs object and whole vs split for instance).

- Image Schemas
  - gestural grammar (Mehler, Lücking, Abrami, 2015): bridge between natural language and gesticulation.
  - can be used to drive gesture (Cienki, 2005)
- Examples
  - UP, DOWN, FRONT, BACK, LEFT, RIGHT, NEAR, FAR, INTERVAL, BIG, SMALL, GROWING, REDUCING, CONTAINER, IN, OUT, SURFACE, FULL, EMPTY, ENABLEMENT, ATTRACTION, SPLIT, WHOLE, LINK, OBJECT.

# Computational Model




Theoretical model




Computational model

# Metaphoric Gesture - Example

Idea = concrete object with physical properties, such as size, location or weight

Example:

- Important idea = an object big in size
- Ideas can be thrown away
- Ideas can be hold tightly
- Ideas can be made visible

# Extract Image Schemas from the text

*"idea to rise to the surface"*

Textual speech of the agent → Extract Image Schemas → Associate Image Schemas to Gesture Primitives → Combine primitives into ideational units → Produce co-verbal metaphoric gestures

# Extract Image Schemas from the text

*"idea to rise to the surface"*

OBJECT PATH UP

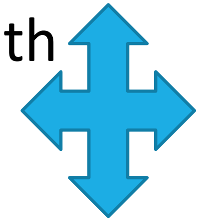
Textual speech of the agent → Extract Image Schemas → Associate Image Schemas to Gesture Primitives → Combine primitives into ideational units → Produce co-verbal metaphoric gestures

# Associate Image Schemas to gesture primitives

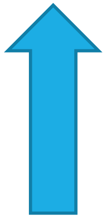
Based on Geneviève Calbris

- Object

- Path



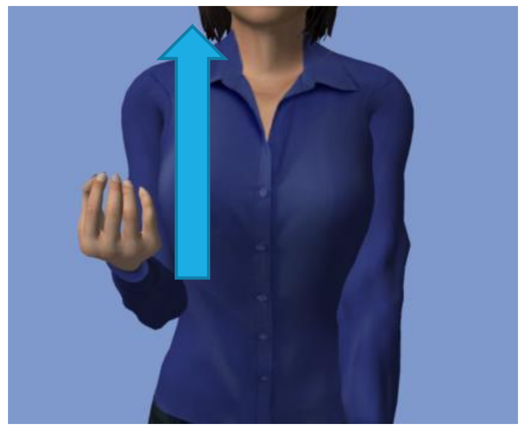
- UP



Textual speech of the agent → Extract Image Schemas → Associate Image Schemas to Gesture Primitives → Combine primitives into ideational units → Produce co-verbal metaphoric gestures

# Associate Image Schemas to gesture primitives

« idea | to rise | to the surface »
--- | --- | ---
OBJECT | PATH | UP



Ideational Units (Xu et al. 2014

Textual speech of the agent → Extract Image Schemas → Associate Image Schemas to Gesture Primitives → Combine primitives into ideational units → Produce co-verbal metaphoric gestures

# Combine the primitives into ideational units


Textual speech of the agent → Extract Image Schemas → Associate Image Schemas to Gesture Primitives → Combine primitives into ideational units → Produce co-verbal metaphoric gestures

# Interaction

Build socially interactive agents:

- Able to manage the impression it gives on users
- Optimize engagement
- Manage interpersonal relationship


In order to enhance user’s perception of SIAs

Focus on adaptation mechanisms

# Adaptation

During interaction, several mechanisms of adaptation occur to

- Favor engagement
- Enhance user's experience
- Signal interpersonal relationship
- Increase rapport
- Establish trust
- …

Can be signaled through:

- Imitation, backchannel, verbal alignment, synchronization

# Adaptation

How an agent able to perceive user's state and to adapt to her state affects user's perception?

How does it impact user's perception of her interaction with the agent?

Conduct studies where agent adapts to user to enhance engagement or impression

Studies

- Adaptation of body movement
- Adaptation at nonverbal behaviors level
- Adaptation at conversational strategies level
- Adaptation at cues level

# Laughter

Laughter is an essential social signal in human-human communication.

It is a social vocalization universal across cultures and languages

It can convey various functions:

- Feedbacks to humorous stimuli or praised statements
- Mask embarrassment
- Reinforce bonding
- Social indicator of in-group belonging [Adelsward 1989]
- Speech regulator during conversation [Provine 1996]
- Elicit interlocutor’s laughter [Provine 1996]

# LoL – Laugh out Loud

## Pecune & Mancini

Study impact of laughter on human experience during a human-agent interaction

Effect of dynamic coupling between interactants → enhances sense of engagement (Prepin et al., 2012)

Behavior expressivity conveys affective content (Castellano et al, 2012)

Copying paradigm: copying the expressivity dynamically as it evolves in human's performance.

AIM: Study how a virtual agent able to copy and to adapt its laughing and expressive behaviors on the fly participates in enhancing user's experience in the interaction.

# LoL – Laughing out Loud
## Pecune & Mancini

# LoL – Evaluation study
## Biancardi

Context

- 32 participants listen to funny music first without then with a virtual agent.
- Conditions: The agent can laugh performing a prefixed behavior, or copying user's laughter intensity.
- Evaluate user's perception of music funniness
- Evaluate user's mood during the experience
- Evaluate social and spatial presence, and believability of the virtual agent

Results

- Participants perceived the music as **funnier** when the agent **was present and copied** user's laughter intensity, than when they listened to the music alone;
- Participants' mood was **more positive** when the agent **was present and copied** user's laughter intensity, than when they listened to the music alone;

# Overall Architecture

## Mancini, Wang

User's analysis

Agent's behavior

Dialog model

Adaptation mechanism

# Scenario
## Biancardi

Agent = virtual guide of an exhibit on video games

Location: Museum of Sciences and Industry at La Villette, Paris

Participants: museum visitors

3 stages

- Pre-questionnaire: NARS. apriori attitude of participants towards the agent
- Interaction with agent
- Post-questionnaires:
  - Perception of agent
  - Interaction quality

# Scenario
## Biancardi

e-LAB ESPACE JEU VIDEO

cité des sciences & de l'industrie

# Study 1: Adapting agent’s behavior according to user’s impressions
## Biancardi, Mancini, Wang

Goal: Let agent learn the best combinations of nonverbal behaviors according to its goal to be perceived as warm or socially competent

Detection of user’s impressions of agent’s warmth and competence → from the analysis of their facial expressions. (C. Wang et al, 2019)

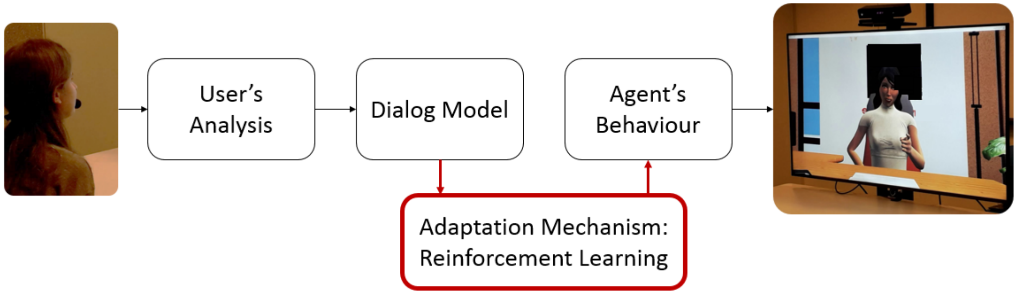
Agent’s impression manager: Flipper, dialog manager + Reinforcement learning

→ verbal and non-verbal behaviors agent displays next

→ rewards: detected impressions

Communicative Intention

- Types of gestures
- Arm rest position
- Smile
- Verbal



# Experiment

## Biancardi


Interaction with a virtual guide at Museum of Sciences and Industry at La Villette,

- 71 participants
- 3 conditions:
  - **Warmth**, when the agent adapted its behaviors according to user's warmth impressions, with the goal to maximize its warmth;
  - **Competence**, when the agent adapted its behaviors according to user's competence impressions, with the goal to maximize its competence;
  - **Random**, when the model was not exploited and the agent randomly chose its behavior, without considering user's reactions.

pre-questionnaire: NARS

post-questionnaires:

- Perception of Warmth & Competence: using 4 adjectives for each
- Perception of interaction

# Results
## Biancardi

Adaption at behavior level to maximize participant's impression

Capture behaviors that play a role in impression formation

Significant results for the *competence* condition

But did not manage to change user's negative apriori (NARS) on agent's warmth

But

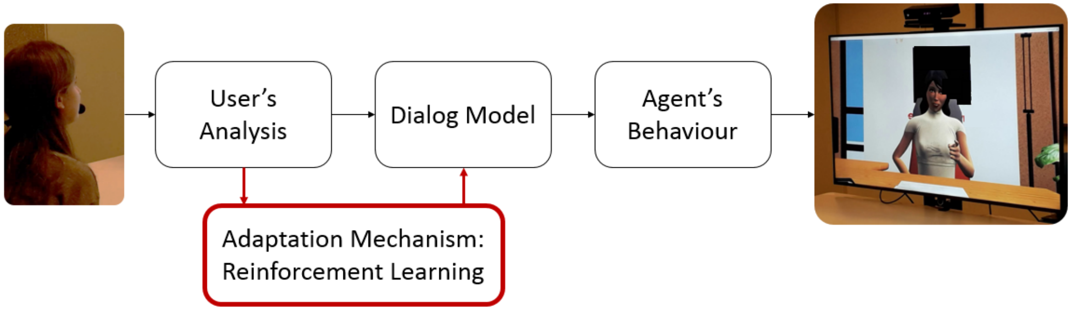
No assured behaviors coherency across turns

No consideration of conversational strategy

# Study 2: Adapting agent's strategies
## Biancardi

Goal: Let agent learn the best combinations of conversational strategies according to its goal to engage user.

Conversational strategies linked to warmth and competence




Reinforcement learning:
- Conversational strategy
- Reward function: user's engagement

# Conversational Strategies

**Conversational strategies**:

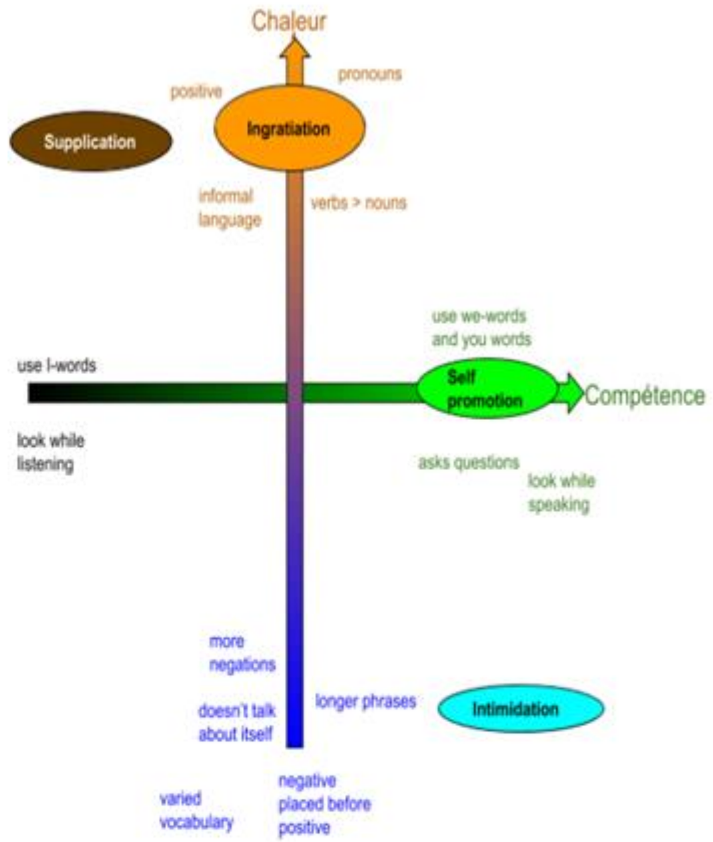
use of you- and we-words, the level of formality of the language, the length of the sentences.

Example:

Intention: explain a topic

**Supplication**: “I think that while you play there are captors that measure tons of stuffs!” accompanied by smiling and beat gestures

**Intimidation**: “While you play at video games, several captors measure your physiological signals.” accompanied by ideational gestures without smiling




Jones & Pittman, Pennebaker, Callejas

# Experiment
## Biancardi


Interaction with a virtual guide at Museum of Sciences and Industry at La Villette, Paris

- 75 participants
- 6 conditions: adaptation, random, ingratiation, supplication, self-promotion and intimidation

Results:

Primacy of warmth dimension:

- Supplication, ingratiation: agent appears warmer
- Self-promotion: same level of warmth as supplication and ingratiation → halo effect with competence

Stronger impact of negative impression over positive one (Peeters and Czapinski, 1990)

- Intimidation: agent appears colder

Interaction quality: adaptive agent increases user's engagement and user's preference

# Study 3: Adapting agent’s behavior to user’s cues

## Dermouche

Aim: develop a computational model that

- Captures the adaptation of interactants at the cues level
- Predicts agent’s behavior taken into account user’s cues
- Conveys agent’s communicative intents

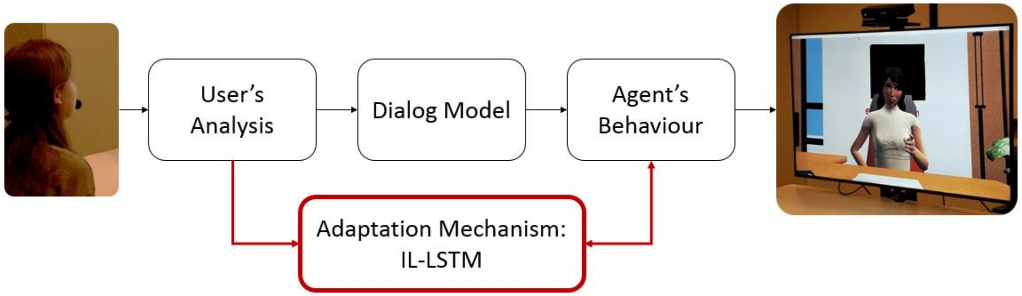
Steps:

- Analyze behavior adaptation in human-human interaction
- Predicts agent’s behaviors from user’s ones
- Merge agent’s behaviors from its intentions with the predicted behaviors

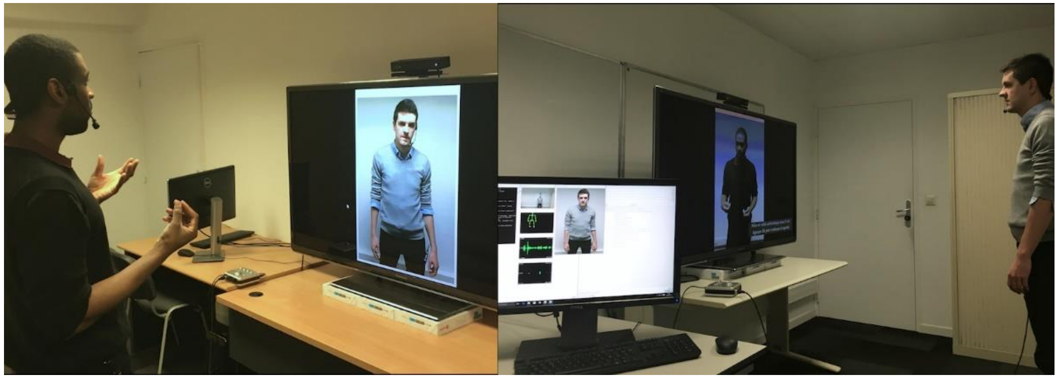
# Study 3: Architecture
Dermouche

## Adaptation mechanism

- IL-LSTM: predict behavior from learned model
  - Input:
    - user's detected behavior
      - smile, head and gaze
    - Agent's previous behavior
  - Output:
    - Agent's predicted behavior
  - Merge predicted behavior and communicative behavior of agent



# Prediction Model
## Dermouche



Corpus: NoXi

- Smile activation and intensity
- Head rotation
- Gaze direction
- Conversational state: who speaks

Prediction Model: IL-LSTM

Input:

- Time window of 20 frames of both humans A's and B's behaviors

Output:

- Next human B's behaviors

# Prediction Model
## Dermouche

Input:

- Time window of 20 frames of user’s and agent’s behaviors

Model: IL-LSTM

Output: next agent’s frame

- (f0, ..., f20) → f21
- (f1, ..., f21) → f22
- (f2, ..., f22) → f23

# Evaluation
## Dermouche

Same scenario

Same location

5 conditions:

- *REF*: agent does not adapt its behavior.
- *HEAD*: agent adapts its head rotation according to the user's behavior.
- *SMILE*: agent adapts its smile according to the user's behavior.
- *GAZE*: agent adapts its gaze according to the user's behavior.
- *ALL*: agent adapts its head rotation, smile, and gaze according to the user's behavior.

# Experiment
## Dermouche

101 participants (50 F)

Results: unpaired t-tests

Compared to REF condition, agent in *SMILE* condition is evaluated as:

- more friendly ($p = .01$)
- more involved ($p < .01$),
- less distant ($p < .01$)
- more satisfied ($p = .01$)

Idem for agent in *ALL* condition

Agent in *HEAD and EYE* condition: not validated

Effect of user's apriori (NARS)

# Conclusion

Validation for SMILE

For other modalities: users stared at screen, so they did not move their head and gaze

→ agent adapted its head and gaze behaviors to user’s ones

→ agent did not move head and gaze

Future:

need to validate with measure

- user’s behaviors
- synchronization between interactants
- behaviors coupling

# Adaptation - Conclusion

Presentation of studies that model different aspects of adaptation

- Body movement
- Behaviors
- Strategies
- Cues

Need to model complex phenomena such as rapport building, empathy…

# Social Touch

## Boucaud - Thouvenin

- Study touch in human-agent interaction in virtual reality
- Functions of social touch
  - Attract attention
  - manage turn taking
  - Backchannel
  - Emotional emphasis
  - Encourage
  - Comfort
  - Calm
- Develop a decision model to trigger when
  - Agent can touch human
  - When and with which touch
- Evaluate decision model and touch acceptability

# Social Touch and Emotion
## Boucaud - Thouvenin

Touch communicates distinct emotions. (Hertenstein et al. (2006 & 2009))

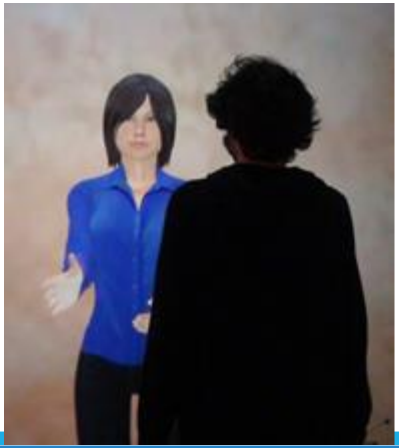
Relationship between toucher and touchee important for better results (Thompson & Hampton, 2011) and touch facilitates bonding. (Montagu, 1971) (Chatel-Goldman et al., 2014)

# Virtual Social Touch
## Boucaud - Thouvenin

To what extent can touch help an ECA to express emotions and bond with a human in virtual reality?

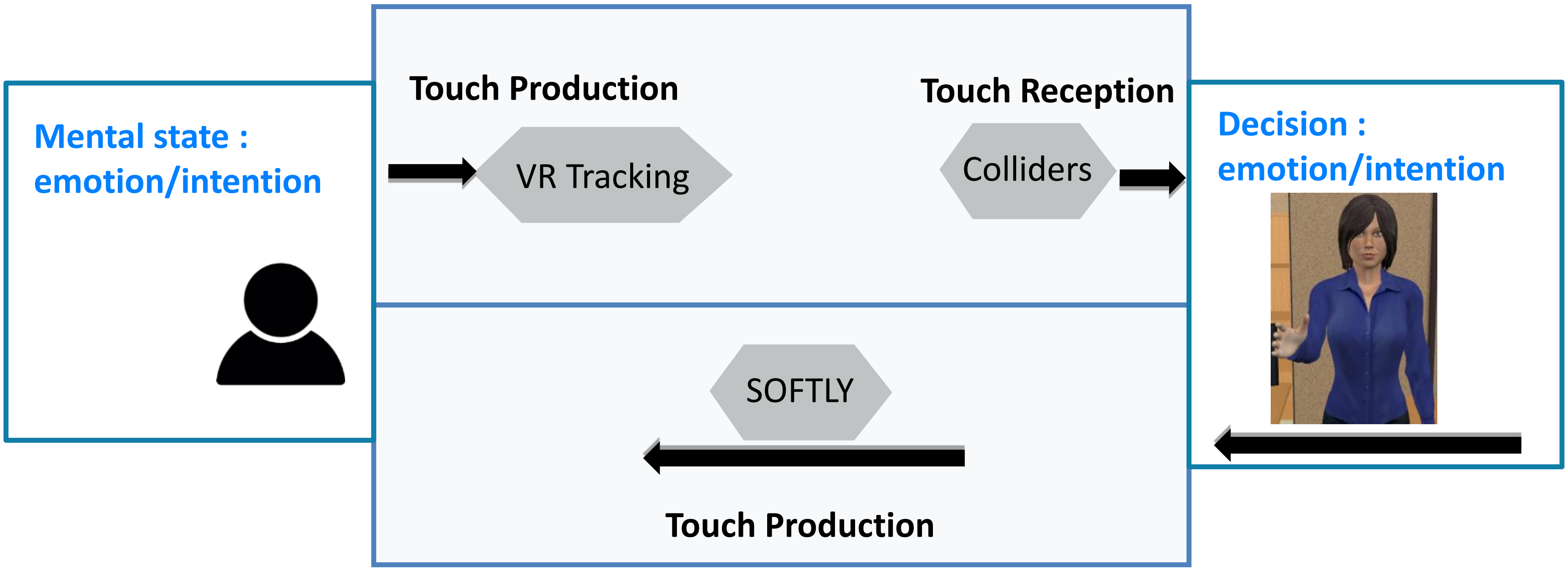
How can we determine when and how to touch?

Important to monitor touch acceptability

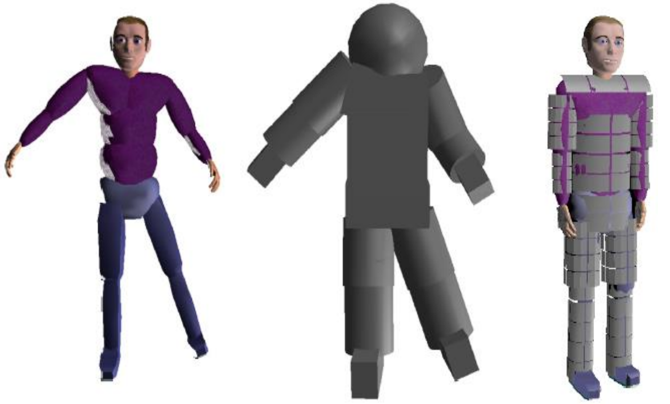


# Framework

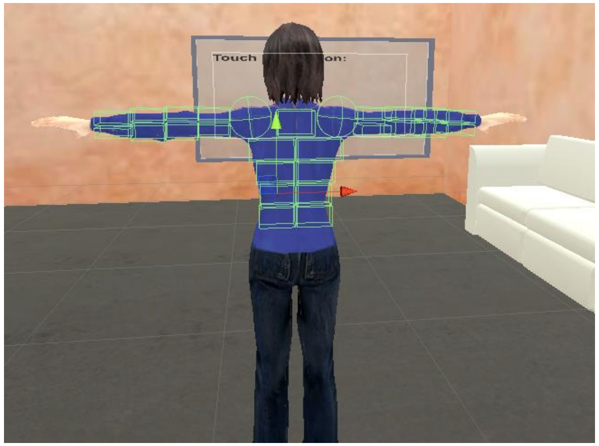
## Boucaud - Thouvenin



# Touch Perception
## Boucaud - Thouvenin



Virtual receptors and proximity zones by Nguyen & Wachsmuth (2009)



Tactile cells of our agent (back, arms, shoulders)

# DECISION MODEL
## Boucaud - Thouvenin

- Human sensing:
  - Gaze direction: agent's eyes/head/body
  - Proxemics: intimate, personal, social, public
  - Touch: body part (head, arm, body), type of touch
- Agent's emotion state: FaTiMa (Dias et al, 14)
- Decision model:
  - Agent's emotional state
  - Agent's perception of human's emotional state
  - Agent's perception of rapport (emotion valence, human attentiveness)
  - Dialog state
- Human touch avoidance: low, medium, high
- Output: verbal and nonverbal behavior including touch

# DECISION MODEL

## Boucaud - Thouvenin

Functions of touch:

- Attention getting: try to grab the attention
- Turn management: taking or giving the floor
- Emotional emphasis: display emotion
- Supporting touch: comfort, calm

Types of touch:

- Hit
- Tap
- Caress
- Sustained touch

Example : initial inputs:

- Attentiveness(H) = 2, Mood(H) = 5 and StaticTouchAvoidance(H) = Medium.

→ Rapport(H) = 60 → Speak(Step1, Step1, Inform, Gesture)

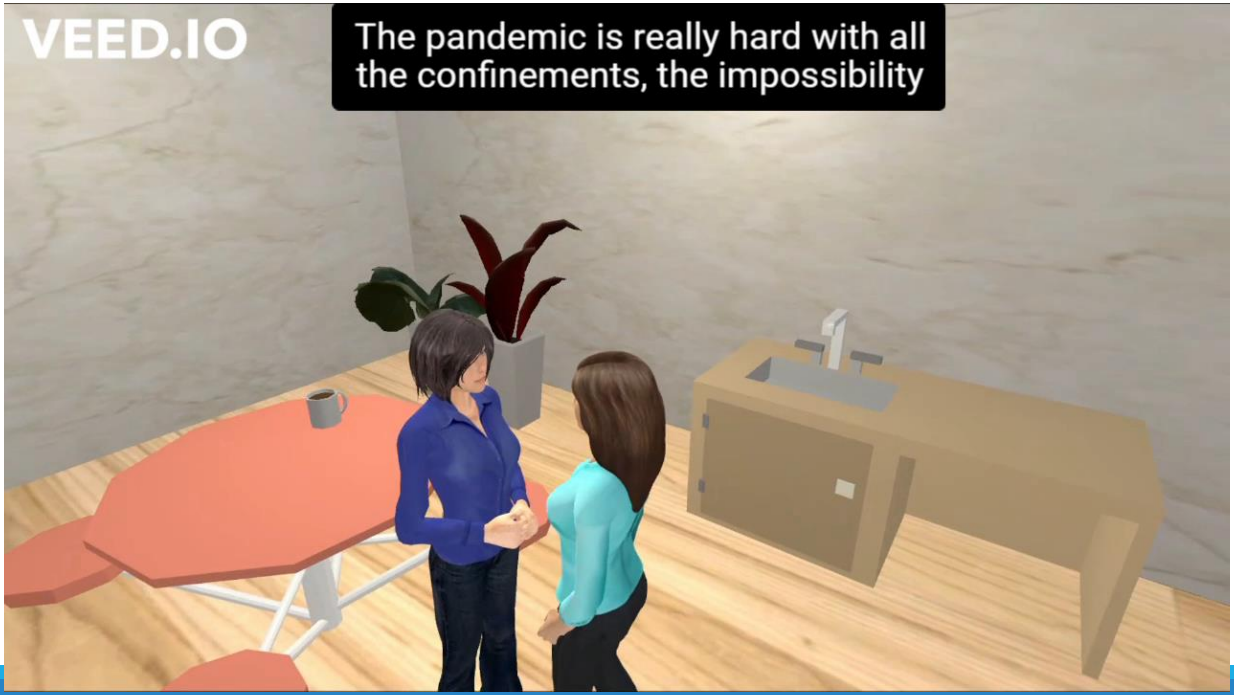
→ Failure to task → Mood(H) = 4, Attentiveness(H) = 1

→ Rapport(H) < 60 ; Mood(A) decreases → Speak(Fail1, Fail1, GetAttention, Touch)

# Evaluation
## Boucaud - Thouvenin

Scenario: discussion on experience of lockdown

- Autonomous virtual agent (dark blue shirt) driven by the decision model
- Avatar of human (turquoise shirt) driven by human



# Any questions?

AGENT PLATFORM: GRETA AVAILABLE AT HTTPS://GITHUB.COM/ISIR/GRETA