Emotional Intelligence on the Road: Empathic AI in Response to Stressful Driving Situations

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Problem Statement

Modern driving assistance systems increasingly include real-time monitoring of driver states, yet the step beyond detection – supporting drivers emotionally – remains underexplored.

Stressful driving events such as near-accidents or high cognitive load can impact both driver safety and emotional well-being. While physiological stress detection has been researched, there is little empirical work on how voice-based AI assistants could help regulate stress and provide post-event emotional support.

This study investigates whether an empathic voice assistant can reduce perceived stress, enhance emotional support, and improve user acceptance after stress-inducing driving scenarios. It addresses the gap between affective computing and in-vehicle interaction design.

Method

We conducted a within-subject user study with 20 participants (aged 25–45), each exposed to two stressful driving scenarios in a high-fidelity hexapod simulator:

• Scenario 1: A sharp-curved driving sequence requiring advanced maneuvering.
• Scenario 2: A sudden appearance of a child on the road, requiring immediate braking (emergency hazard).

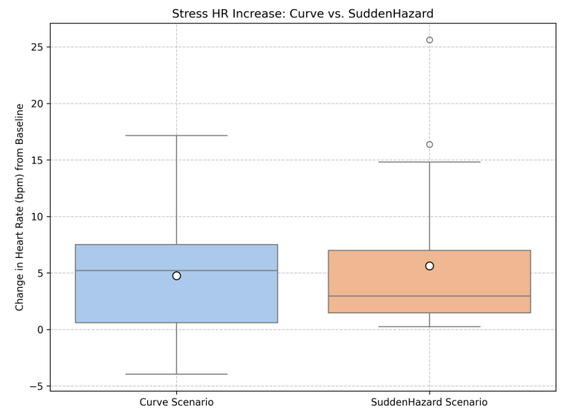
Each scenario was experienced once with an empathic AI voice assistant and once without, counterbalancing the order across participants. The empathic AI delivered a short, reassuring voice message directly after the stressful event (e.g., "That was a close moment, but you handled it very well.").

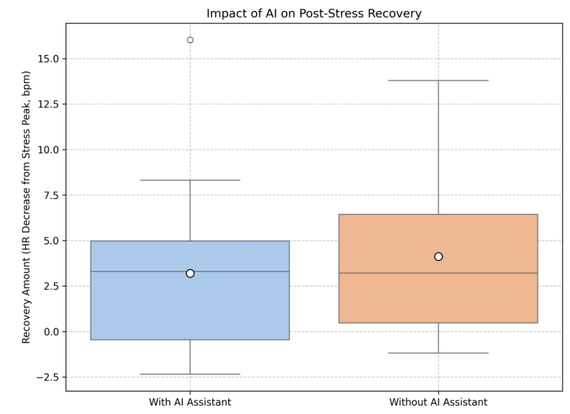
Results

Physiological Results (Heart Rate):

1. **H1 (Percieved Stress):**

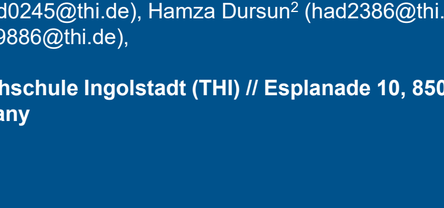
- **Stress induction: Both scenarios induced similar stress levels (Curve: +4.76 bpm, Hazard: +5.63 bpm, p = 0.6198).**
- **Recovery phase: No statistically significant improvement with AI (With AI: –3.20 bpm, Without AI: –4.12 bpm, p = 0.7915).**





Subjective Results:

2. **H2 (Emotional support): Significant improvement with AI (AI = 5.11, No-AI = 2.42, p < .001).**
3. **H3 (User acceptance): 17 out of 20 participants preferred the AI-supported scenario and reported feeling better supported.**
4. **H4 (Safety perception): Slight increase in perceived safety with AI (non-significant trend, p = 0.403)**



Conclusion

The empathic voice assistant did not significantly enhance physiological recovery but was clearly valued by participants on a subjective level. Emotional support scores and user preference strongly favored the AI condition. Participants appreciated the calming, human-like tone and felt more emotionally supported. However, limitations such as message length, timing, and lack of personalization were noted. Future systems should provide shorter, better-timed, and adaptive support, possibly integrating real-time affect sensing.

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