GAZE, PERSONALITY, AND THE UNCANNY VALLEY:

Implicit Cues of Uncanny feelings and Interaction Strategies to Overcome them.

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CLASP SEMINAR (March 31st, 2021)

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Introduction to Studies
10 minutes

Paper 1 – Gaze and the Uncanny Valley
30 minutes

Q&A – Paper 1
15 minutes

Paper 2 – Personality and the Uncanny Valley
30 minutes

Q&A – Paper 2
15 minutes

Uppsala Social Robotics Lab

1.

Perugia, G., Paetzel-Prüsmann, M., Alanenpää, M., & Castellano, G. (2021). I Can See it in Your Eyes: Gaze as an Implicit Cue of Uncanniness and Task Performance in Repeated Interactions with Robots. *Frontiers in Robotics and AI*, 8, 78.

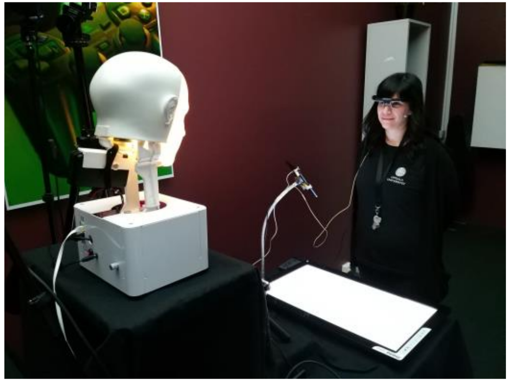
2.

Paetzel-Prüsmann, M., **Perugia, G.**, & Castellano, G. (2021). The Influence of Robot Personality on the Development of Uncanny Feelings. *Computers in Human Behavior*, 106756.

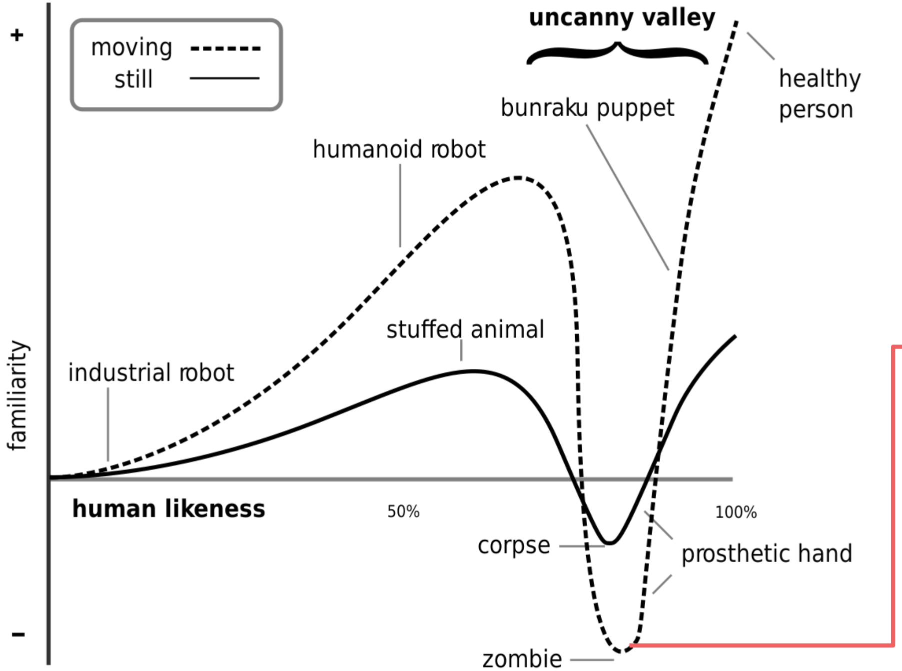
STUDY 1
Long-term Study
(2019)

Goal: Observe how people's perceptions of a social robot, especially in terms of uncanniness, developed over several interaction sessions with multiple days of zero exposure in between.

STUDY 2
Tekniska Study
(2020)



Goal: Observe whether people's perceptions of a social robot, especially in terms of uncanniness, could change once they were exposed to the robot's personality.



Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & Automation Magazine*, *19*(2), 98-100.

Source: spectrum.ieee.org

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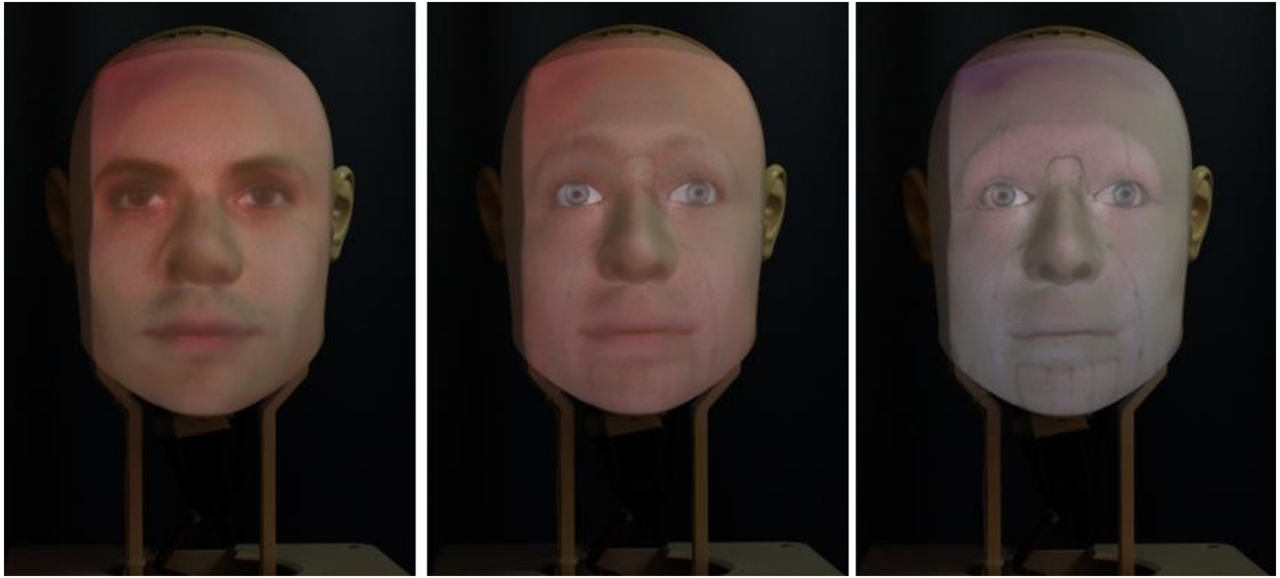
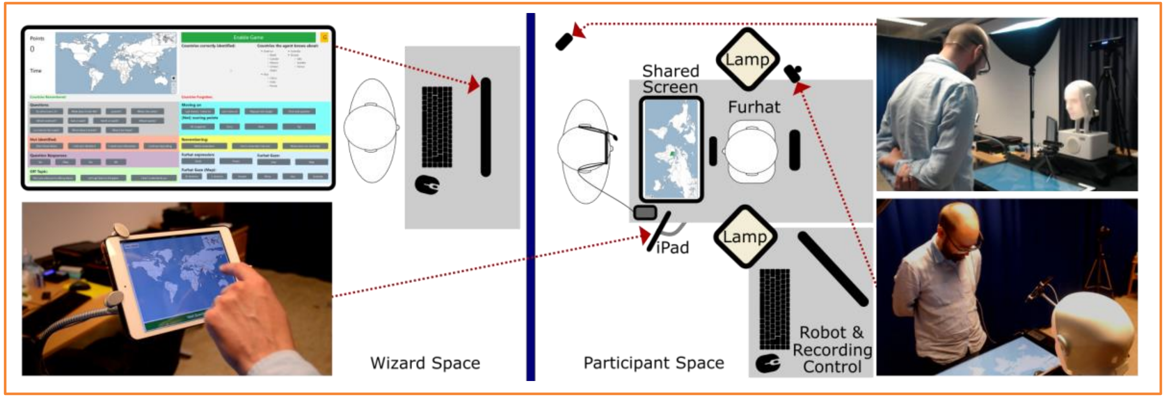


HUMANLIKE MORPH MECHANICAL

THE MAP GAME

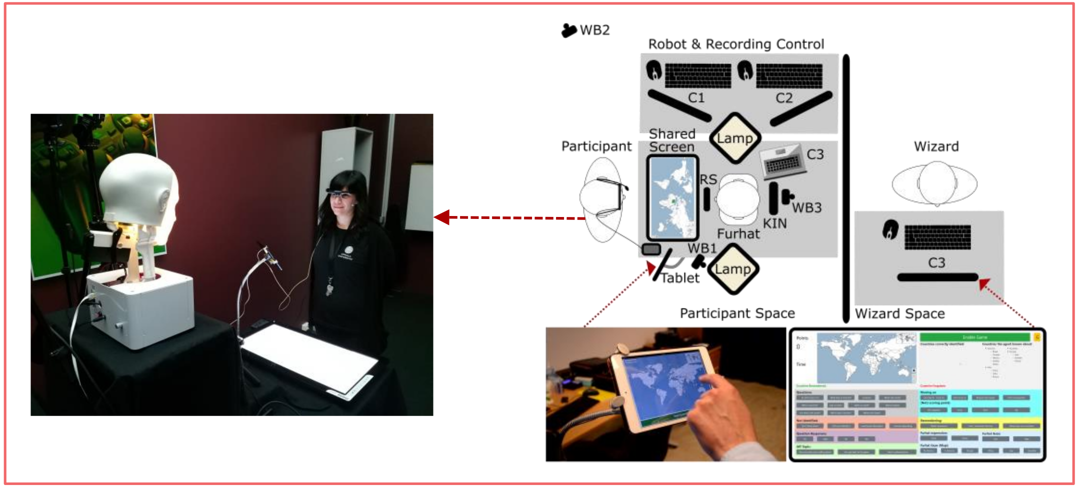

The RDG-Map Scenario
A Pedagogical Reference Resolution Game
Uppsala
Social Robotics Lab

DATASETS



Study 1
Long-term Map game dataset

Study 2
Tekniska Study



1.

Perugia, G., Paetzel-Prüsmann, M., Alanenpää, M., & Castellano, G. (2021). I Can See it in Your Eyes: Gaze as an Implicit Cue of Uncanniness and Task Performance in Repeated Interactions with Robots. *Frontiers in Robotics and AI*, 8, 78.

MUTUAL GAZE

source: news.artnet.com/

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1. novelty / staring-stigma hypothesis

Robots perceived as uncanny elicit higher staring than robots that are not perceived as such, as uncanny robots often feature atypical cues in their appearance, and might be perceived as more novel.

2. mutual gaze-liking relationship

uncanny robots attract less direct gaze, as they are less likable and elicit more discomfort

JOINT TASKS

source: drjohngkuna.com/

HRI scholarship

Most of the HRI studies on gaze in joint tasks (e.g., a chess game) use the allocation of gaze towards the robot as a behavioral cue signaling engagement

Our hypothesis

In joint tasks, gaze towards the robot is not a precise measure of the robot's likability and of participants' social syntony with it because it is hindered by participants' willingness to complete the task

PARTICIPANTS

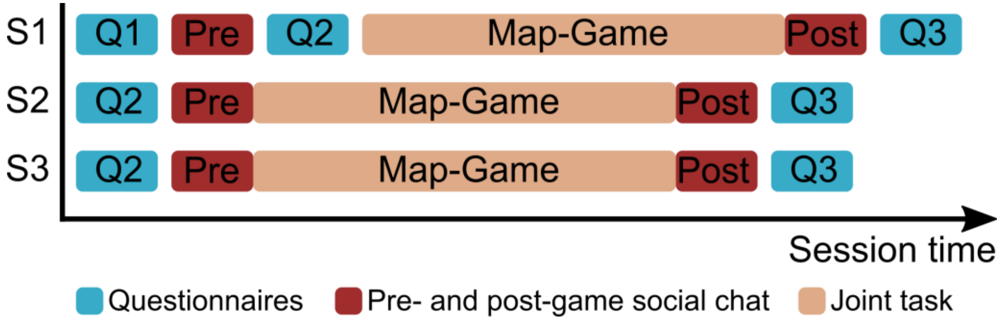
- 60 participants (8 excluded; M=38; F=13, 1 undisclosed)
- Three sessions with multiple days of zero exposure in between (6.9 days on average)
- Participants randomly assigned to one of the three levels of humanlikeness of the Furhat robot

ROBOT’S GAZE

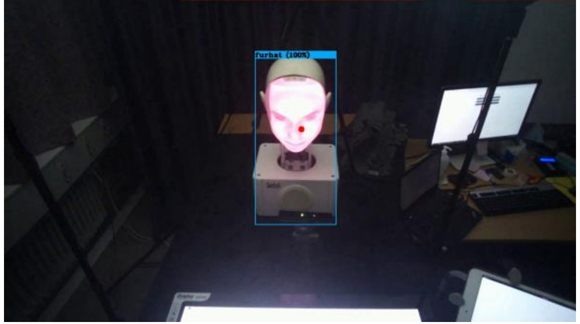
	Session 1			Session 2			Session 3		
	social chat		task	social chat		task	social chat		task
	pre	post	game	pre	post	game	pre	post	game
User	99.4%	99.5%	2.1%	99.5%	99.6%	2.0%	99.9%	99.9%	1.9%
Shared Screen	0.0%	0.0%	97.9%	0.0%	0.0%	98.0%	0.0%	0.0%	98.1%
Somewhere else	0.6%	0.5%	0.0%	0.5%	0.4%	0.0%	0.1%	0.1%	0.0%

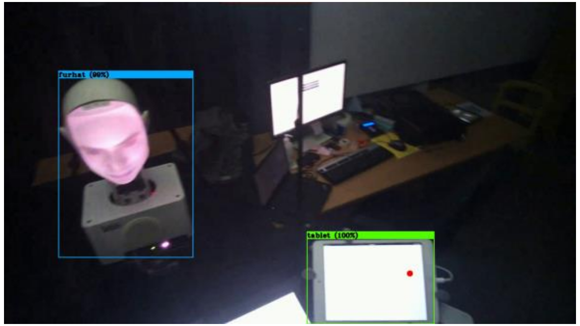
QUESTIONNAIRES

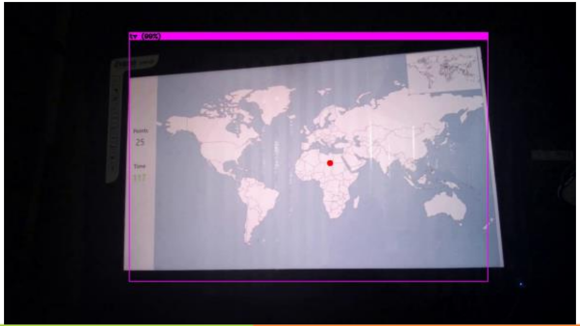
- **Q1**: Demographic questionnaire
- **Q2**: perceptions of the robot's anthropomorphism (Bartneck et al., 2009), likability, threat (Rosenthal-Von Der Pütten & Krämer, 2014), warmth, competence and discomfort Carpinella et al., 2017)
- **Q3**: same questions of Q2, but also involvement with the robot and with the game (O'Brien & Toms, 2010)

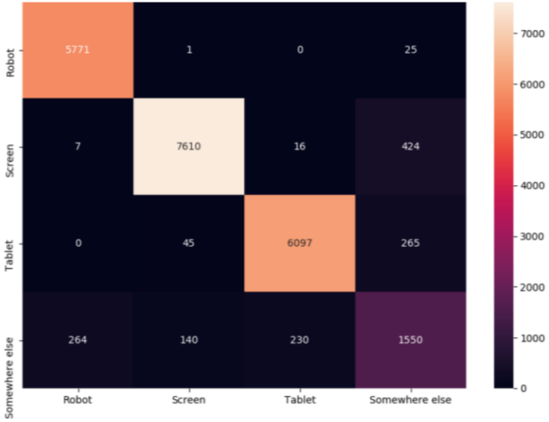


GAZE DETECTION







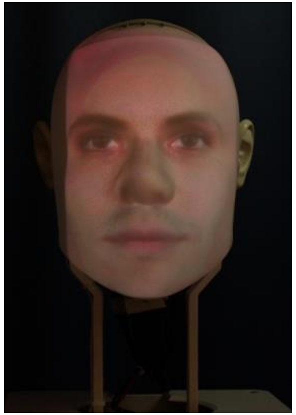


HUMANLIKENESS

Humanlike: more anthropomorphic (p=.004), warm (p=.001), likable (p=.008) and competent (p=.001) than the morph

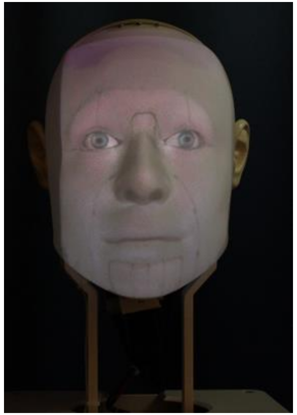
Did not differ significantly

HUMANLIKE



MORPH

MECHANICAL



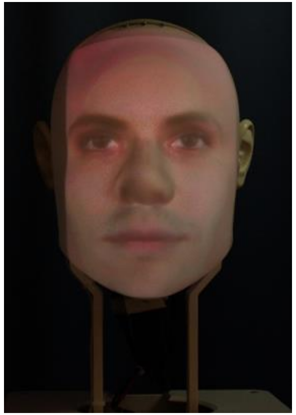
Humanlike: more anthropomorphic (p=.020), warm (p=.021), and competent (p=.015) than the mechanical robot

HUMANLIKENESS

Humanlike: more anthropomorphic (*p*=.004), warm (*p*=.001), likable (*p*=.008) and competent (*p*=.001) than the morph

Did not differ significantly

HUMANLIKE



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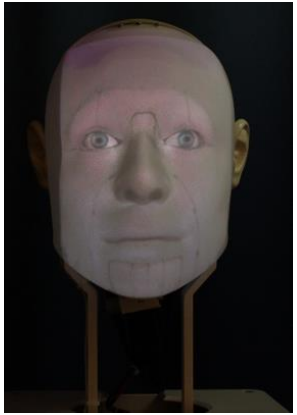
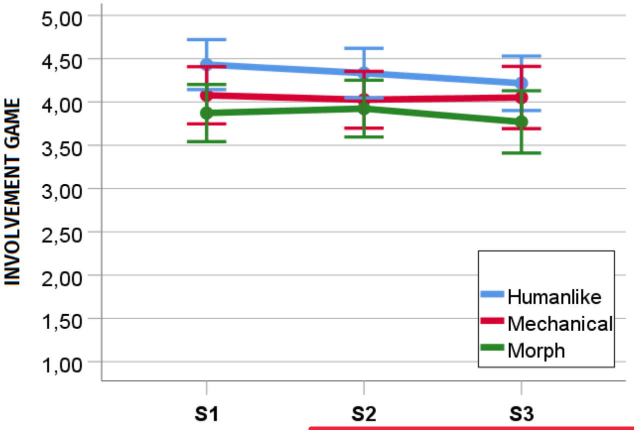
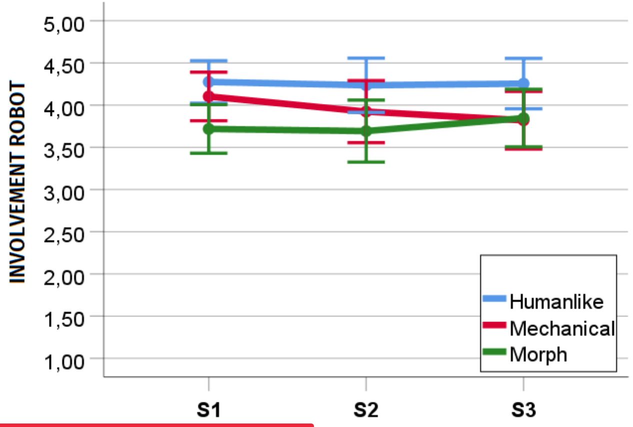


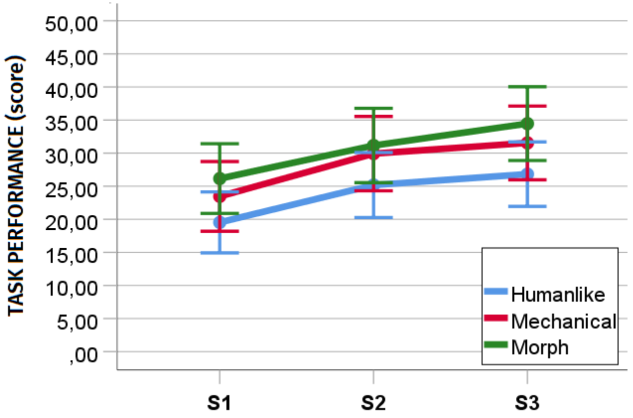
Humanlike: more anthropomorphic (*p*=.020), warm (*p*=.021), and competent (*p*=.015) than the mechanical robot

* **Uncanniness varied over time for all three robots**

ENGAGEMENT AND TASK PERFORMANCE







Task performance increased from S1 to S2 (p<.001), S2 to S3 (p=.019), and S1 to S3 (p<.001).

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SOCIAL CHAT

Predictor: Mutual Gaze				
Dependent variable	β	$t(132)$	p-value	r^2
Anthropomorphism	.064	.733	.465	.004
Likability	**.219**	**2.574**	**.011**	**.048**
Warmth	**.172**	**2.000**	**.048**	**.030**
Competence	.015	.177	.860	.000
Threat	**-.216**	**-2.534**	**.012**	**.047**
Discomfort	**-.221**	**-2.592**	**.011**	**.049**

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JOINT TASK

GAZE ROBOT

Involvement with the robot
β=.021, $t(130)$=.243, p=.809

Involvement with the game
β=-.041, $t(130)$=-.470, p=.639

task performance
β=-.249, $t(130)$=-2.917, p=.004

GAZE SCREEN

Involvement with the robot
β=.128, $t(130)$=1.466, p=.145

Involvement with the game
β=.192, $t(130)$=2.220, p=.028

task performance
β=.305, $t(130)$=3.643, p<.001

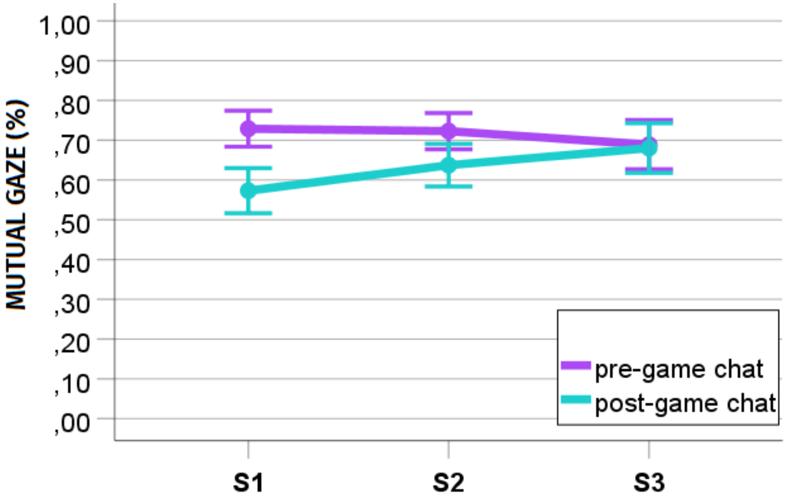
GAZE TABLET

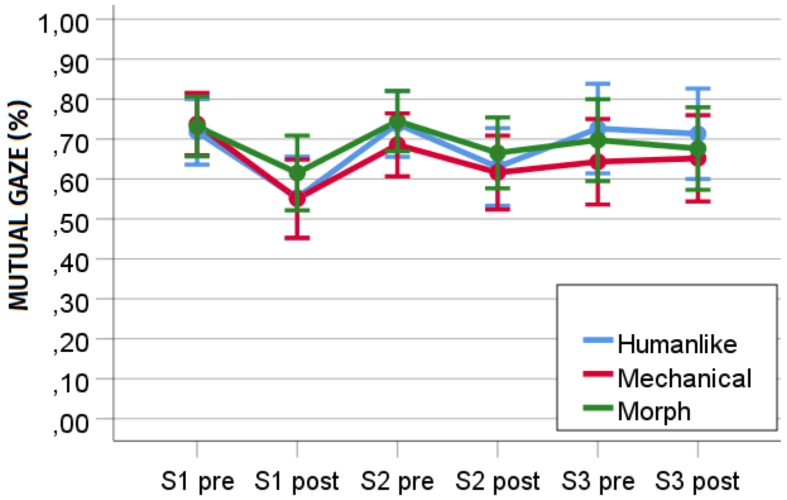
Involvement with the robot
β=-.118, $t(130)$=-1.351, p=.179

Involvement with the game
β=-.172, $t(130)$=-1.983, p=.049

task performance
β=-.248, $t(130)$=-2.907, p=.004

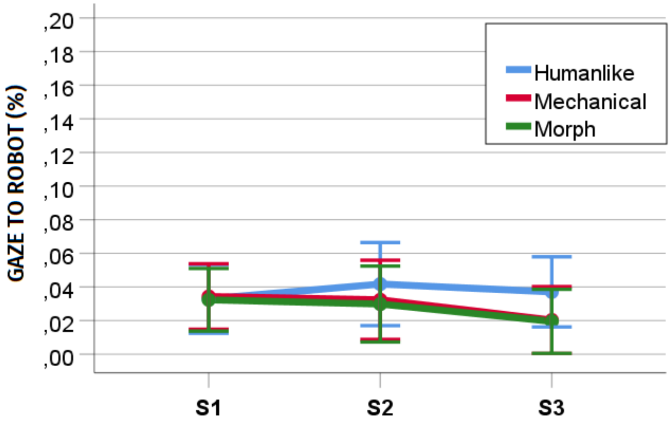
DEVELOPMENT OF MUTUAL GAZE OVER TIME

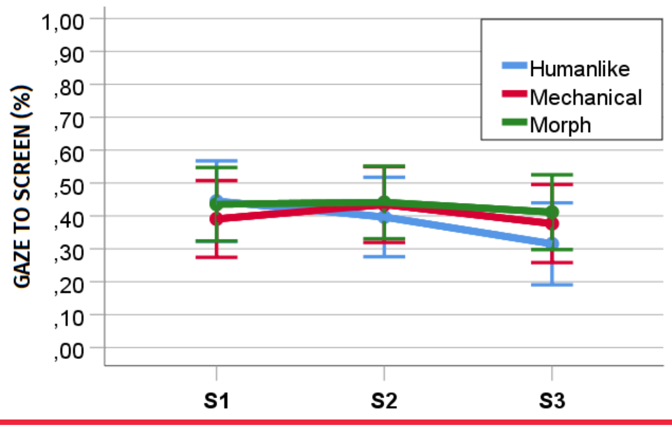


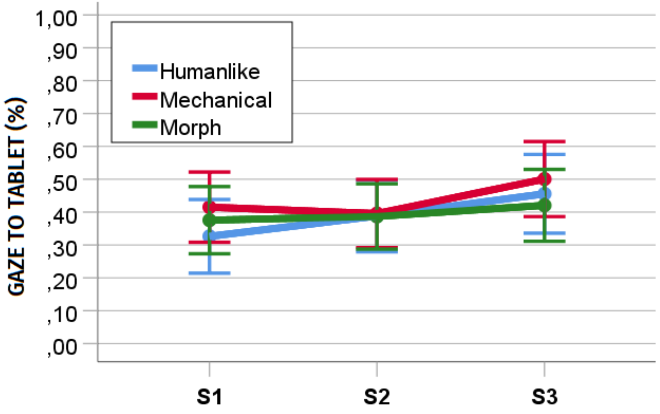


Mutual gaze significantly decreased from pre- to post-game social chat in S1 (p<.001) and in S2 (p<.001), but not in S3 (p=.968).

DEVELOPMENT OF GAZE PATTERNS OVER TIME

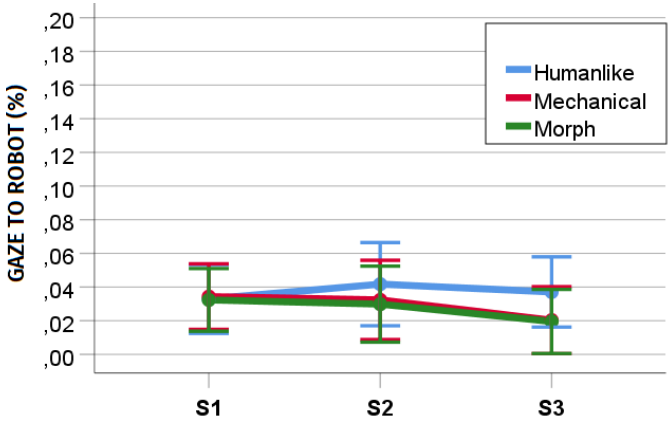


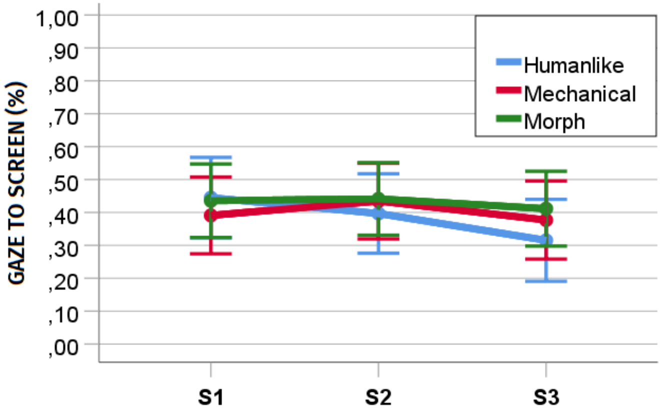




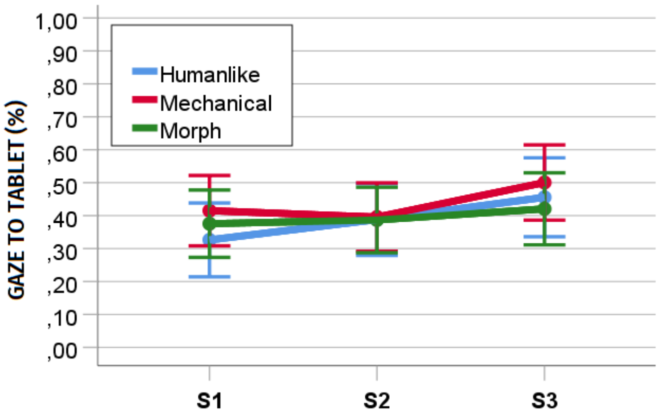
Decrease in **gaze to screen** in the joint task between S1 and S3 (*p*=.023), and between S2 to S3 (*p*=.007).

DEVELOPMENT OF GAZE PATTERNS OVER TIME





Increase in **gaze to tablet** in the joint task between S1 and S3 (p=.004) and between S2 and S3 (p=.002).



CONCLUSIONS

- Mutual gaze towards a robot in a social chat is related to perceptions of uncanniness
- The gaze directed to the robot in a joint task is a predictor of poor task performance
- Mutual gaze in a social chat changes across repeated interaction sessions in line with changes in perceived uncanniness
- The gaze patterns in a joint task change over time and seem to signal a higher confidence in the game strategies

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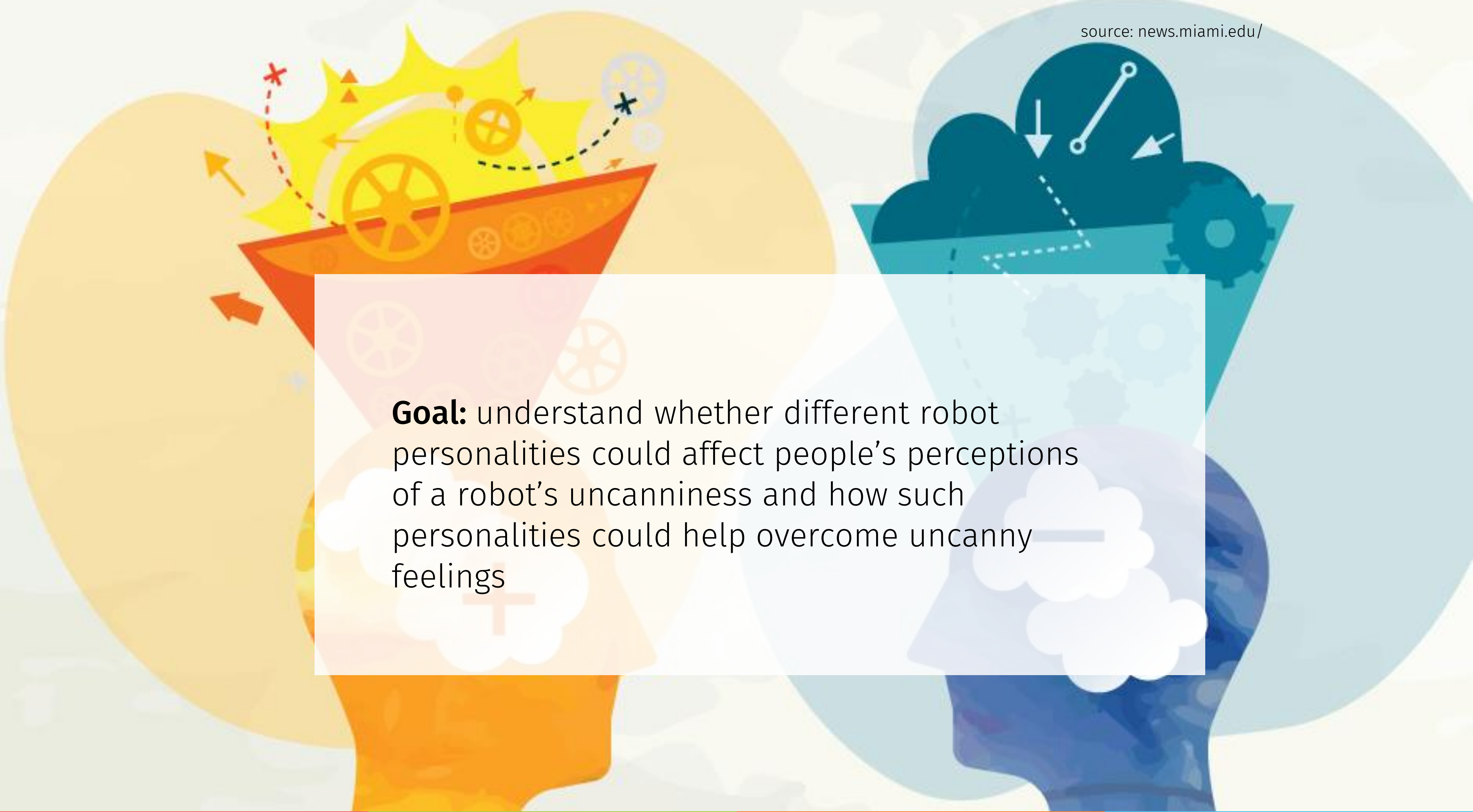
2.

Paetzel-Prüsmann, M., **Perugia, G.**, & Castellano, G. (2021). The Influence of Robot Personality on the Development of Uncanny Feelings. *Computers in Human Behavior*, 106756.



source: news.miami.edu/

Goal: understand whether different robot personalities could affect people's perceptions of a robot's uncanniness and how such personalities could help overcome uncanny feelings

RESEARCH QUESTIONS

- **RQ1.** To what extent does robot personality influence people's perception of robots with different levels of humanlikeness?
- **RQ2.** To what extent does a match in personality between a robot and a human interlocutor influence the human's perception of the robot?
- **RQ3.** How do robot personality characteristics influence people's engagement and task performance?
- **RQ4.** To what extent does the personality of the robot influence how people's perception of it develops over time?


source: news.miami.edu/

OPTIMISTIC AND ENCOURAGING

One personality was lighthearted, optimistic, and determined to engage and encourage others in every situation

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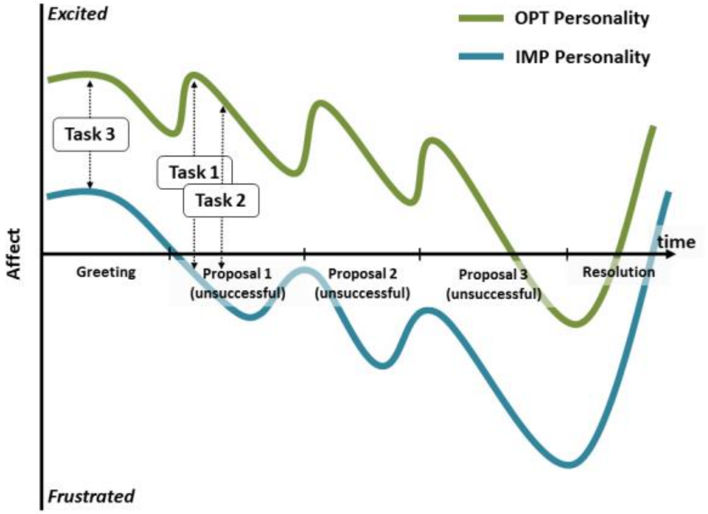
source: news.miami.edu/

IMPATIENT AND PROVOCATIVE

The other personality was snarky, with little patience for life's imperfections and people's mistakes and getting pleasure from challenging others.

PERSONALITY (TIME)



- **OPTIMISTIC PERSONALITY**: gets easily excited, responds positively to question, is more indifferent to failures in the game.
- **IMPATIENT PERSONALITY**: gets more easily frustrated if less favorable responses are given, and is less affected by positive events in the game (e.g., scoring a point).

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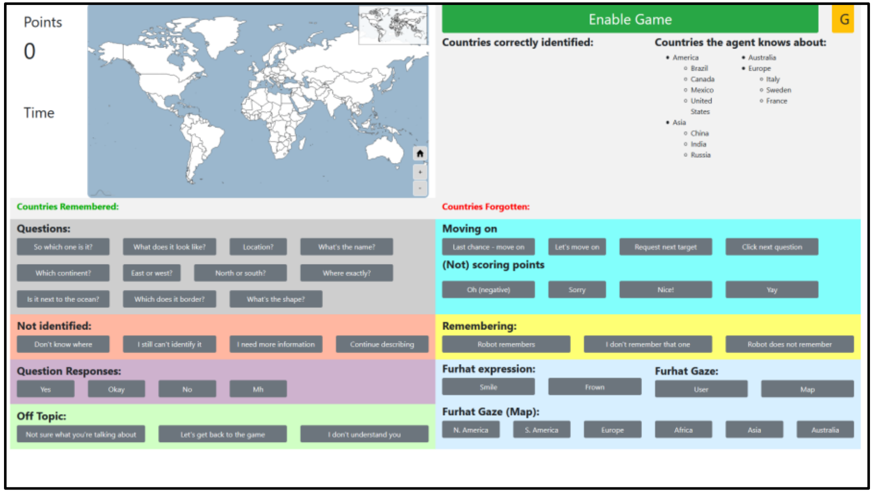
CROWD-AUTHORED IN-GAME RESPONSES

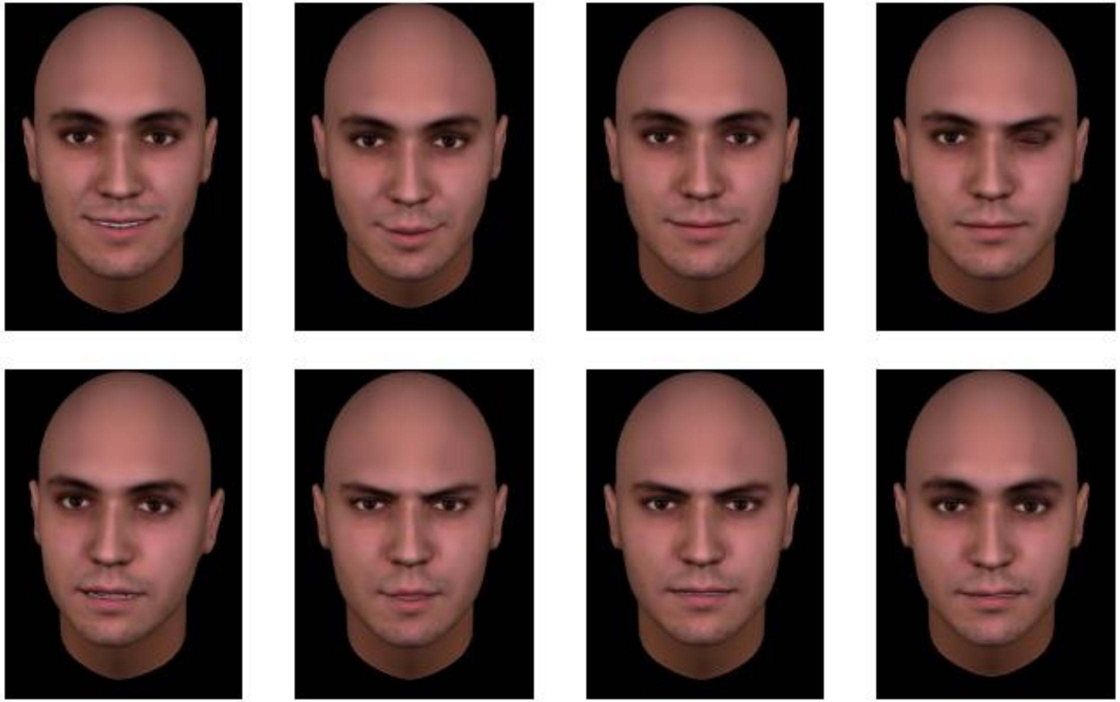
1. **Authoring**: crowd-workers were provided with situational descriptions and a specific affective state of the robot and asked to author one utterance for the robot
2. **Situational evaluation**: crowd-workers were shown the authored lines and asked to judge how (a) typical and ordinary, and (b) offensive these were
3. **Affective evaluation**: crowd-workers were asked to evaluate whether the authored lines were excited and encouraging, frustrated and provocative, or indifferent and how strongly

CONTROLLING INTERFACE



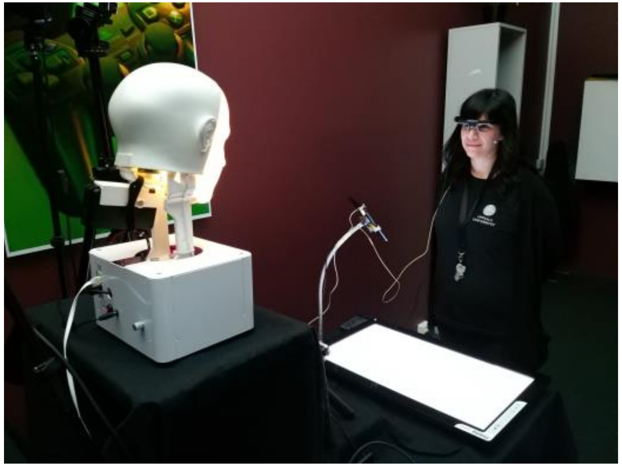
Each robot's response in the controlling interface was annotated with one affective state per robot personality.

- The label + indicated that the response made the robot more excited and encouraging
- The label - that the response made it more impatient and provocative
- The label o that the response left the robot indifferent and thus kept the robot's affective state as stable as possible



- **FOUR EXCITED** (top row): Smile, nodding, slight smile with raised eyebrows, wink
- **FOUR IMPATIENT** (bottom row): shaking head, strong frown, slight frown, slightly disgusted mouth shape with raised eyebrows

PARTICIPANTS



- 73 participants (12 excluded; 59.26% male, 40.74%, 0% other)
- Four conditions: humanlike optimistic, humanlike impatient, morph impatient, and morph optimistic robot.
- Each session had 3 phases: (1) a social chat, (2) map game, and another (3) social chat.

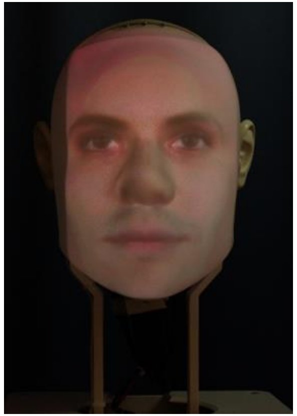
QUESTIONNAIRES

- **Q1**: demographic questions, Big Five Personality traits (Rammstedt and John, 2007); Negative Attitude Towards Robots (NARS) scale (Nomura et al., 2006)
- **Q2**: perceptions of the robot's anthropomorphism (Bartneck et al., 2009), likability, threat (Rosenthal-Von Der Pütten & Krämer, 2014), warmth, competence and discomfort (Carpinella et al., 2017)
- **Q3**: satisfaction, involvement, focused attention (O'Brien and Toms, 2010), and perception of the robot's personality (adapted from Rammstedt and John, 2007), and of its coherence.

HUMANLIKENESS

the morph robot was perceived as more anthropomorphic than the humanlike version (p=.029), but also as more threatening (p=.081)

HUMANLIKE



MORPH

MANIPULATION OF PERSONALITY

	Personality			
	F	p	ηp^2	pow.
Extraversion	.084	.773	.001	.059
Agreeableness	**34.731**	**<.001**	**.379**	**1.000**
Open. Exper.	.022	.882	<.001	.052
Conscient.	**4.746**	**.034**	**.077**	**.572**
Neuroticism	**4.033**	**.049**	**.066**	**.506**
Coherence	.391	.534	.007	.094

	Personality			
	impatient		optimistic	
	M	SD	M	SD
Extraversion	3.233	.716	3.290	.824
Agreeableness	2.883	.827	4.016	.664
Openness to Experience	2.883	.751	2.919	.958
Conscientiousness	3.733	.583	4.032	.482
Neuroticism	2.083	.671	1.774	.530
Coherence	3.617	.499	3.702	.572

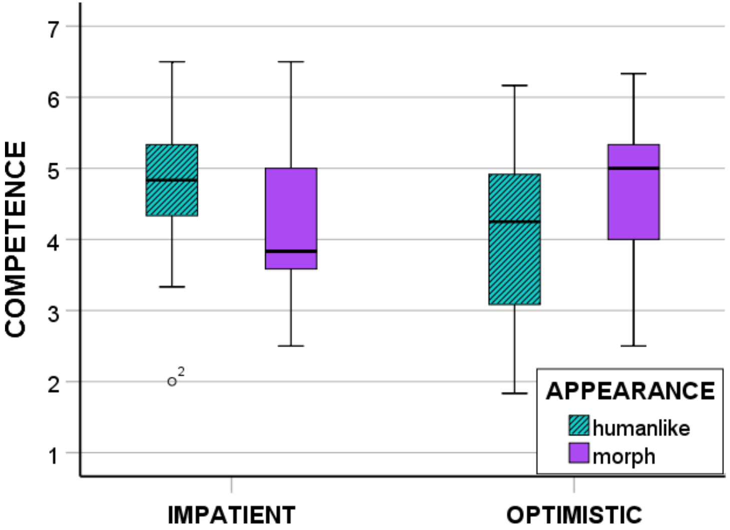
	Appearance			Personality		
	U	z	p	U	z	p
Discomfort	445.0	-.289	.772	403.0	-.897	.370
Losing temper	396.5	-1.06	.289	**160.5**	**-4.710**	**<.001**
Supportiveness	429.5	-.546	.585	**180.5**	**-4.379**	**<.001**
Robot understood me	464.0	-.017	.987	438.0	-.451	.652
Robot played efficiently	431.0	-.573	.567	396.0	-1.163	.245
I understood what the robot was saying	426.0	-.710	.478	**336.0**	**-2.348**	**.019**
I knew what to say to the robot	455.5	-.144	.885	**252.0**	**-3.238**	**.001**

RQ1. To what extent does robot personality influence people's perception of robots with different levels of humanlikeness?

source/creator: Disney Pixar

Main effect of personality on threat (p=.020). the **impatient robot was perceived as more threatening** than the optimistic robot.

RQ1. To what extent does robot personality influence people's perception of robots with different levels of humanlikeness?



Interaction effect of appearance and personality on competence (*p*=.040)

The **humanlike impatient robot** was perceived as more competent than the humanlike optimistic one, and the **morph optimistic robot** was perceived as more competent than the morph impatient one.

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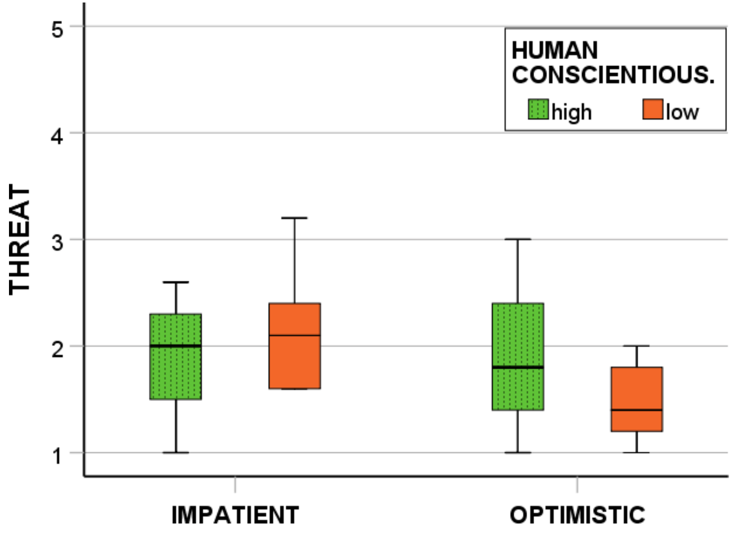
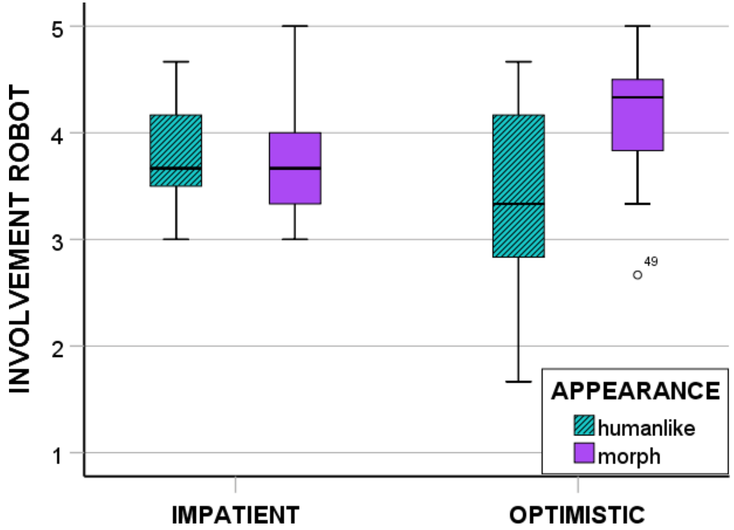
RQ2. To what extent does a match in personality between a robot and a human interlocutor influence the human's perception of the robot?



The match in personality between robot and human did not affect people’s perceptions of robots, except for conscientiousness (p=.039).

Participant's **low in conscientiousness** perceived the impatient robot (the robot matching their personality) as more threatening than the optimistic robot (the robot not matching their personality)

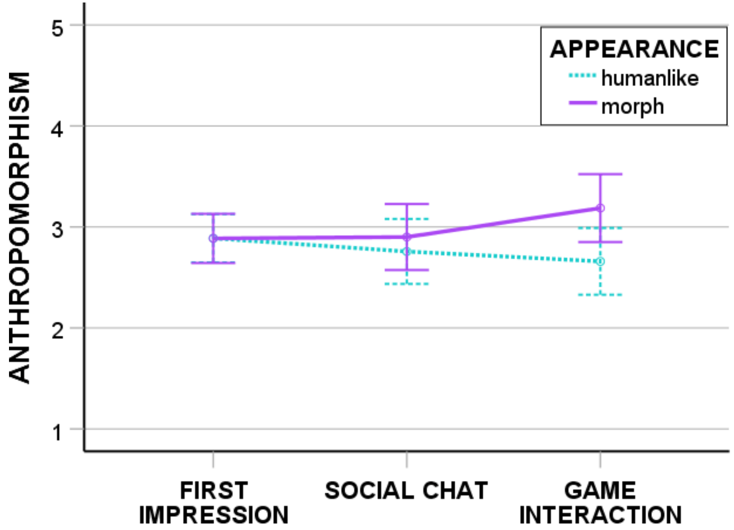
RQ3. How do robot personality characteristics influence people's engagement and task performance?



The robot's personality did not affect participants' involvement with the robot, involvement with the game, task performance and focused attention.

The **morph optimistic robot** elicited more involvement (*p*=.018) than the humanlike optimistic robot, while no major difference was found between the morph impatient and the humanlike impatient robot.

RQ4. To what extent does the personality of the robot influence how people's perception of it develops over time?



Significant interaction effect of time and appearance on anthropomorphism (*p*=.012)

The **anthropomorphism** of the morph robot grew over time and the anthropomorphism of the humanlike robot slightly decreased over time.

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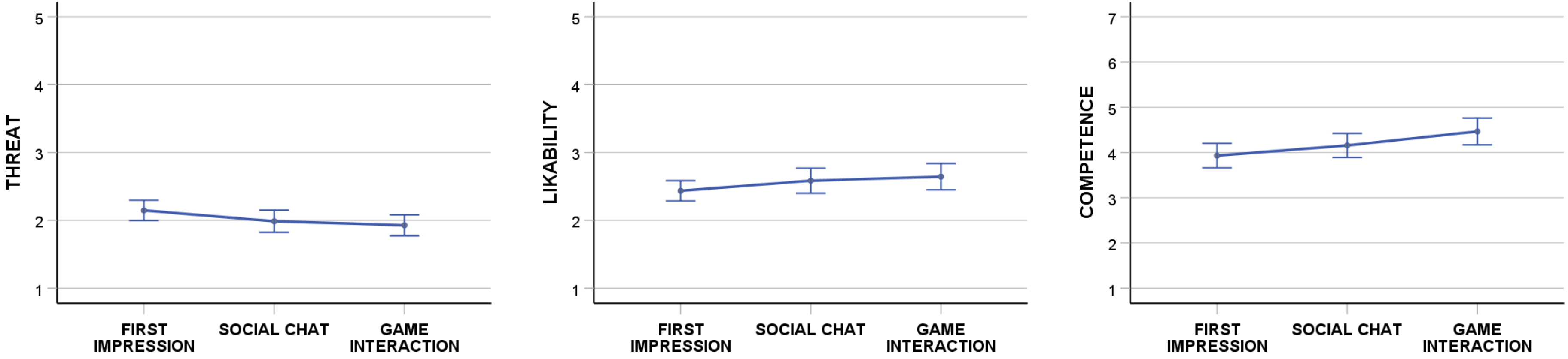
RQ4. To what extent does the personality of the robot influence how people's perception of it develops over time?



The perceived **threat** elicited by the robots decreased over time (p=.045), whereas their perceived **likability** (p=.044) and **competence** increased over time (p=.003)

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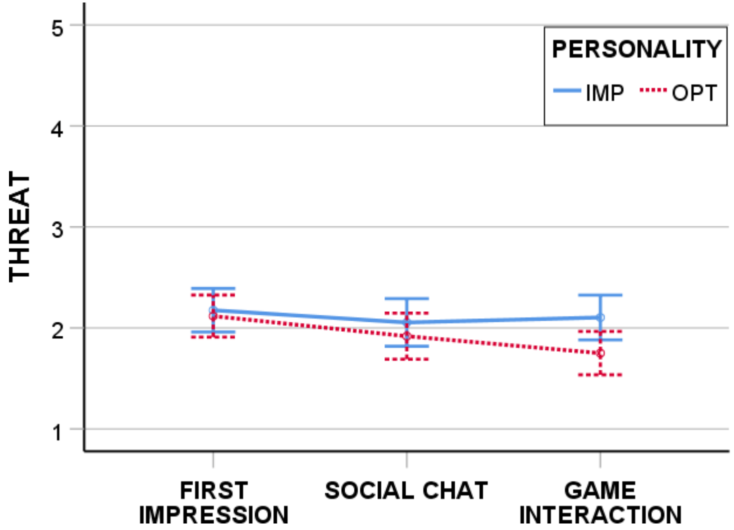
RQ4. To what extent does the personality of the robot influence how people's perception of it develops over time?



Looking at the data revealed an **interesting trend**.

The optimistic personality was perceived as increasingly less threatening over time, while the impatient one remained equally threatening over the course of the interaction.

CONCLUSIONS

- The morph robot was perceived as more anthropomorphic and threatening than the humanlike robot
- The two robot personalities differed in agreeableness, emotional stability and conscientiousness
- The robot that acted impatient was perceived as more threatening
- The difference in uncanniness between the two personalities develops over time. It seems that the longer people interact with a robot, the more influential its behavioral patterns become

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Thanks for your attention!

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