In Gaze We Trust: Comparing Eye Tracking, Self-report, and Physiological Indicators of Dynamic Trust during HRI

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BACKGROUND

Trust has been shown to affect outcomes of human-robot interactions (HRI) [1]. Human operators can over-trust and misuse the system by not providing sufficient monitoring, causing accidents, and it is also possible for them to disuse the robot due to under-trusting [2, 3]. Thus, it is important to continuously measure and understand the dynamics of shared space HRI trust and how trust is built, breached, and recovered.

OBJECTIVE

Assess if eye tracking or physiological indicators offer greater sensitivity in capturing dynamic trust during HRI than the commonly used trust self-reports

METHODS

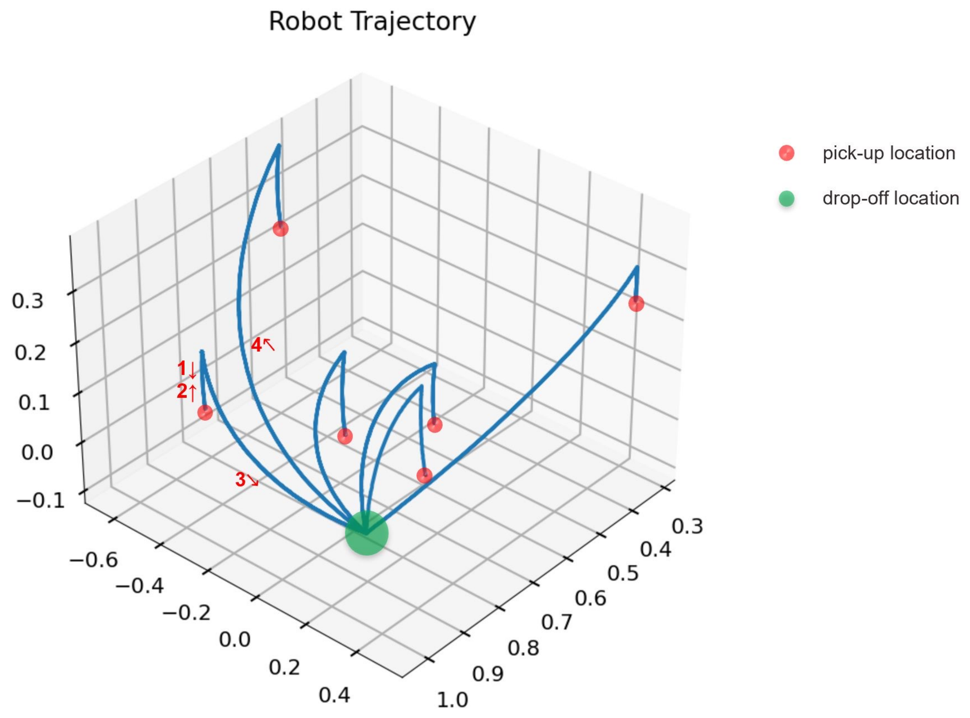
- 38 participants (18 males, 22 females), mean age 25.88±5.27 years
- Universal Robots collaborative-robot (UR10; Universal Robots, Denmark)
- **Ten 100% reliable trials**, then **ten 76% reliable trials** to **manipulate trust**

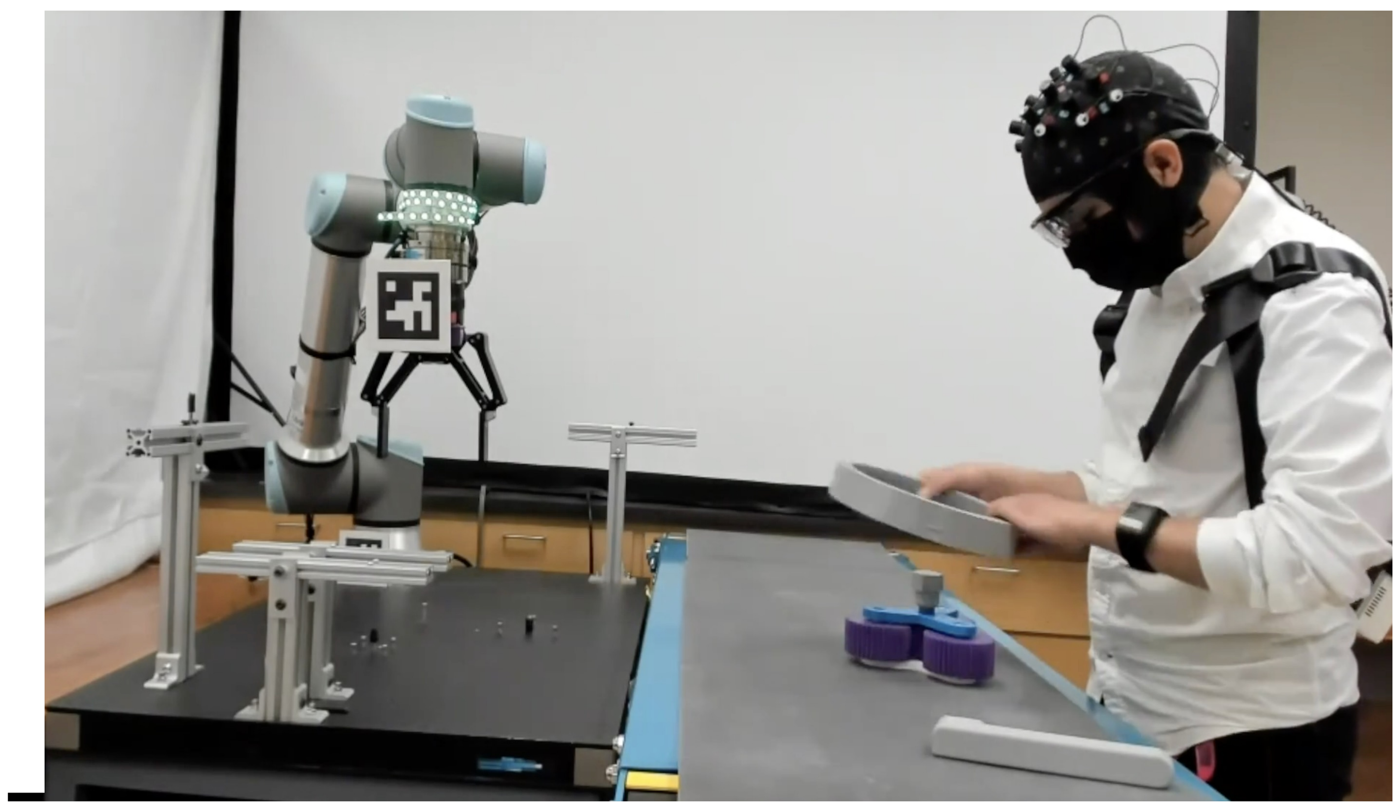
Tobii Glasses 2 (Tobii Pro AB, Sweden)
eye tracker for gaze behavior

Actiheart 5 (CamNtech, UK) ECG
for physiological indicators

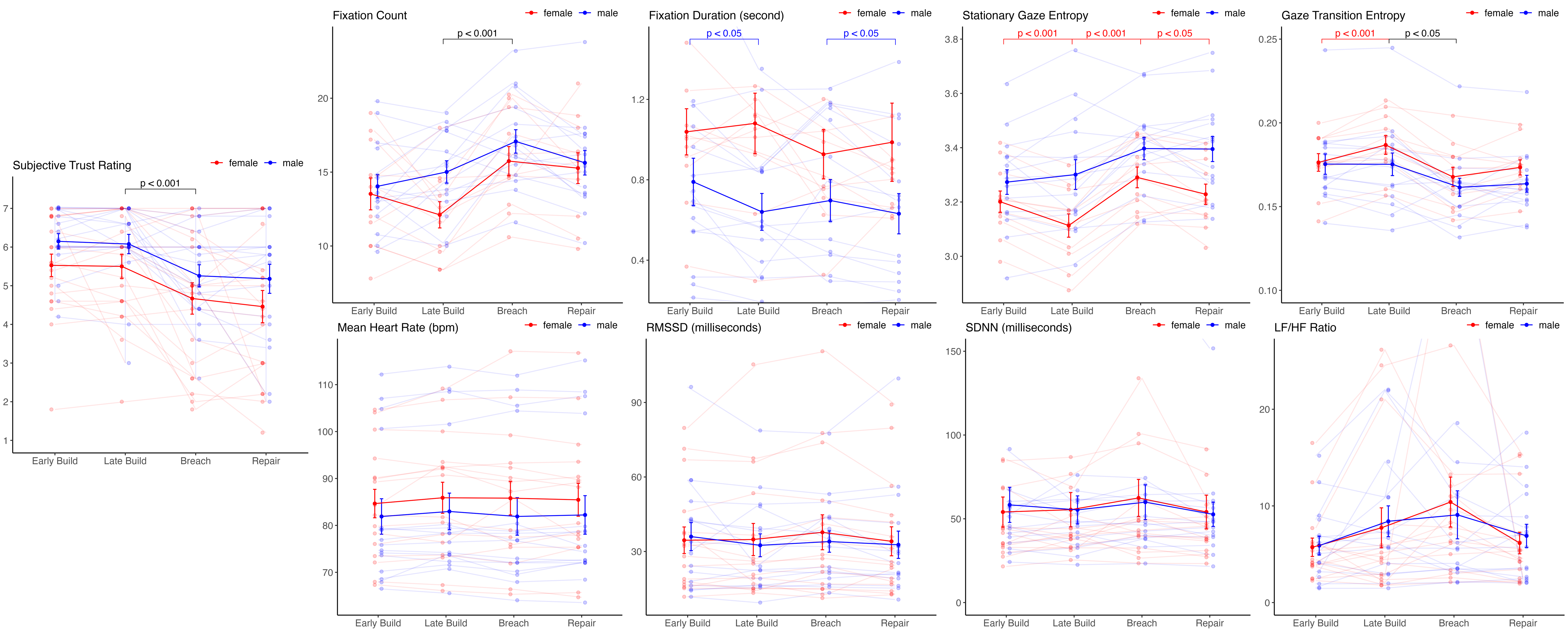
Robot Perturbations

1. Sudden increase in speed to 100% max designed joint speed (120°/Sec.)
2. Sudden loss of speed to 30% max designed joint speed
3. Sudden change in robot indicator light to idle color during operation
4. Invasion of human space while delivering part
5. Variation (±20 cm) in X and Y drop-off location
6. Providing a part in the incorrect sequence
7. Dropping a part from 30 cm above the workspace table25





RESULTS



Subjective trust	**Only captured trust breach**, with no change during the build and repair phases. No sex differences.
Heart rate variability	**Not sensitive to dynamic trust change**, potentially due to complex motor movements.
Eye tracking fixation	**Decrease in subjective trust was associated with increased fixation counts**, reaffirming evidence of the negative relationship between human-automation trust and monitoring frequency [5].
Eye tracking entropy	**Decreased GTE** during the **trust breach** resembled **distrusting behavior** [6], **supported by decreased trust ratings. Sex differences –** Only **males exhibited less automation monitoring** during the **late build** and **repair** phase; **females**' unique changes were in **entropies** throughout the phases.

KEY TAKEAWAYS

- Subjective trust measure was not sensitive to all trust manipulations and additional gaze behavior differences were observed across trust build, breach, and repair phases.
- Gaze behavior is a cognitive outcome, and males & Females demonstrated different cognitive behaviors during trust changes.
- Ultra-short-term HR metrics (<5min) did not capture trust changes, and its sensitivity can be context-based.

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