Investigating the social facilitation effect in human-robot-interaction

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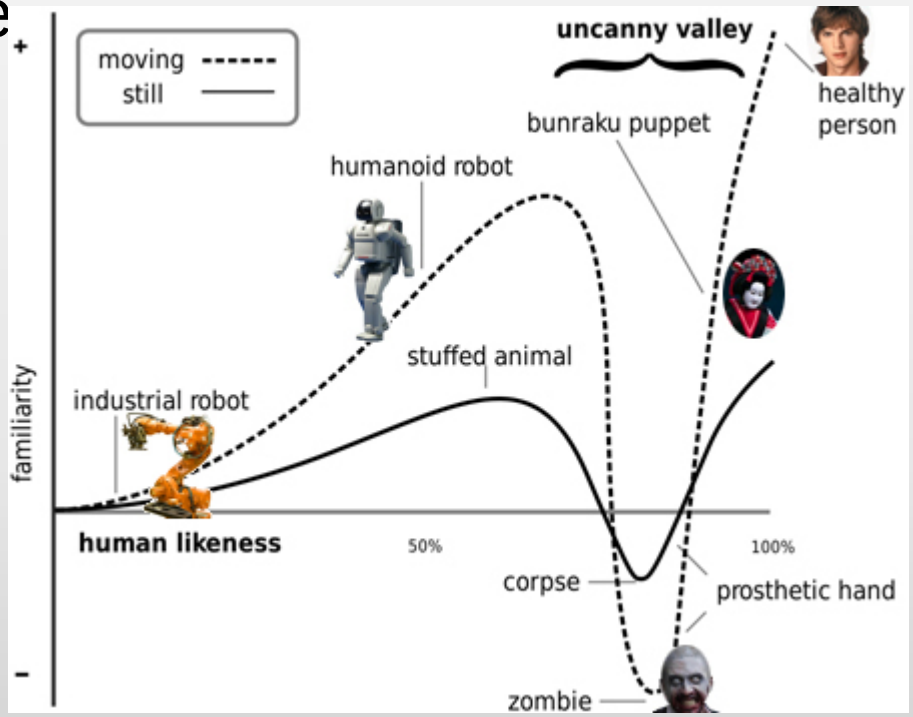
Introduction

- Today, most robots are not developed to socially interact with humans but to accomplish a given work task
- But: usage of so-called “social robots” is slowly increasing
- To be capable of meaning-ful social interactions, social robots need to have anthropomorphic qualities (Duffy, 2003)

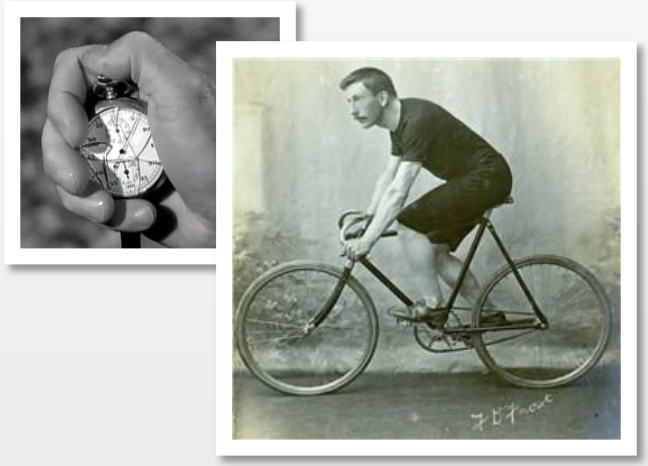
The Uncanny Valley

- Very human-like robots “behaving” non-human may be perceived as strange or eerie
- On a physiological level this effects increases the level of arousal



The Social Facilitation Effect

- Early study (Triplett, 1889):



- Performance increases in presence of others
- Replicated for other tasks (e.g. winding in fishing line) and other species (e.g. cockroaches, monkeys)

The Social Facilitation Effect

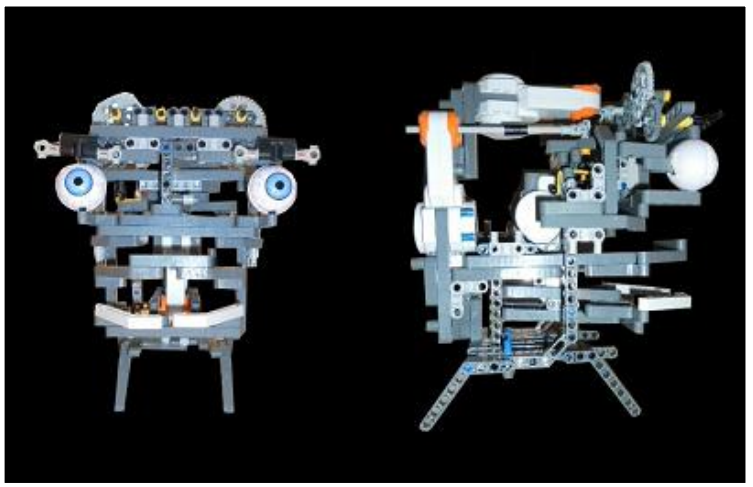
- But: also opposite was observed
  - Social inhibition
  - For complex tasks (e.g. deductive reasoning) performance decreases in presence of others
- Explanation of drive theory (Zajonc et al., 1969):
  - Presence of other ➔ higher arousal ➔ dominant, well-learned reactions
    - ☑ easy tasks
    - ☒ complex tasks
- Uncanny valley
  - Very human-like robot ➔ eerie feeling ➔ high arousal ➔ strong social facilitation/inhibition effect

Aim

- Investigating the influence of differing levels of human-likeness on the social facilitation/inhibition effect
- Hypotheses:
  - Human-likeness increases arousal
  - Performance dependent on task complexity
    - High human-likeness ➔ high performance in easy tasks
    - High human-likeness ➔ low performance in complex tasks

Method

- 3 self-built robots served as artifical experimenter



- Lego Mindstorms NXT
- Voice: Mary TTS
  (“bits3 de male unitselection general”)

Method

Head$_{box}$ - no anthropomorphic features

Head$_{human}$ based on plaster mask of a real human face

Head$_{cartoon}$ same mask but human features were altered in accordance with DiSalvo et al. (2002)

- Head width > head length
- Distance between eyes > diameter of eye

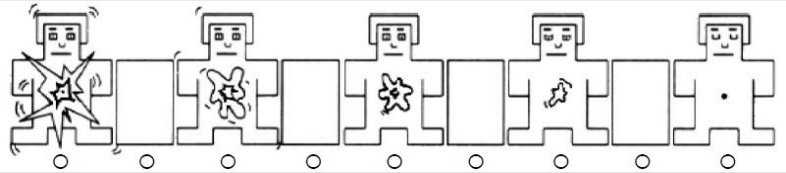
Participants

- 41 participants were invited
  - 12 were excluded due to technical problems, being too old, or producing outliers
- 29 German-speaking subjects included in analysis
- Age range: 18-35 years

Tasks

- Arithmetic tasks (subtraction and addition) in three different complexity levels
  - Easy: Pairs of one two-digit number and one single-digit number, no carry operation involved (e.g.: 13 + 5)
  - Medium: Pairs of two-digit numbers, no carry operation involved (e.g.: 13 + 44)
  - Complex: Pairs of three-digit numbers, carry operation involved (e.g.: 345 + 156)
- Parallel monitoring task
  - Monitor robot‘s LED and contact human experimenter if the LED starts blinking
  - Aim: Ensure constant awareness of the robot’s presence

Measures



- Performance: Error rate of arithmetic tasks
- Manipulation check: Human-likeness card sorting
- Arousal: Self-Assessment-Manikin questionnaire
- Mental effort: SEA - scale

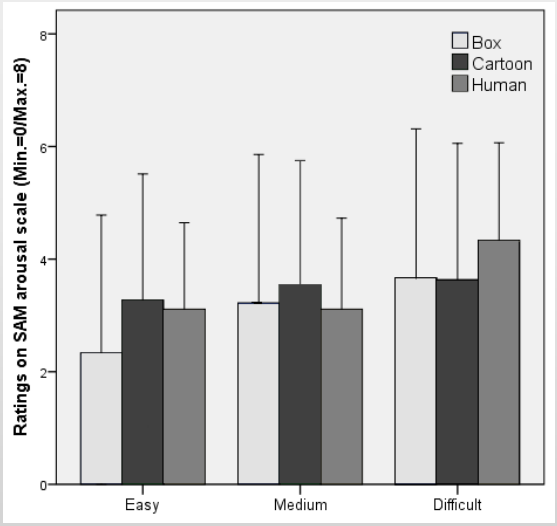
Procedure


demographic questionnaire & consent form
introduction to robot & LED monitoring task
instructions training
training trial
instructions test complexity level "easy"
test trial complexity level "easy" – set 1
test trial complexity level "easy" – set 2
test trial complexity level "easy" – set 3
instructions questionnaires
SEA & SAM questionnaires
randomized
instructions test complexity level "medium"
test trial complexity level "medium" – set 1
test trial complexity level "medium" – set 2
test trial complexity level "medium" – set 3
instructions questionnaires
SEA & SAM questionnaires
randomized
instructions test complexity level "difficult"
test trial complexity level "difficult" – set 1
test trial complexity level "difficult" – set 2
test trial complexity level "difficult" – set 3
instructions questionnaires
SEA & SAM questionnaires
randomized
randomized
human-likeness card sorting
debriefing & payment

Results

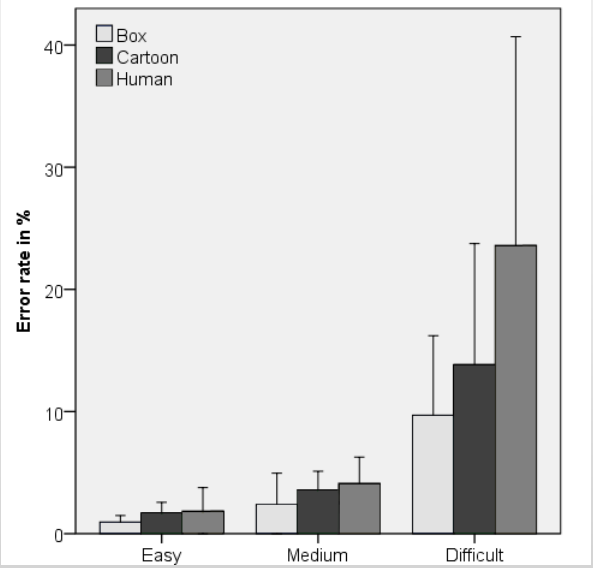
- Human-likeness ratings
  - $\mathbf{Head_{human}} > \mathbf{Head_{cartoon}} > \mathbf{Head_{box}}$ ($p < .05$)

- Arousal
  - Only main effect for task complexity
  - No differences between the robot heads
  - No interaction effect between robot head and task complexity



Results

- Performance
  - Main effect for task complexity
  - Main effect for robot head
    - $Head_{human}$ significantly different from $Head_{box}$
  - Interaction effect between task complexity and robot head
    - As expected $Head_{human}$ led to highest error rate in difficult condition
    - However performance was always best for $Head_{box}$
    - Social inhibition was observed, social facilitation was not.



Discussion & Conclusion

- A higher degree of human-likeness is more likely to trigger a social inhibition effect.
  - Such robots are “deeper” in the uncanny valley?
- Higher degree of human-likeness does not trigger social facilitation effect
  - The non-human robot always led to best results.
  - Tasks too difficult?
  - Effect of camera?
  - Test situation?
- Self-reported data is not in line with theory and performance measures
  - Induced change in somatic arousal was too subtle to be perceived consciously by the subjects

Thank you for your attention!

Questions?

Results

- Mental Workload
  - Main effect for task complexity
  - No differences between the robot heads
  - No interaction effect between robot head and task complexity