



**Are computer-generated emotions and moods plausible to humans?**

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# Outline

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- A computational Model of Affect
  - affect classification and representation
  - appraisal language
- Evaluation
  - methodology
  - material and participants
  - results





# ALMA – A Layered Model of Affect

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- Implemented computational model of affect<sup>1</sup>
- Designed for interactive virtual characters
- Psychological models of personality, emotion, mood, and appraisal
- Provides an appraisal language
  - events, actions, and objects
  - dialog acts
- **Projects:**
  - VirtualHuman (<http://www.virtual-human.org>)
  - NECA (<http://www.ofai.at/research/nlu/NECA/>)
  - CrossTalk (<http://www.dfki.de/crosstalk>)

<sup>1</sup> Gebhard , ALMA – A Layered Model of Affect, Proceedings of AMAAS05, 29-36, 2005





# Affect Classification

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- *General term for feelings, emotions, or moods – the conscious subjective aspect of feeling*
- Can be distinguished by<sup>1</sup>
  - **time** (short-term vs. long-term)
  - **influence** (unnoticed vs. dominant)
  - **cause** (specific vs. diffuse)
- Affect classified by time
  - short-term: **emotions** (dominant, specific)
  - medium-term: **moods** (unnoticed, diffuse)
  - **and** long-term: **personality** (dominant)

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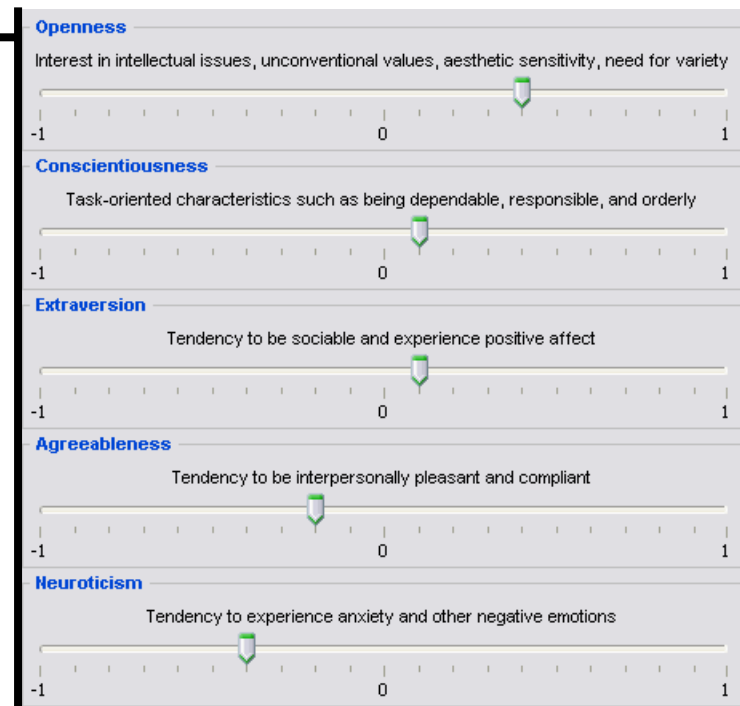
<sup>1</sup> Krause , Affekt, Emotion, Gefühl, In: Merten W., Wandvogel B. Handbuch psychoanalytischer Grundbegriffe, Kohlhammer, 2000, 73-80





# Personality

- BigFive personality traits
  - emotion intensity and decay<sup>1</sup>
  - default mood



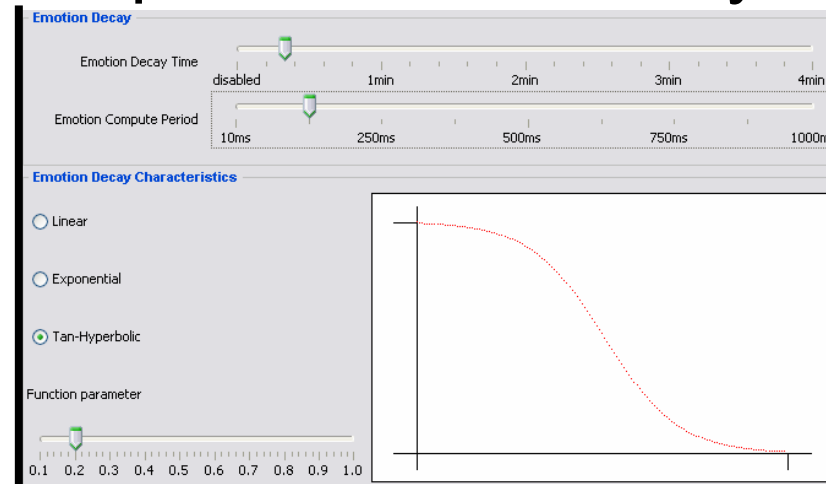
<sup>1</sup> Becker P. Structural and Relational Analyses of Emotion and Personality Traits.  
In: Zeitschrift für Differentielle und Diagnostische Psychologie, 22,3, 2001, 155-172





# Emotions

- OCC-Model of emotions<sup>1</sup>
- Reactions to situational appraisal
- 24 types of emotion
- Real-time computation and decay<sup>2</sup>



**Fortunes-of-others**

HappyFor

Pity

Gloating

Resentment

**Attraction**

Liking

Disliking

**Attribution**

Admiration

Pride

Reproach

Shame

**Prospect-based**

Hope

FearsConf...

Disappoint...

Fear

Satisfaction

Relief

**Attraction/attribution**

Hate

Love

**Well-being/attribution**

Gratitude

Remorse

Gratification

Anger

**Well-being**

Distress

Joy

1 Orthony A., Clore G.L., and Collins A. The Cognitive Structure of Emotions. Cambridge University Press, Cambridge, MA, 1988

2 Gebhard et al. Adding the Emotional Dimension to Scripting Character Dialogues, Proc. of IVA03 , 2003, 48-56

Gebhard et al. Coloring Multi-Character Conversations through the expression of emotion, Proc. of ADS04, 2004, 128-141

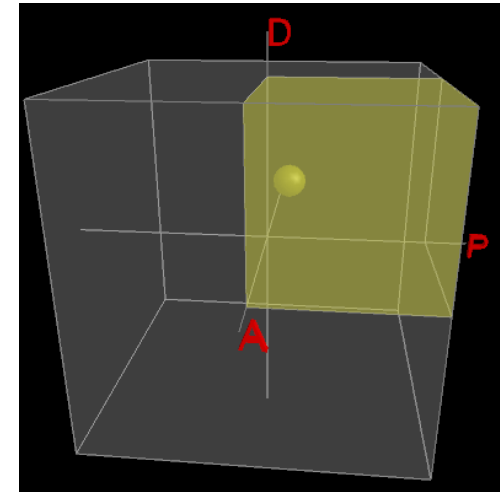




# Moods

- **PAD** space for describing mood<sup>1</sup>
  - mood is a value of the dimensions **Pleasure, Arousal, and Dominance**
  - 8 discrete mood types:

+P+A+D	Exuberant	-P-A-D	Bored
+P+A-D	Dependent	-P-A+D	Disdainful
+P-A+D	Relaxed	-P+A-D	Anxious
+P-A-D	Docile	-P+A+D	Hostile
  - mood strength = distance to origin
  - initial mood through BigFive personality traits<sup>2</sup>
  - provides relation of emotions to moods<sup>3</sup>  
(e.g. pride – exuberant)



1 Mehrabian A. Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament  
Current Psychology, 14 1996, 261-292

2 Analysis of the Big-Five Personality Factors in Terms of the PAD Temperament Model. Australian Journal of Psychology, 48-2, 1996, 86-92

3 Framework for a Comprehensive Description and Measurement of Emotional states. Genetic, Social, and General Psychology, 22, 1995, 334-361





# Mood Changes

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- **Concept**  
mood change due to emotional experiences<sup>1</sup>
- Mood change function
  - *pull phase*:  
emotions change mood
  - *push phase*:  
emotions intensify mood

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<sup>1</sup> Morris, W.N. The frame of mind, New York, Springer, 1889





# Exploitation for Virtual Characters

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- Enhance non-verbal behavior
  - speech parameters
  - wording in utterances
  - facial expressions and complexions
  - conversational gestures
- Tailoring dialog and interaction strategies in script and plan based systems
- **What for?**
  - enhance believability
  - create the illusion of “human-like” behavior





## Exploitation – Emotion Example

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facial expression and complexions reflect emotions





# Exploitation – Mood Example

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posture reflects mood





# Appraisal Language

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- **Concept**  
Affect is reaction to situational appraisal
- Situational appraisal using **appraisal tags**
  - shortcuts to variables of OCC-Model<sup>1</sup>
- Appraisal tags are input for affect computation
- Simplifies affect generation in script- and plan- based applications

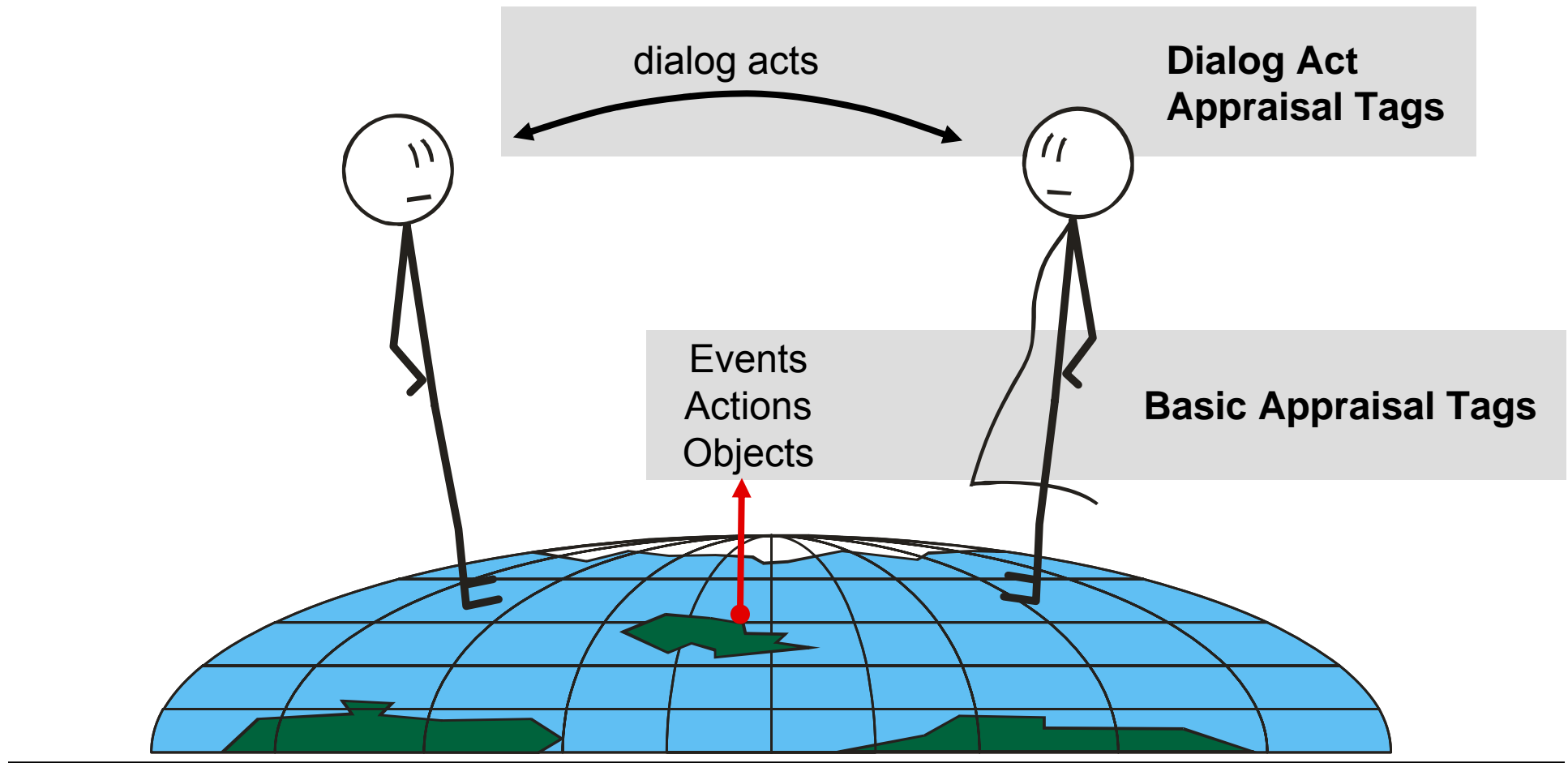
<sup>1</sup> Gebhard et al. Adding the Emotional Dimension to Scripting Character Dialogues, Proc. of IVA03, 2003, 48-56

Gebhard et al. Coloring Multi-Character Conversations through the expression of emotion, Proc. of ADS04, 2004, 128-141





# Appraising Situations





# Appraisal Tags

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- Situation appraisal from a character's point of view





# Basic Event Appraisal Tags

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- 12 tags for appraising events



GoodEvent  
BadEvent  
GoodEventForBadOther  
GoodEventForGoodOther  
BadEventForGoodOther  
BadEventForBadOther  
GoodLikelyFutureEvent  
GoodUnlikelyFutureEvent  
BadLikelyFutureEvent  
BadUnlikelyFutureEvent  
EventConfirmed  
EventDisconfirmed





# Basic Event Appraisal Tags – Example

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## GoodEvent



Bob





# Basic Event Appraisal Tags – Example

## GoodEvent

↓ tag mapping

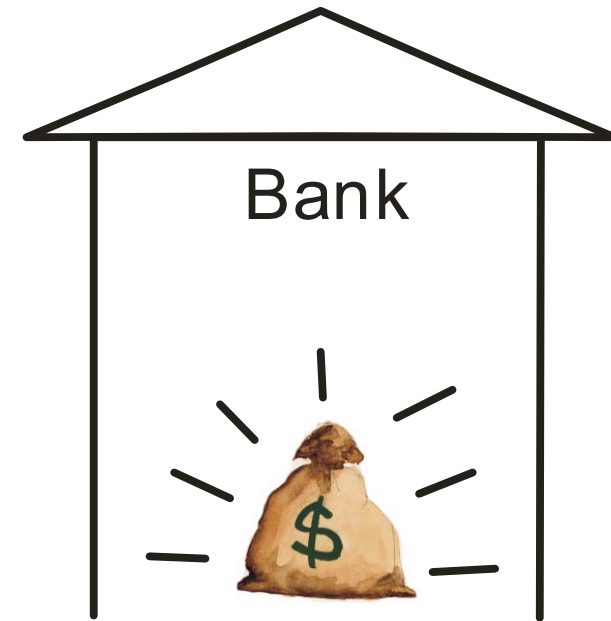
pos. desirability [occ variable]

↓ emotion generation

## Joy



Bob





# Basic Action Appraisal Tags

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- 4 tags for appraising actions



GoodActSelf  
BadActSelf  
GoodActOther  
BadActOther





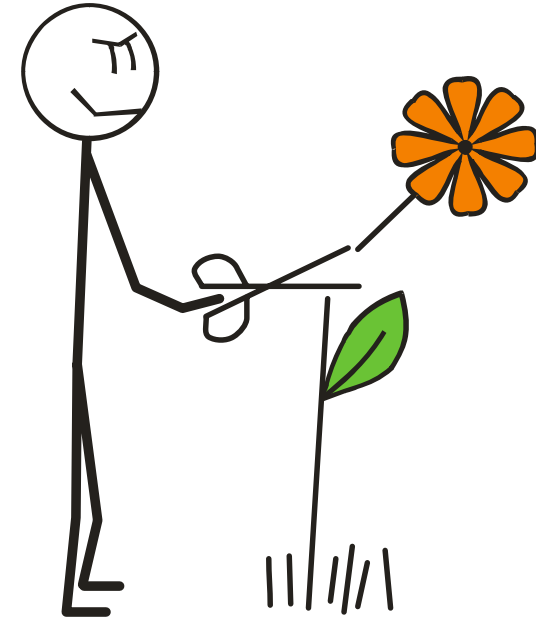
# Basic Appraisal Tags - Example

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## BadActOther



Bob





# Basic Appraisal Tags - Example

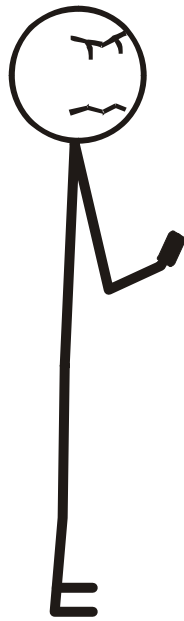
BadActOther

↓ tag mapping

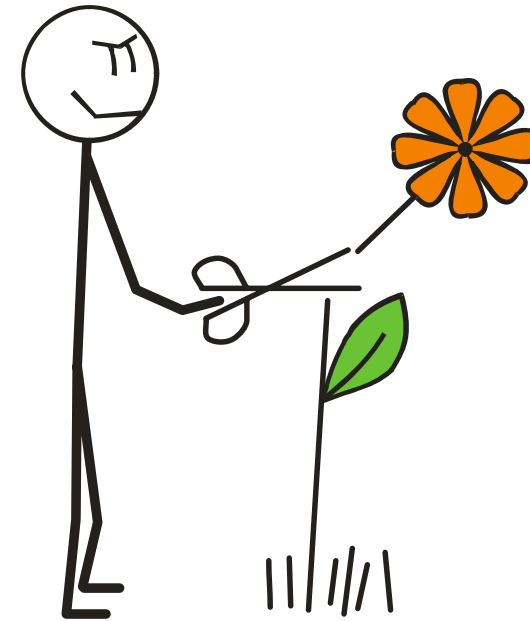
blameworthiness [occ variable]

↓ emotion generation

Reproach



Bob





# Basic Object Appraisal Tags

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- 2 object appraisal tags



NiceThing  
NastyThing





## Basic Appraisal Tags – Combination

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# GoodEvent + GoodActSelf





# Basic Appraisal Tags – Combination

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## GoodEvent + GoodActSelf

↓ tag mapping

pos. desirability [occ variables]  
praiseworthiness

↓ emotion generation

## Joy + Pride





# Basic Appraisal Tags – Combination

## GoodEvent + GoodActSelf

↓ tag mapping

pos. desirability [occ variables]  
praiseworthiness

↓ emotion generation

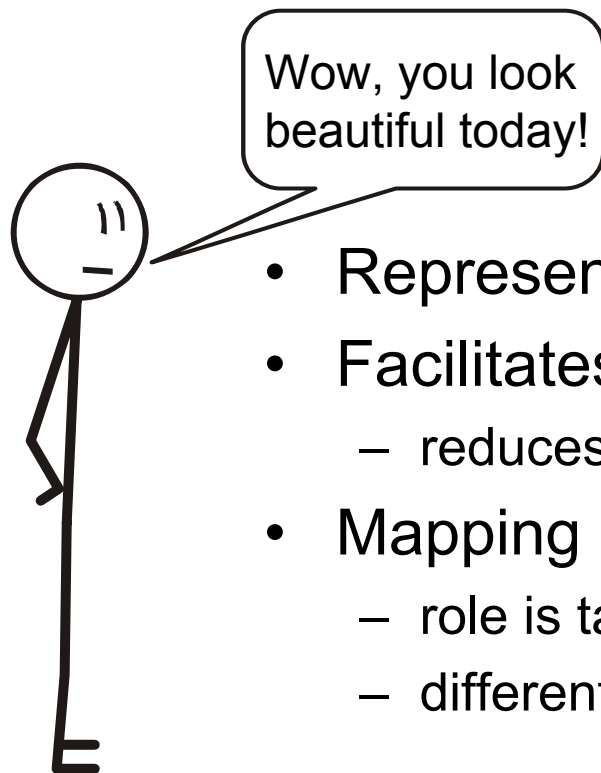
## Gratification





# Dialog Act Appraisal Tags

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Wow, you look beautiful today! **[PayCompliment <Adressee> <Hearer>]**

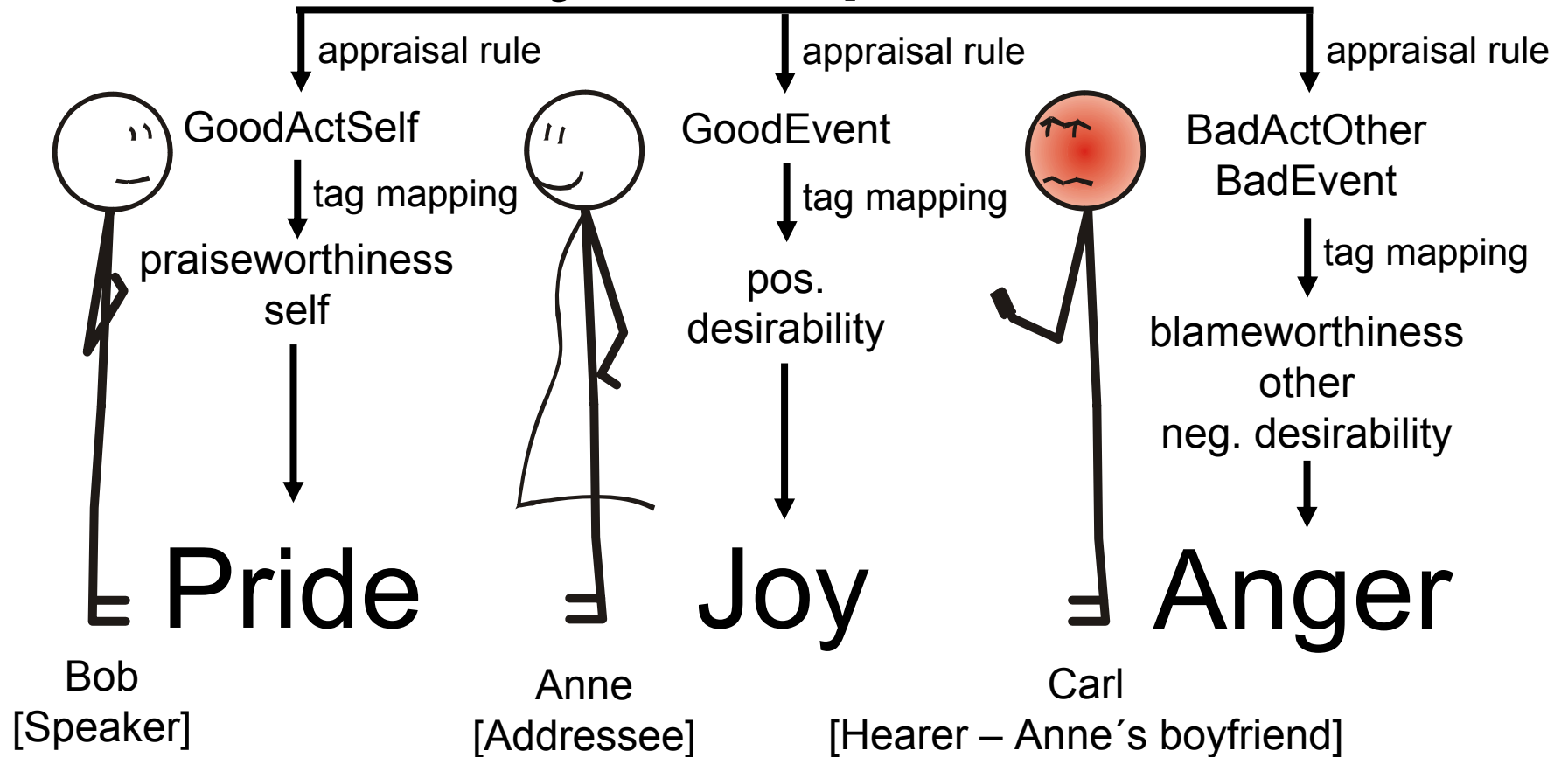
- Represents communicative intent
- Facilitates scripting affect
  - reduces amount of basic appraisal tags
- Mapping on Basic Appraisal Tags required!
  - role is taken into account
  - different appraisal of each involved character





# Dialog Act Appraisal Tag – Example

## PayCompliment





## Dialog Act Appraisal Tag – Example

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- Affect scripting reduction:

Bob: Wow, you look beautiful today!  
**[PayCompliment Anne, Carl]**

instead of

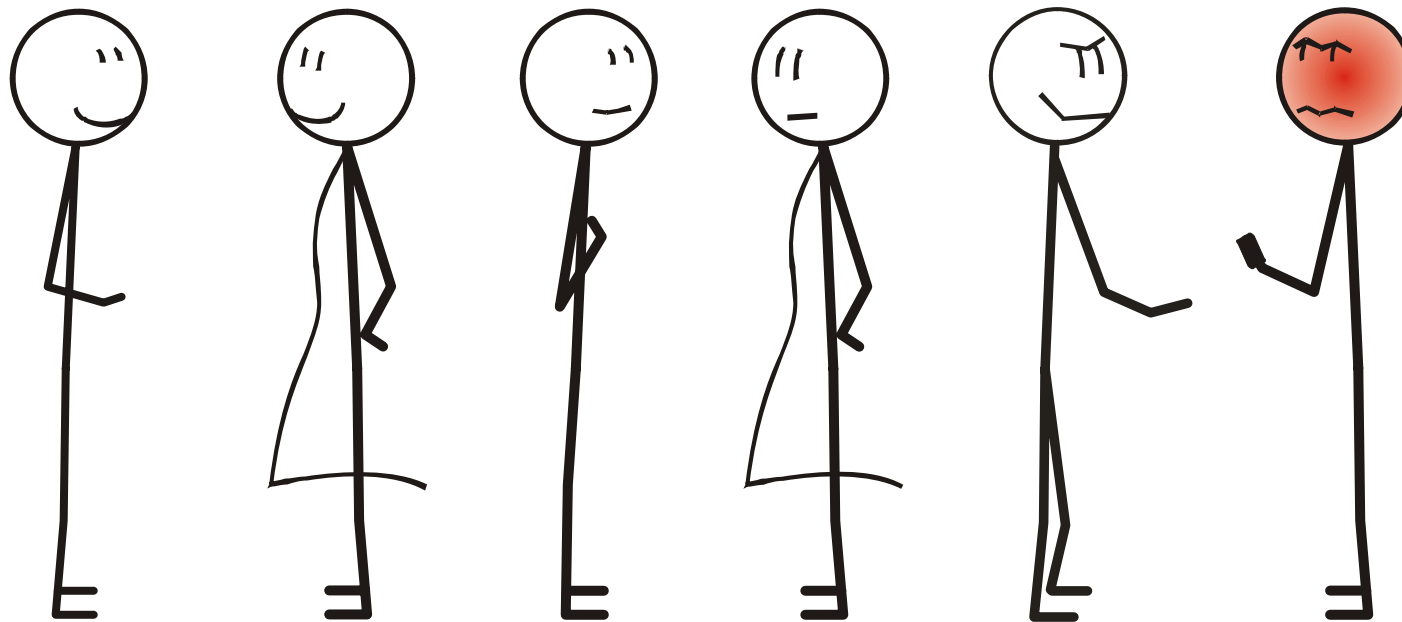
Bob: Wow, you look beautiful today!  
**[Bob: GoodActSelf, Anne: GoodEvent, Carl:BadEvent,BadActOther]**





# How to evaluate computer-generated affect?

- **Approach:** Plausibility check of affect through virtual character behavior



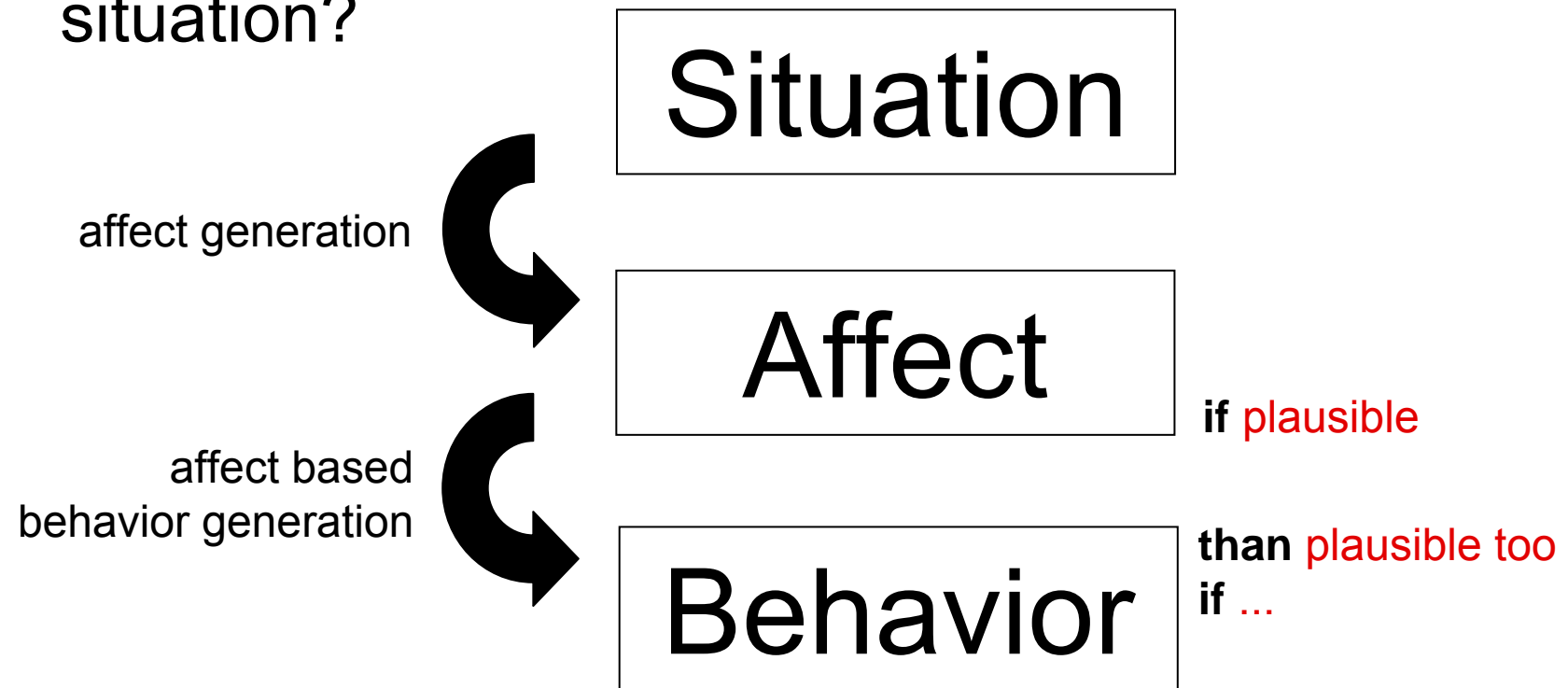
**But:** Behavior might not reflect generated affect efficiently - worst case: not at all!





## Evaluation Question

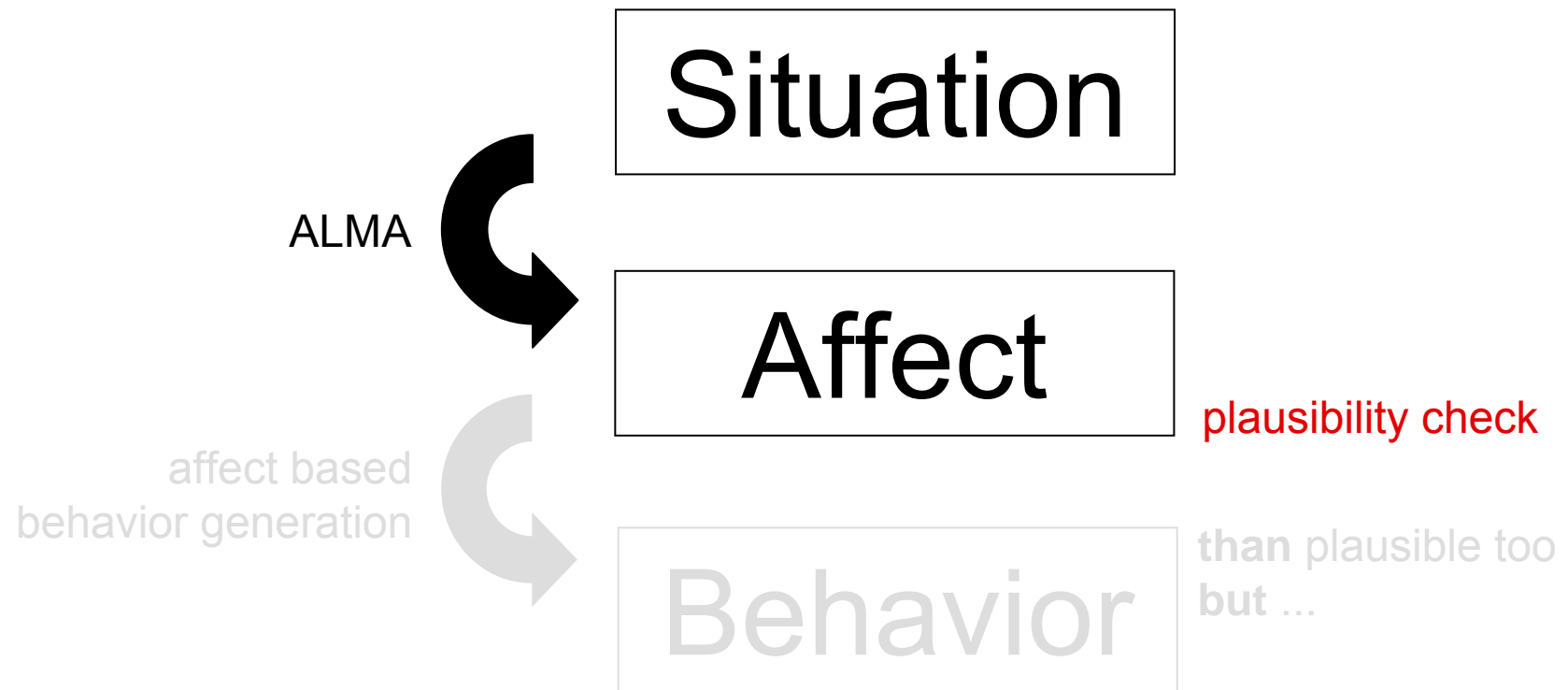
- Is affective behavior plausible in the current situation?





# Evaluation Plan

- Is affect plausible in the current situation?





## Material

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- 30 min. textual questionnaire
  - plausibility check for 24 emotions, and 8 moods
  - only moods described verbally, e.g.  
**bored**: sad, socially withdrawn, physically inactive ...
- 24 dialog contributions for emotions and  
24 dialog scenes for moods (3 per mood)
  - both annotated with appraisal tags (hidden!)
  - emotions and moods computed by ALMA
- 33 Participants (17: (age 18-19), 16:(age 25-38))





# Material - Emotions

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- 24 dialog contributions, like:

**Bruno:** Anne, it's cool that you're helping grand-mother in cleaning up the garden!

**Anne's emotion: pride**

plausible      not plausible

**Bruno's emotion: admiration**

plausible      not plausible





## Material - Mood

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- 24 dialog scenes, like:

**Situation:** Mark is reorganizing his computer hard drive by letting Microsoft Windows removing unneeded files. Tanja just shows up.

**Mark:** Crap, Windows has killed all pictures of our last summer holiday at Mallorca.

**Tanja:** Don't panic, you'll find them surely in the waste bin.

**Mark:** Are you sure? But what if not, what I'm doing then – they will be lost forever!

**Tanja:** Well, I've no clue, I'm not the computer expert.

*(Mark tries to recover the files by restoring the files of the waste bin)*

**Mark:** No, damn it! All the pictures gone – and there's no way to get them back!

**Tanja:** Oh no, all our pictures are lost! You are a clean up maniac. I always told you that this will led some days to something bad. Well, and that's just happened. Wonderful!

**Mark:** Get of my back!

**Marks mood after: hostile**

**plausible**      **not plausible**





# Material - Appraisal Tags

- **Dialog contribution:**

**Bruno:** Anne, it's cool that you're helping grand-mother in cleaning up the garden! **[Praise Anne]**

**Anne's emotion:** ...

**Bruno's emotion:** ...

- **Dialog scene:**

**Situation:** Mark is reorganizing his computer hard drive by letting Microsoft Windows removing unneeded files. Tanja just shows up.

**Mark:** Crap, Windows has killed all pictures of our last summer holiday at Mallorca. **[BadEvent]**

**Tanja:** Don't panic, you'll find them surely in the waste bin. **[Calm Bruno]**

**Mark:** Are you sure? But what if not, what I'm doing then - they will be lost forever!

**[AnnounceConcern Tanja]**

**Tanja:** Well, I've no clue, I'm not the computer expert.

*(Mark tries to recover the files by restoring the files of the waste bin)*

**Mark:** No, damn it! All the pictures gone - and there's no way to get them back! **[BadEvent]**

**Tanja:** Oh no, All our pictures are lost! You are a clean up maniac. I always told you that this will led some days to something bad. Well, and that's just happened. Wonderful! **[Accuse Mark]**

**Mark:** Get of my back! **[Condemn Tanja]**

**Marks mood after:** ...





# Affect Computation

- Dialog contributions and scenes → AffectScripts

```
<AffectScript>
<Context>Mark is reorganizing his computer hard drive by letting Microsoft Windows removing unneeded files. Tanja just shows up.
</Context>
<Item time="1000">
  <AffectInput>
    <Character name="Mark"/>
    <Event type="BadEvent" intensity="0.80" elicitor="lost vacation photos"/>
  </AffectInput>
  <Context>Mark: Crap, Windows has killed all pictures of our last summer holiday at Mallorca. [signal]</Context>
</Item>
<Item time="2000">
  <AffectInput>
    <Character name="Tanja"/>
    <Act addressee="Mark" listener="" type="Calm" intensity="0.40" elicitor="may be not lost"/>
  </AffectInput>
  <Context>Tanja: Don't panic, you'll find them surely in the waste bin. [signal]</Context>
</Item>
<Item time="3000">
  <AffectInput>
    <Character name="Mark"/>
    <Act addressee="Tanja" listener="" type="AnnounceConcern" intensity="0.80" elicitor="lost or not that's the question"/>
  </AffectInput>
  <Context>Mark: Are you sure? But what if not, what I'm doing then – they will be lost forever! [signal]</Context>
</Item>
...
```





# Material - Emotions and Moods

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- **Dialog contribution:**

**Bruno:** Anne, it's cool that you're helping grand-mother in cleaning up the garden!

Anne's emotion: **pride**

Bruno's emotion: **admiration**

- **Dialog scene:**

**Situation:** Mark is reorganizing his computer hard drive by letting Microsoft Windows removing unneeded files. Tanja just shows up.

**Mark:** Crap, Windows has killed all pictures of our last summer holiday at Mallorca.

**Tanja:** Don't panic, you'll find them surely in the waste bin.

**Mark:** Are you sure? But what if not, what I'm doing then – they will be lost forever!

**Tanja:** Well, I've no clue, I'm not the computer expert.

*(Mark tries to recover the files by restoring the files of the waste bin)*

**Mark:** No, damn it! All the pictures gone – and there's no way to get them back!

**Tanja:** Oh no, All our pictures are lost! You are a clean up maniac. I always told you that this will led some days to something bad. Well, and that's just happened. Wonderful!

**Mark:** Get of my back!

**Marks mood after:** **hostile**





## Data Analysis and Results

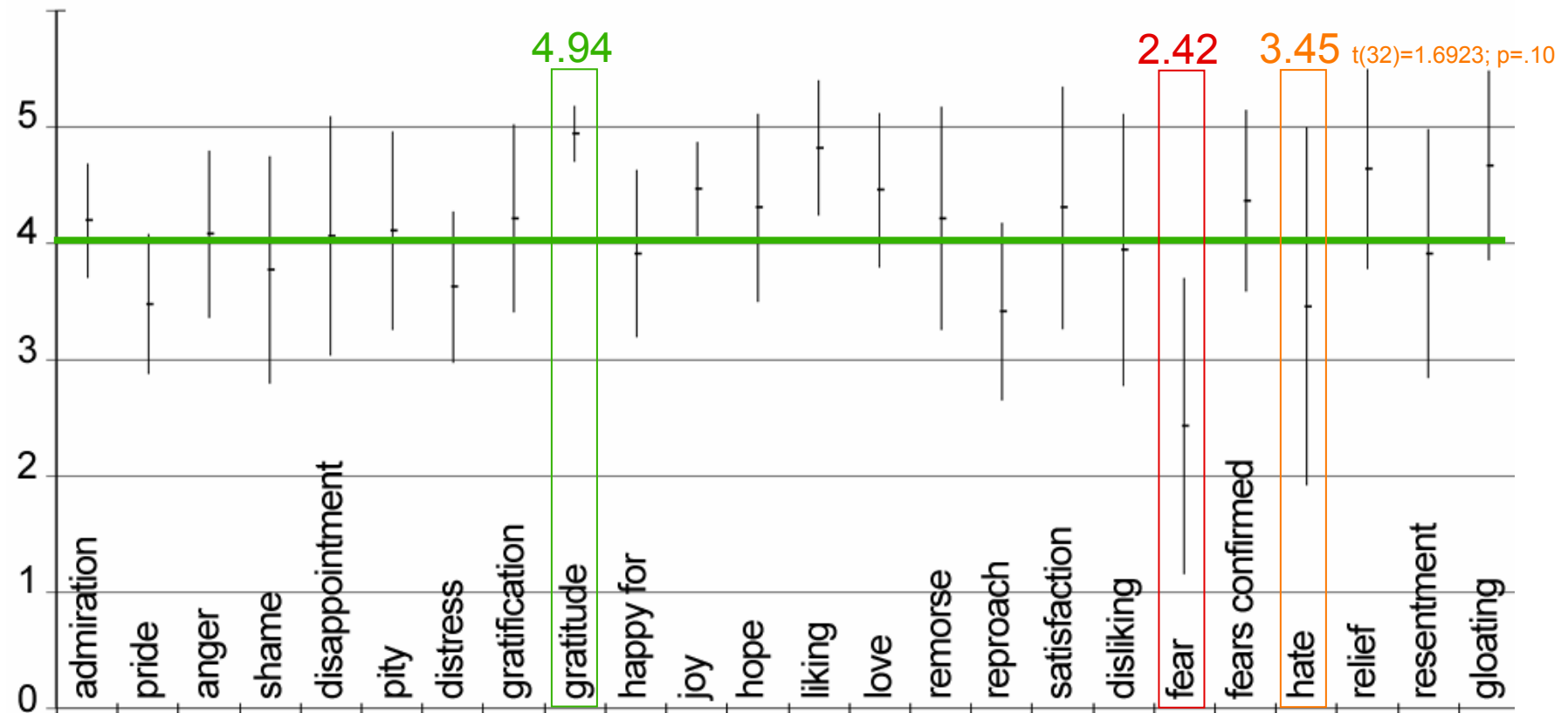
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- Discrete plausibility ranking  
(0: lowest plausibility, 5: highest plausibility, 3: mean plausibility)
- t-test for testing significance:  
emotion/mood is plausible if mean score is significantly greater than 3
- Analysis of variance tests:  
Are plausibility results connected to age and gender?  
▶ *no!*





# Results - Emotions

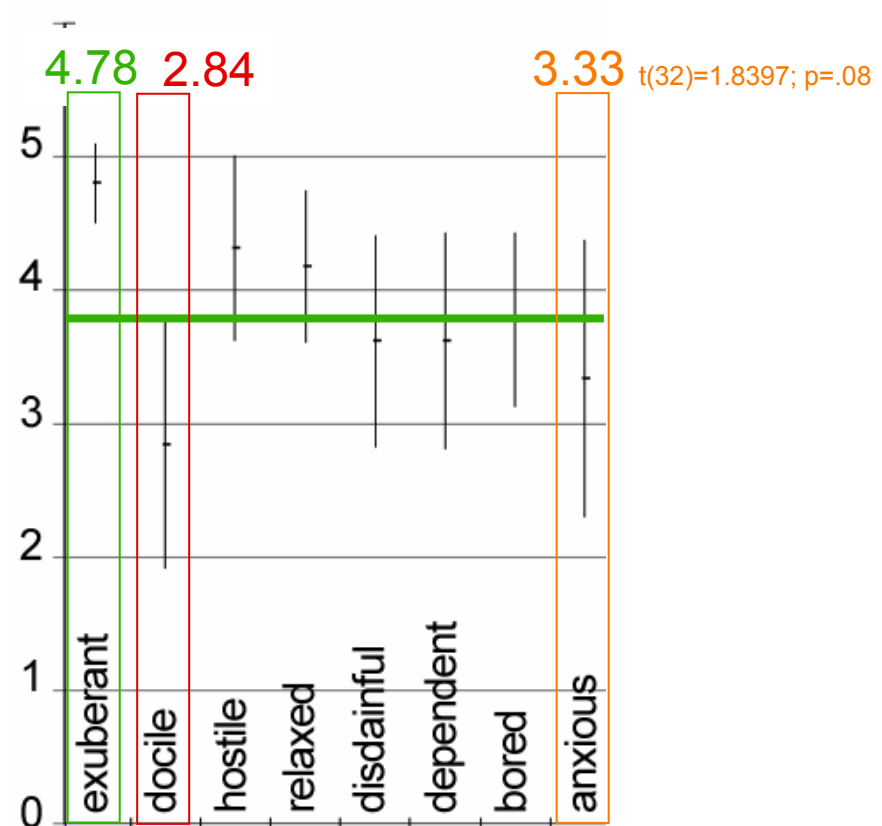


Mean of all emotions: 4.07 - significantly higher than 3 - ( $t(32)=18.6312, p<.001$ )





# Results - Moods



Mean of all moods: 3.81 - significantly higher than 3 - t(32)=11.3195, p<.001)





## Summary

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- Fully operational model of appraisal and affect based on psychological theories
- Appraisal language allows easy appliance in virtual character dialog scenarios
  - Future: AppraisalEngine
- Real-time simulation of 24 emotions and 8 moods
- Evaluation shows positive plausibility of 22 out of 24 emotions and of 7 out of 8 moods.





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<http://www.dfki.de/~gebhard/alma.html>