Mathur MB & Rechling DB (2016). Navigating a social world with robot partners: A quantitative cartography of the Uncanny Valley. *Cognition*, 146, 22-32.

Ruud Hortensius
Social Robotics Journal Club
11.10.17

SOCIAL ROBOTS

SoBA Lab
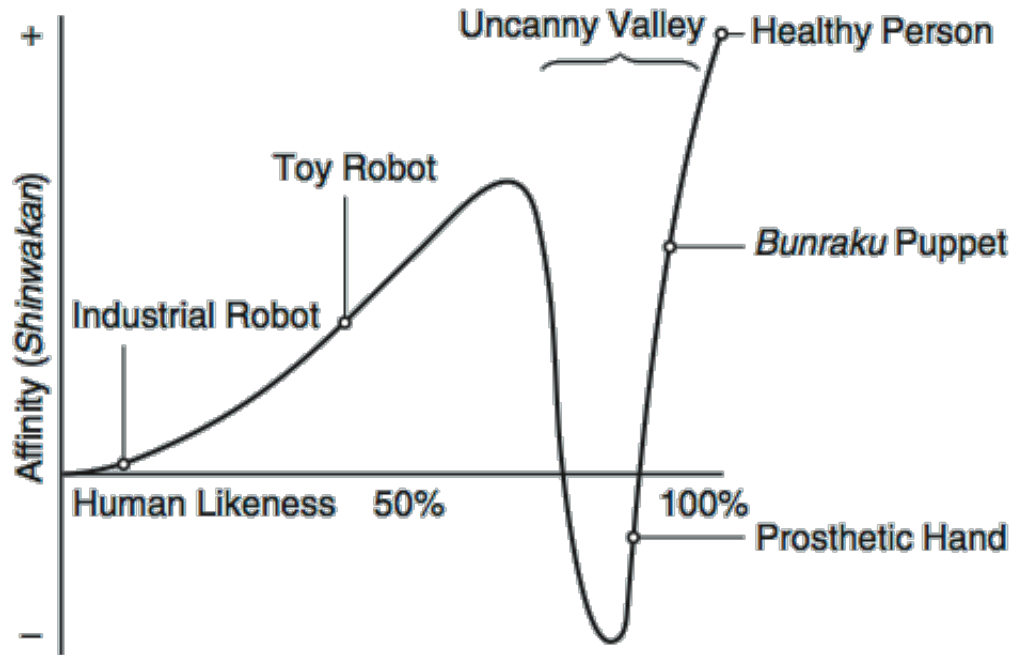SOCIAL BRAIN IN ACTION

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Today's paper

Mathur MB & Rechling DB (2016). Navigating a social world with robot partners: A quantitative cartography of the Uncanny Valley. *Cognition*, 146, 22-32.

Previous literature

Mori (1970), foreshadowed by
Freud (1919) and Jentsch (1906)

Eeriness, fear, unease, negative reactions

Previous literature

- "empirical evidence for the uncanny valley hypothesis is still ambiguous if not non-existent" (Katsyri et al. 2015)
- Methodological confounds: morphing

TABLE 4 | Empirical evidence for hypotheses H1 (naïve hypotheses and morbidity) and H2 (movement).

Author/year	H1a	H1b	H1c	H2a	H2b	H2c
Seyama and Nagayama, 2007	−	−				
MacDorman et al., 2009	−	+				
Looser and Wheatley, 2010	−	+				
Thompson et al., 2011				−	+	
McDonnell et al., 2012	(+)	+	+			(+)
Yamada et al., 2013	(+)	(−)				
Burleigh et al., 2013	−	+				
Carter et al., 2013	−	+				
Poliakoff et al., 2013	+	(+)				
Cheetham et al., 2014	−	+				
Piwek et al., 2014	(+)	−	+	−	+	(−)
Rosenthal–von der Pütten and Krämer, 2014	−	+				
Total	8	9	2	2	2	0
+	1	7	2	0	2	0
−	7	2	0	2	0	0

Aims of the study

(1) "to determine if human reactions to android robots truly exhibit an UV effect"

(2) "to determine the degree to which [the UV effect] actually influences humans' willingness to trust a robot as a social partner.

Explicit (1) and implicit (2) measurement of UV

Wild-type robots (Exp 1) and controlled robots (Exp 2)

Overview

Experiment 1 Wild-Type Robots

1a: Mechano-humanness spectrum (n = 66)

1b: Likability (n = 342)

1c: Trust-motivated behaviour (n = 334)

Exploratory: Category confusion

Experiment 2 Controlled Robots

2a: Likeability (n = 52)

2b: Trust-motivated behaviour (n = 92)
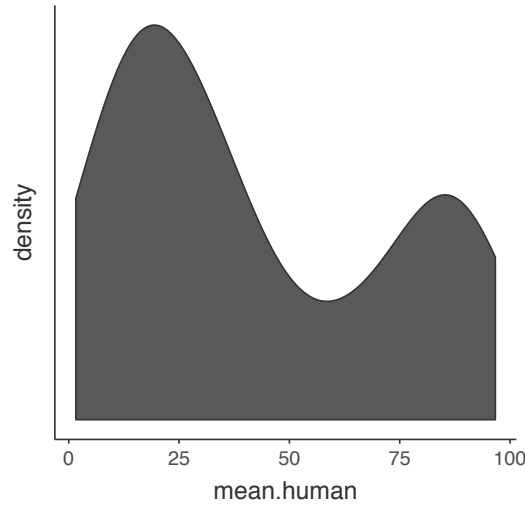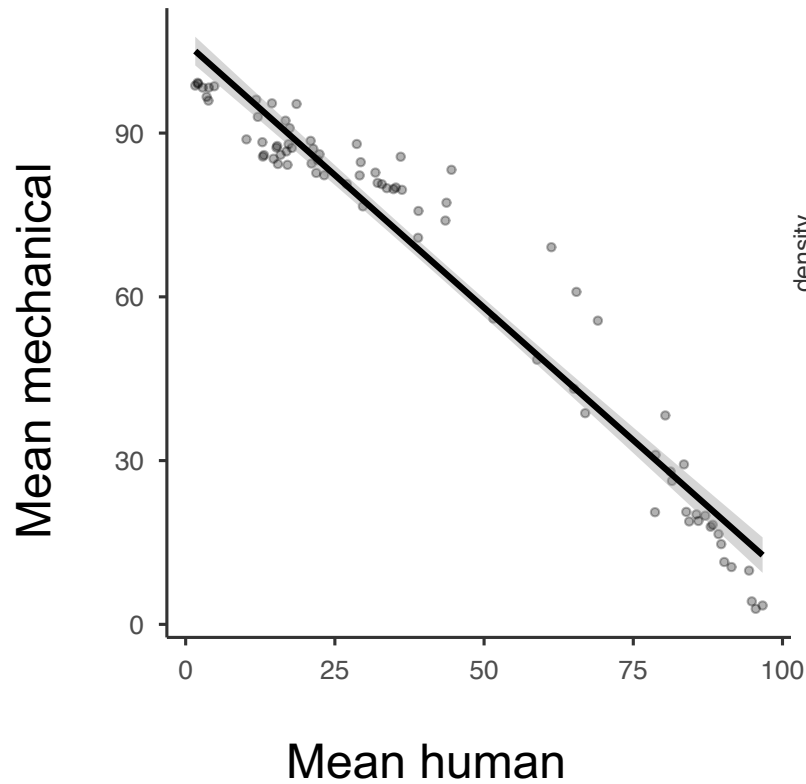
Replication (n = 105 and 98)

Exp 1 – Stimuli and Aims

80 faces selected based on 8 inclusion criteria and 4 exclusion criteria

1 assess human and mechanical properties per robot

2 check unidimensional property of (1)

3 measure valence and magnitude of emotion per robot

1. Overview of all robots
2. No time limit
3. Only mechanical- or human-resemblance

How mechanical does this robot face look?

Not at all mechanical   Extremely mechanical

0   10   20   30   40   50   60   70   80   90   100

How much **positive or negative emotion** is this robot face showing?

Strongest unpleasant   Strongest pleasant
emotion   Neutral (no emotion)   emotion

-100 -80 -60 -40 -20   0   20   40   60   80   100

Experiment 1A – Results

Mean mechanical

Mean human

No relation between emotion and mech/human

One-dimension

Estimate how friendly and enjoyable (versus creep) it might be to interact with each face in an everyday situation

Less friendly; more unpleasant and creepy   More friendly and pleasant; less creepy

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

Model Order

Linear	Quadratic	Cubic
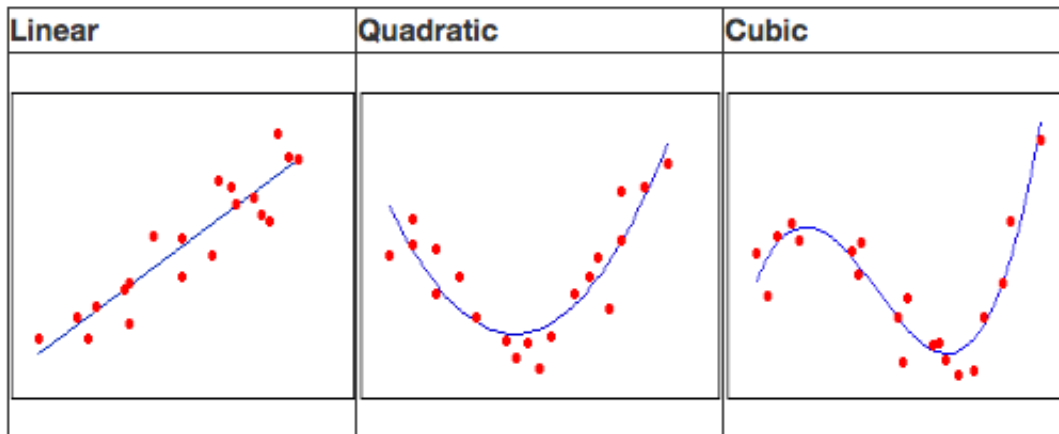
Expectations:
UV: nonlinear relation!
2nd = quadratic
3rd = cubic
4th = quartic

Experiment 1B - Results
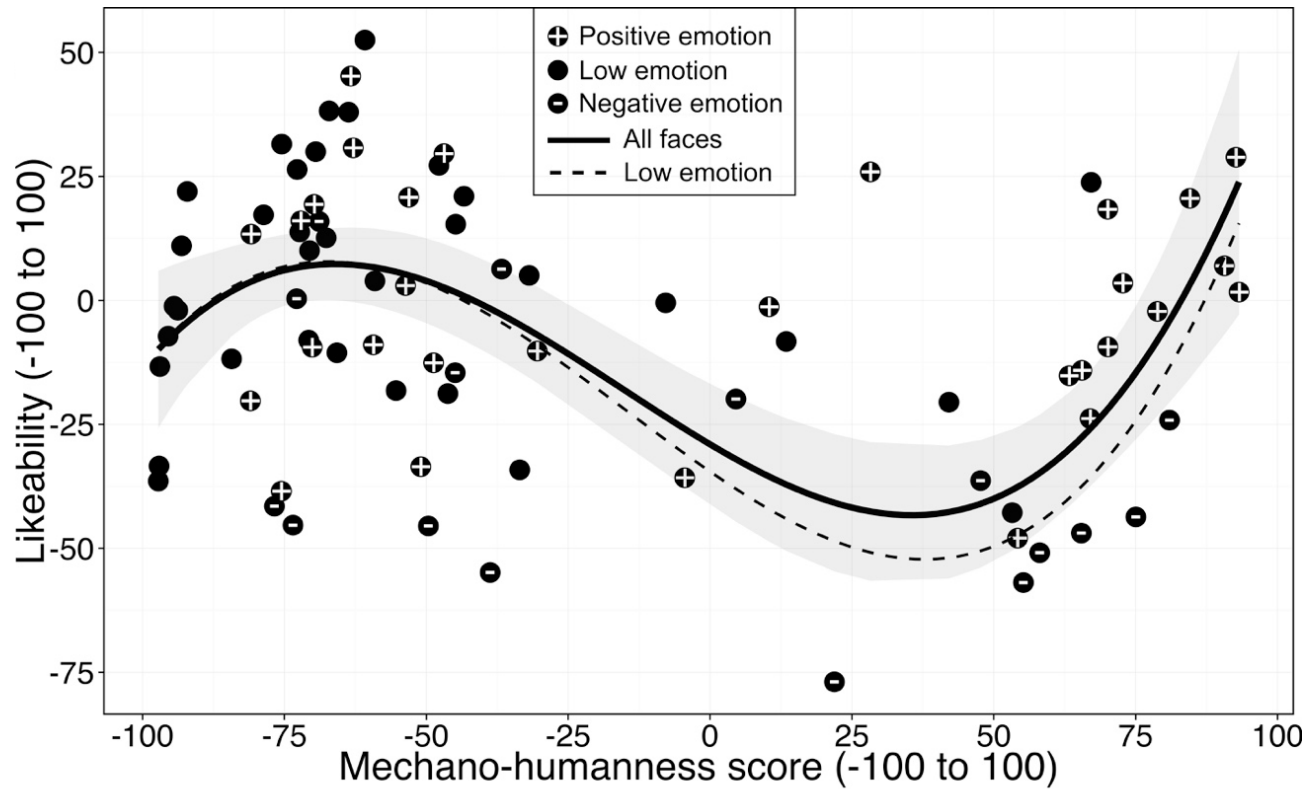
1. 3rd degree model; converging with Mori's UV
2. While emotion → likeability, no effect of emotion of fit
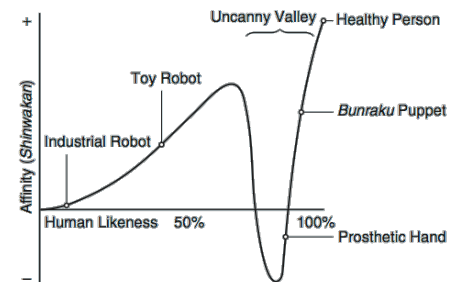
Experiment 1C - Task
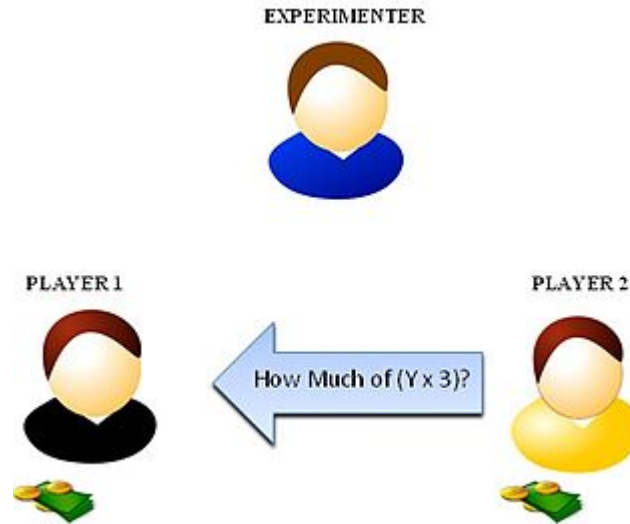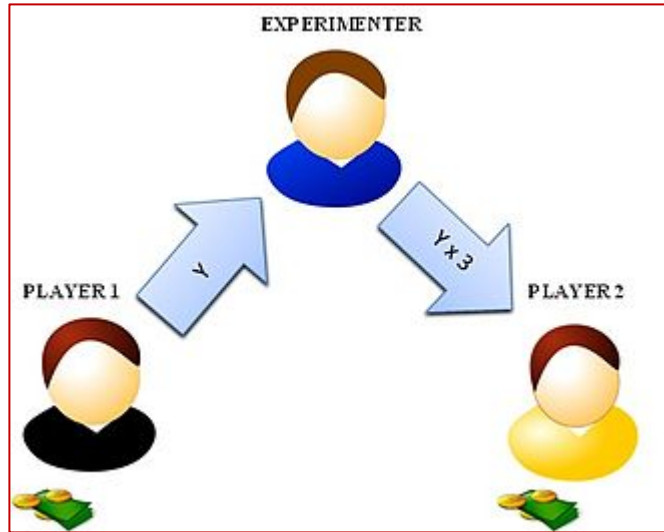
1. "Money would be transmitted to the robot laboratories, and the imaginary money will be distributed according to robots' decision"
2. Able to receive bonus based on performance (motivation).

Expectations:
UV will be also present for implicit judgements

Experiment 1C - Results
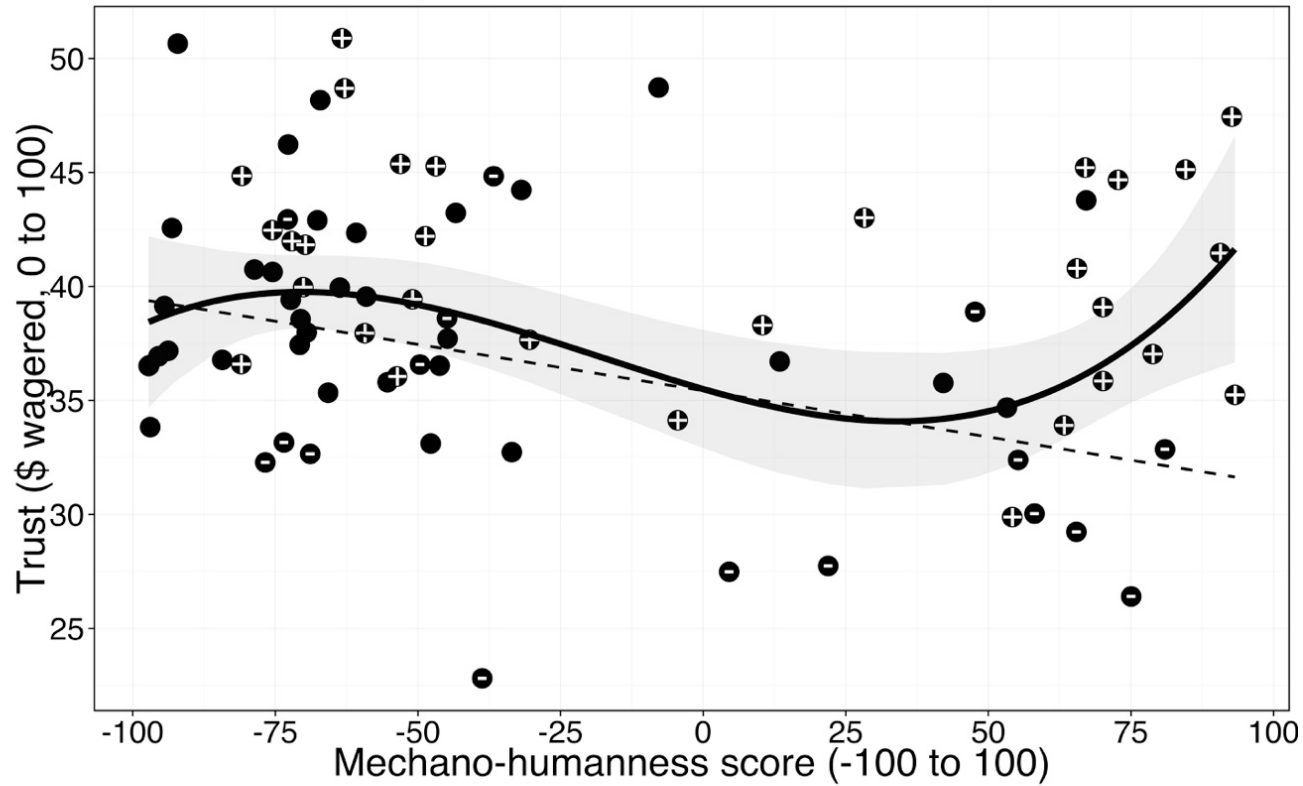
1. 3rd degree model; converging with Mori's UV
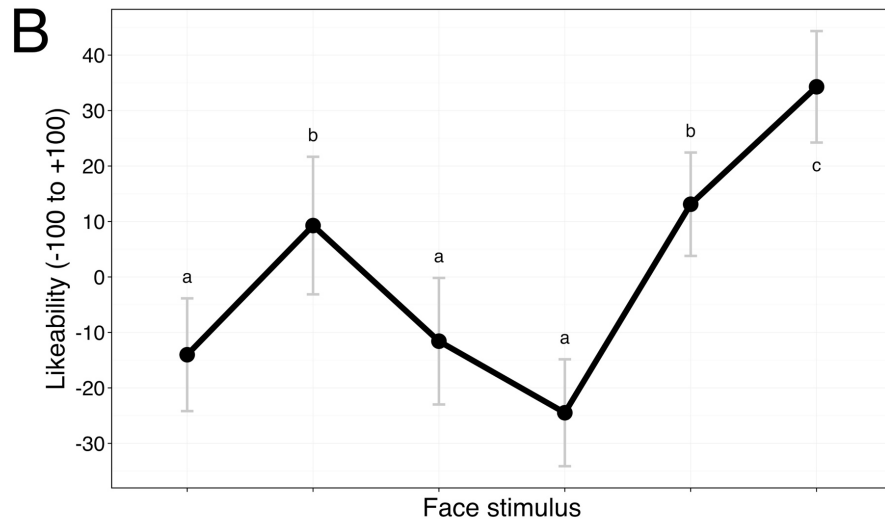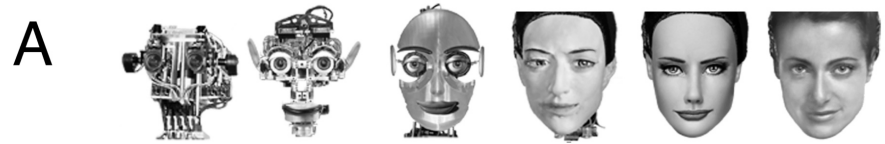2. Emotion → trust, linear model, UV disappears

Exploratory Analysis

- Previous literature:
  - "When stimuli are morphed across categories from non-human to human, the most ambiguous stimuli, rather than the most human-like stimuli, show prolonged classification times and increased eeriness" – de Borst & de Gelder (2015)
- Predictions:
  1. Rating time highest for face closest to maximum UV effect on likability (valley) — **Yes, 2nd degree fit**
  2. Category confusion: rating time should impact nonlinear fit between MH and likeability — No
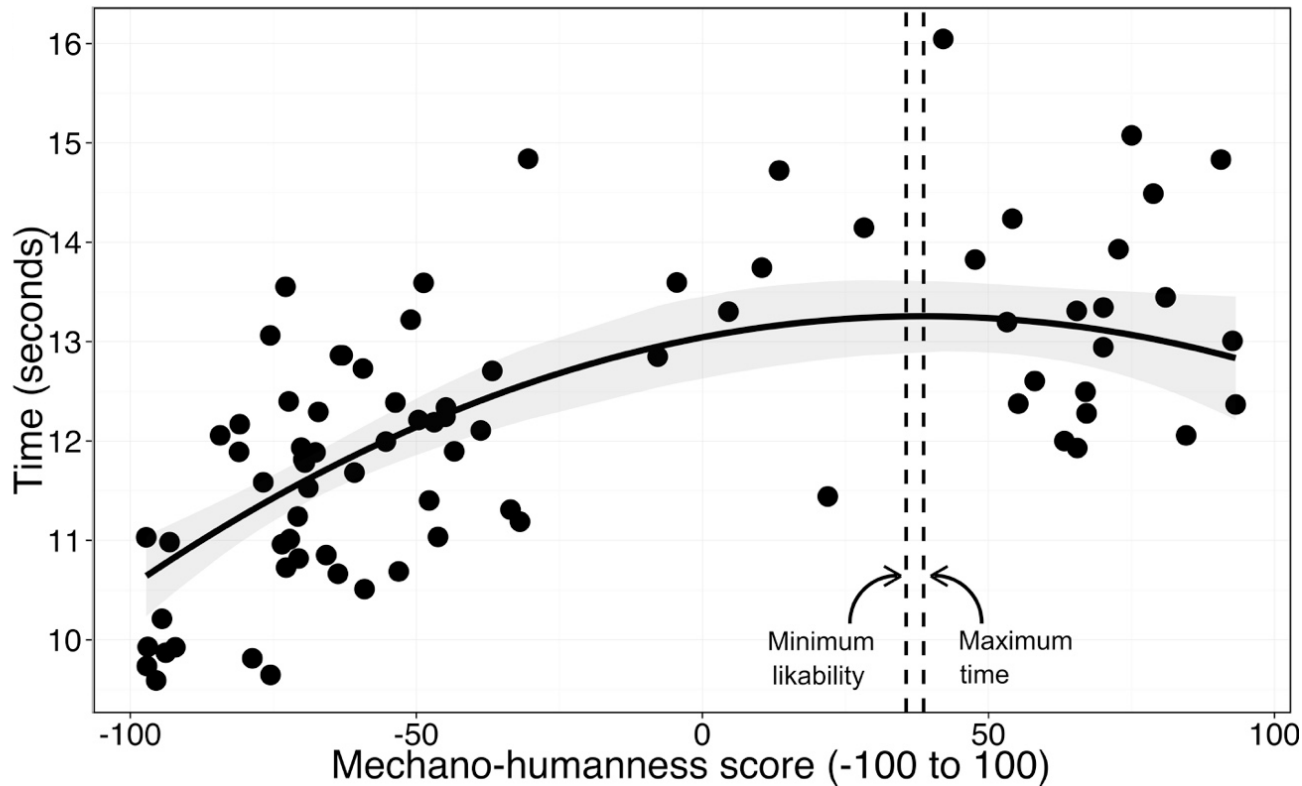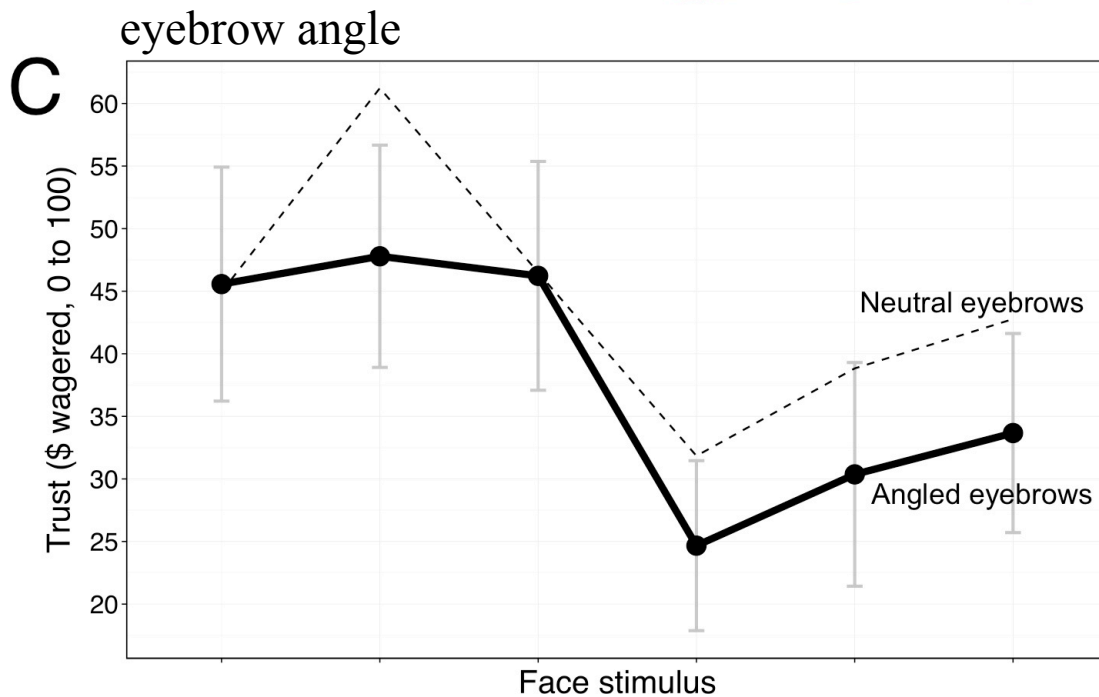
Experiment 2A and 2B:
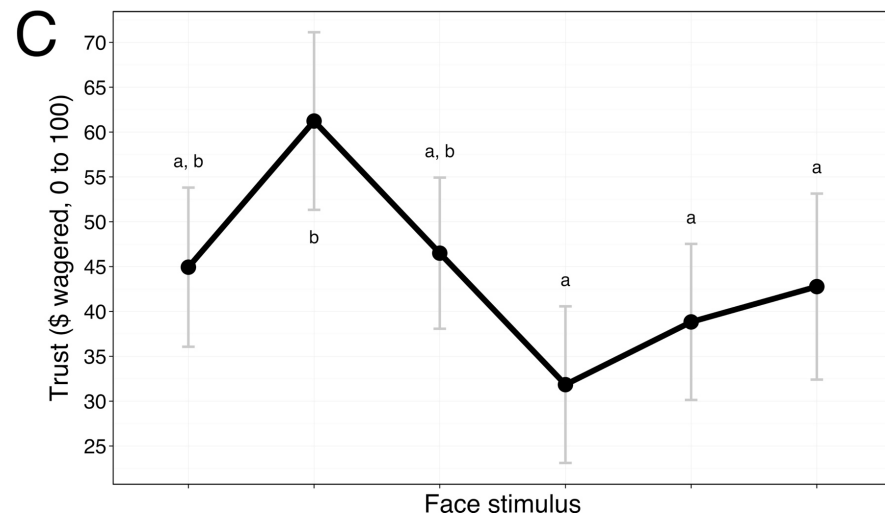
Replication experiment
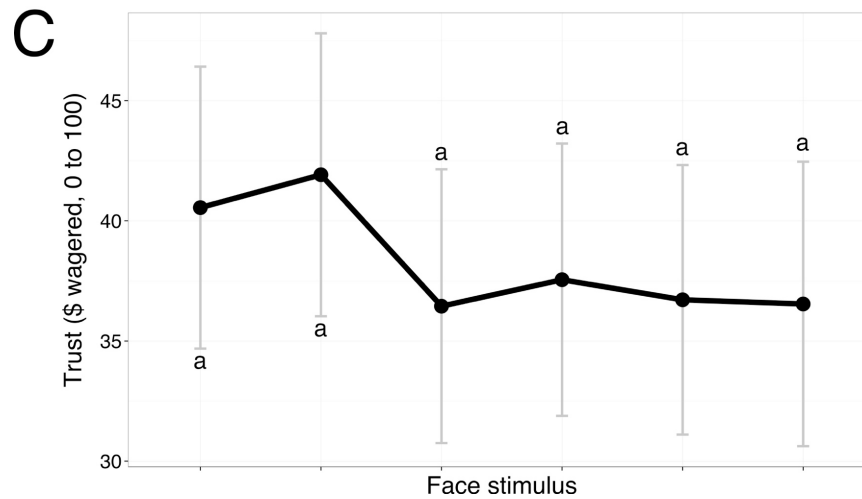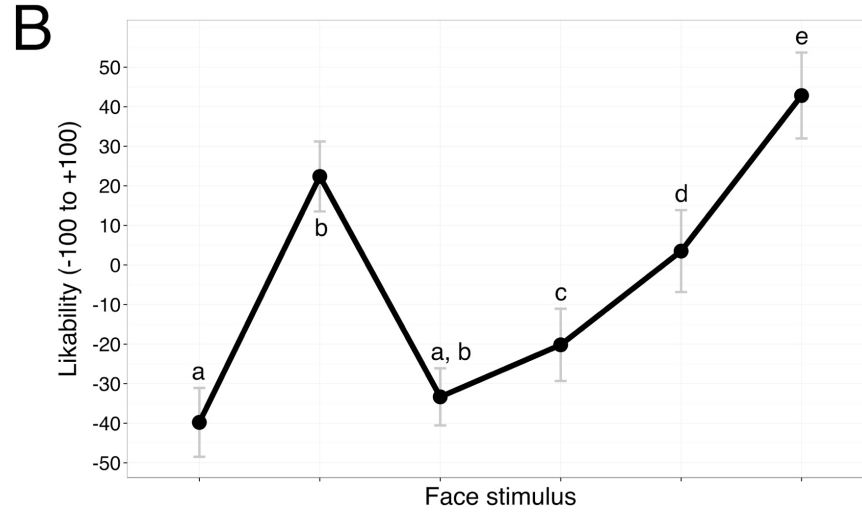
Eyebrow angle → trustworthiness

Refit model of 2B (neutral only)
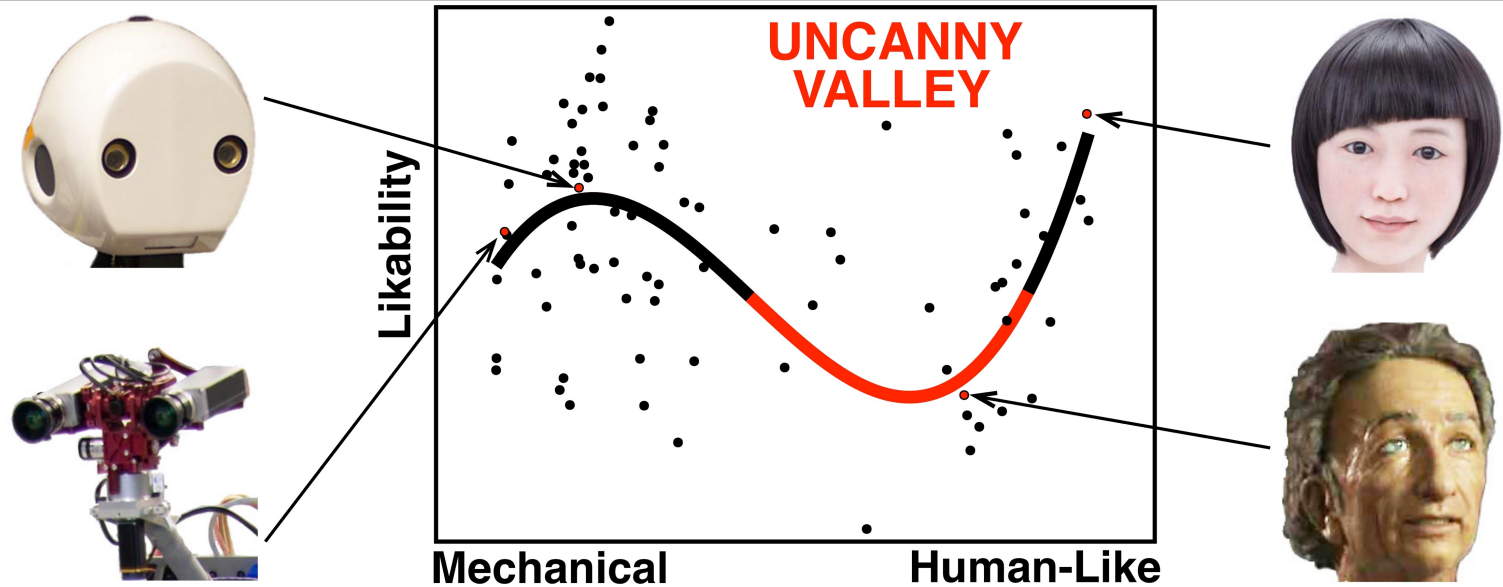
A. Neutral eyebrows:

B. Angled eyebrows:

eyebrow angle

C.

Trust ($ wagered, 0 to 100) vs Face stimulus

Neutral eyebrows

Angled eyebrows

Conclusion

① **"to determine if human reactions to android robots truly exhibit an UV effect"**

② **"to determine the degree to which [the UV effect] actually influences humans' willingness to trust a robot as a social partner.**
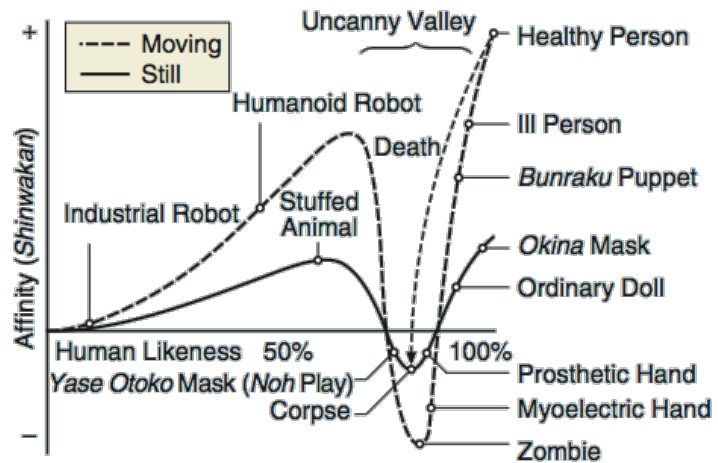
Discussion

- Uncanny Valley:
  - Explicit and implicit
  - Similarity Wild-life and controlled robots
- Mechanisms:
  - Category confusion?
- Overall:
  - Novel methods
  - Careful design
  - Open data
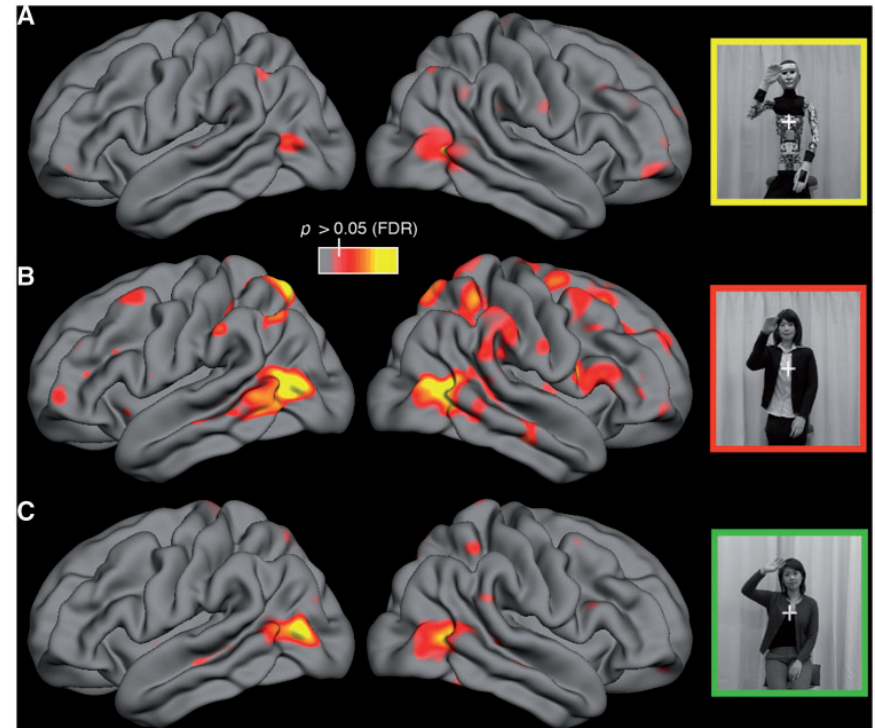 - Preregistered replication
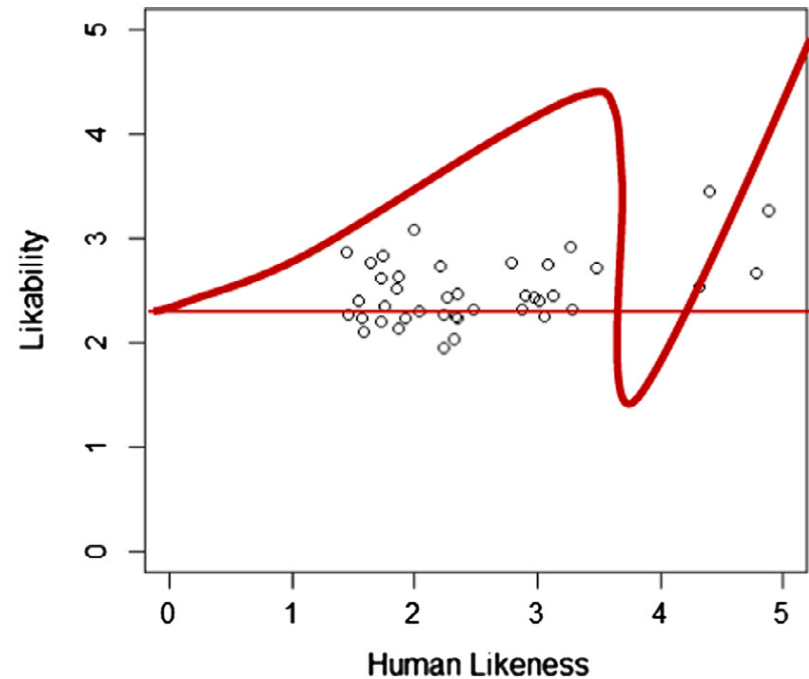
Rosenthal-von der Pütten & Krämer (2014) – 40 robots, Depedent on type of robot (e.g. bipedal, humanoid)
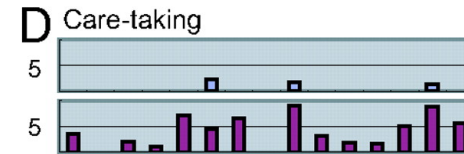
Reflection

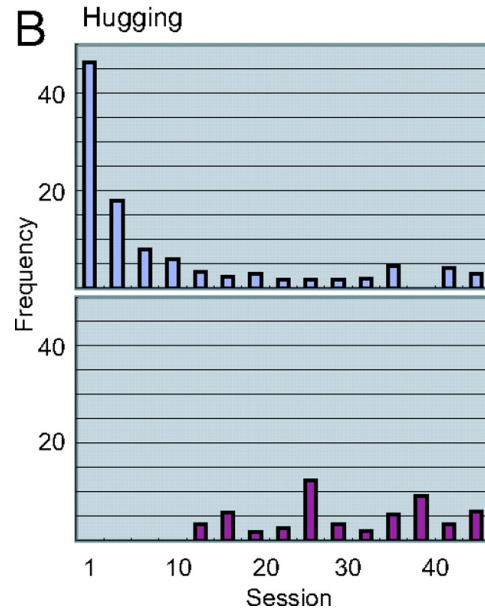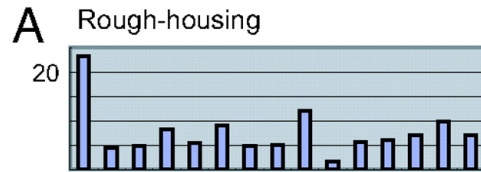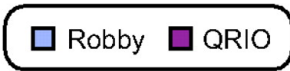Mori (1970)

What about movement?

Saygin et al, 2012
see also Cross et al. 2016; Cross et al. 2012

c.f. Journal Club S01E07

Reflection

Effect of experience?

- 5 month interaction, 27 sessions
- At the end, children "treated the robot as a peer rather than as a toy"

Tanaka, Cicourel & Movellan, 2007

Reflection

- Sample:
  - Inter-individual differences and dispositional characteristics? "[…]the same impression does not necessarily exert an uncanny effect on everybody" – Jentsch, 1906
  - Cultural influences?
  - Target group of social robotics?
- Stimuli:
  - Face-centric
  - Effect of emotion is not directly manipulated
- Construct:
  - What is uncanny? Likeability? Negative reactions? Eeriness?

New Scientist
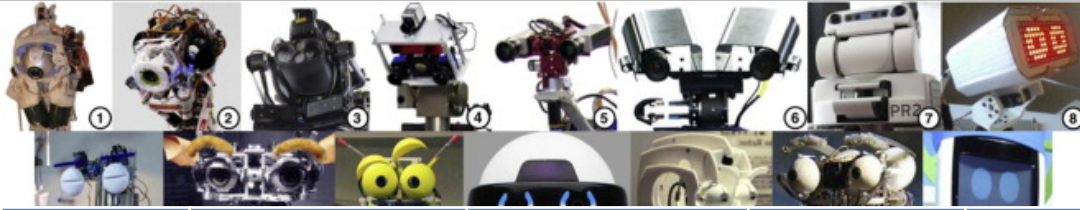
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DAILY NEWS 2 November 2015

Into the uncanny valley: 80 robot faces ranked by creepiness

Reflection

	Mechanical	Humanness	Emotion	Duration	Likeability	Trust
NAO	21.88	82.70	6.78	11.68	52.49	42.35
Pepper	29.15	82.24	29.71	10.69	20.79	45.38

THM

Last words

Wired: Do you think it's possible to bridge the uncanny valley?

Mori: Yes, but why try? I think it's better to design things like Honda's Asimo, which stops right before it gets to be uncanny.

WIRED