HumanTech
Technology for Human Wellbeing Institute

HEIA-FR
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Affective Computing and Biofeedback in Human Vehicle Interaction

Seminar on Affective Computing for Empathic Behaviour Change

Guide: Meteier Quentin

Final Presentation

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Biofeedback in Human Vehicle Interaction

Monitoring driver's state and emotions and give feedback using visual, auditory interfaces to prevent accidents

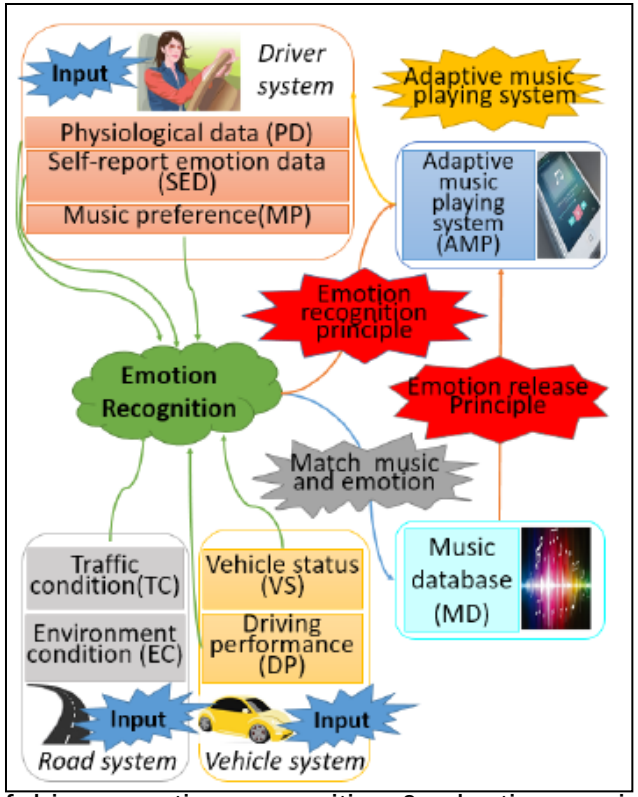
https://dl.acm.org/doi/10.1145/3473682.3477439

Emotion Regulation in the Vehicle

- Adaptive music
- Ambient light
- Empathic speech
- Reappraisal
- Relaxation techniques
- Biofeedback
- Temperature control
- Interventions

M Braun et al. Affective Automotive User Interfaces – Reviewing the State of Emotion Regulation in the Car. ACM Comput. Surv. 2020

Releasing Drivers' Negative Emotions by Using Music

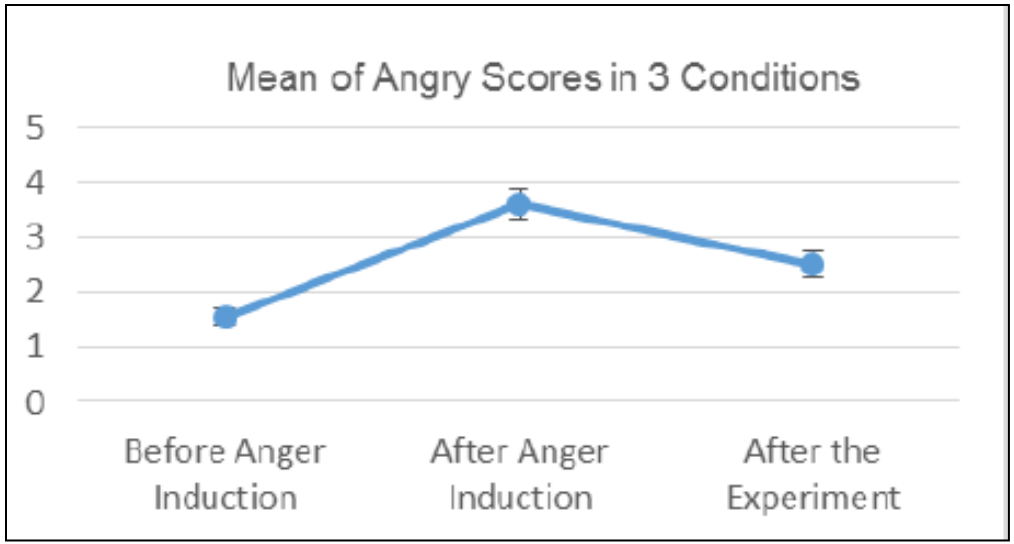


Framework of driver emotion recognition & adaptive music playing system

- Driver emotion recognizing
- Detecting relationship of data & driver negative emotions
- Playing adaptive music to release negative emotion

Yueyan Zhu et al. Recognizing and Releasing Drivers' Negative Emotions by Using Music: 8th International Conference on AutomotiveUI '16, 2016

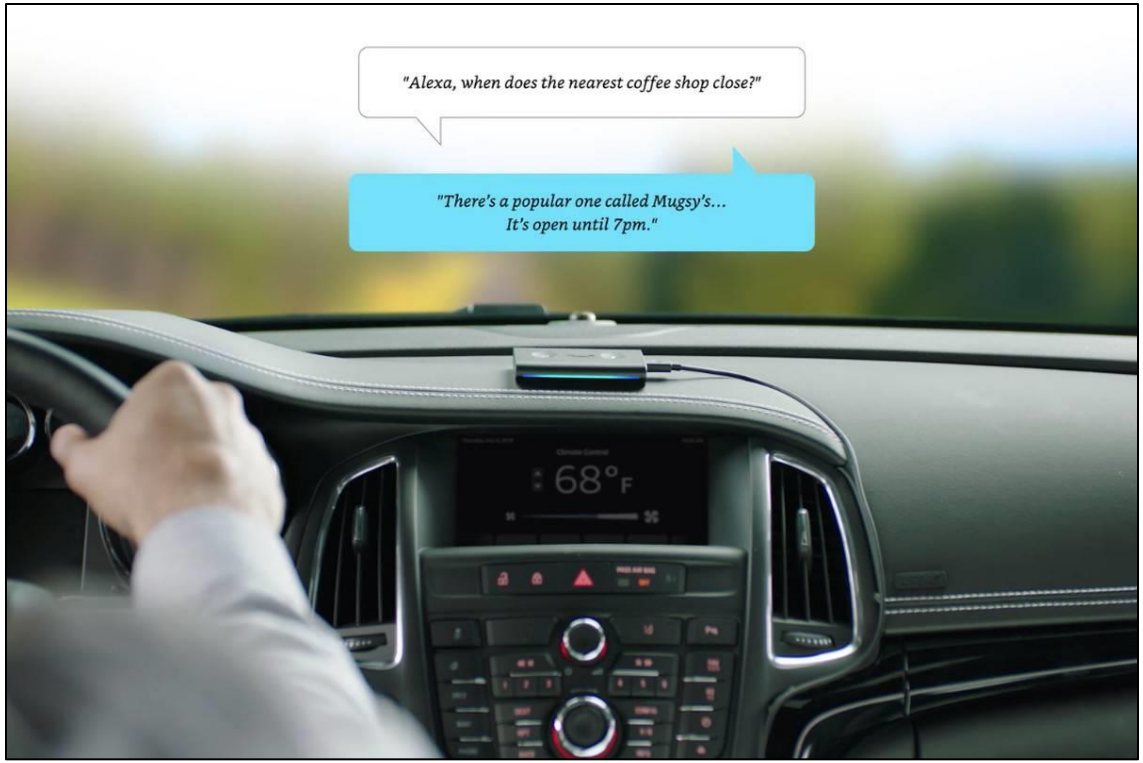
If you’re angry turn on the music



Driver state depending on volume, type, tempo. High tempo will lead to increase the speed will result more errors. Happy music is better than sad music.

Fakhrhosseini et al. If You’re Angry, Turn the Music on: Music Can Mitigate Anger Effects on Driving Performance , Conference paper, 2014

Improving Automotive Safety by Pairing Driver & Car Voice Emotion



- Interaction
- Navigation
- Restaurant recommendation
- Phone calls
- FM
- …

Clifford Nass et al Improving Automotive Safety by Pairing Driver emotion and Car Voice Emotion, Portland, Oregon, USA, 2005

Emotion Regulation for Frustrating Driving Contexts

1. Selection of situation
   - Low traffic routes
   - Travel during off peak hours
   - Smooth routes

2. Modification of Situation
   - pedestrians, cyclists, cars, and traffic signals

3. Deployment of attention
   - Focus on distracting thoughts

4. Change of cognition
   - Prevent a negative response before a full emotional response can occur
   - ->Emotion -> thoughts->Behaviour

5. Modulation of response
   - Operate vehicle safely and efficiently
   - Take care while Adjusting speed and changing the lane

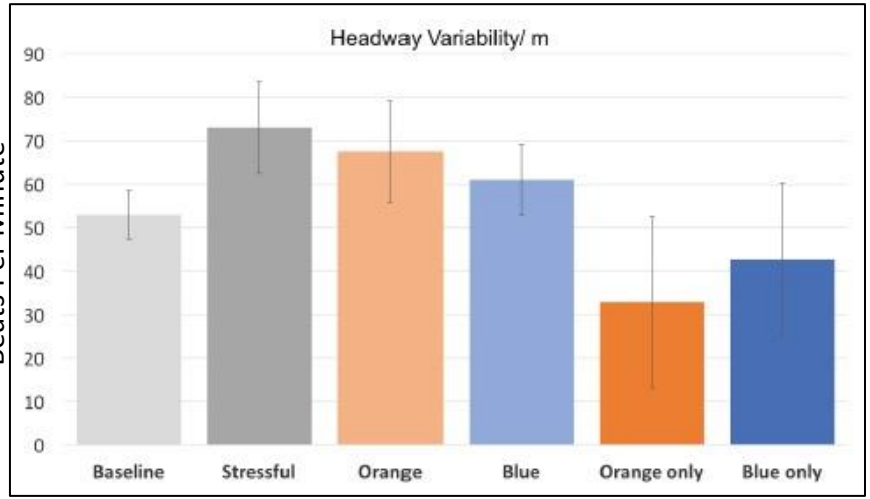
Helen Harris et al Emotion Regulation for Frustrating Driving Contexts, Vancouver, BC, Canada, 2011

Detecting Driver Emotions Using Ambient Light

← Light-based interface to provide feedback

Results from the driving performance analysis →

Headway variability – which is influenced by the behaviour of preceding traffic , lane changes, measures how well a driver is following the car in front



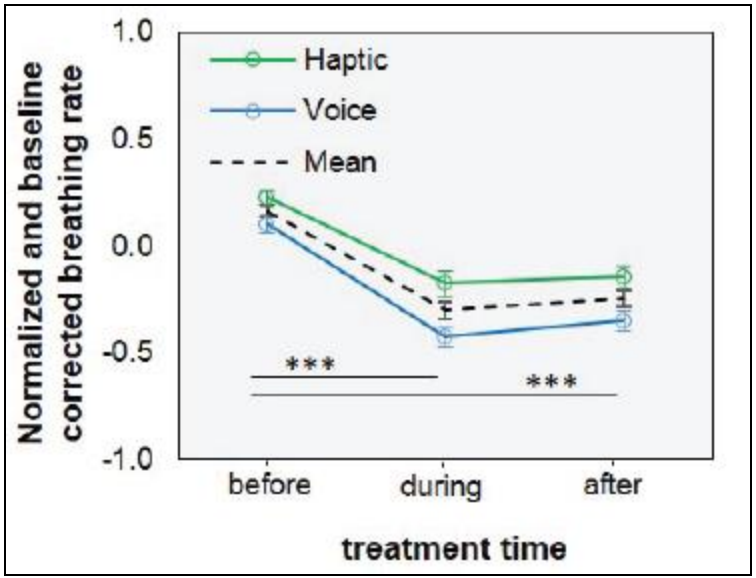
Mariam Hassib et al Detecting and Influencing Driver Emotions Using Psycho-Physiological Sensors and Ambient Light, IFIP, 2019

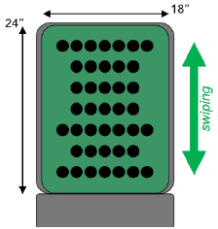
Should I Stay or Should I Go?

Simulator with lights, indicating if the distance to a closing car is safe

Andreas Löcken et al “Should I Stay or Should I Go?” – Different Designs to Support Drivers’ Decision Making, NordiCHI '14, Helsinki, Finland

Just Breathe In-Car



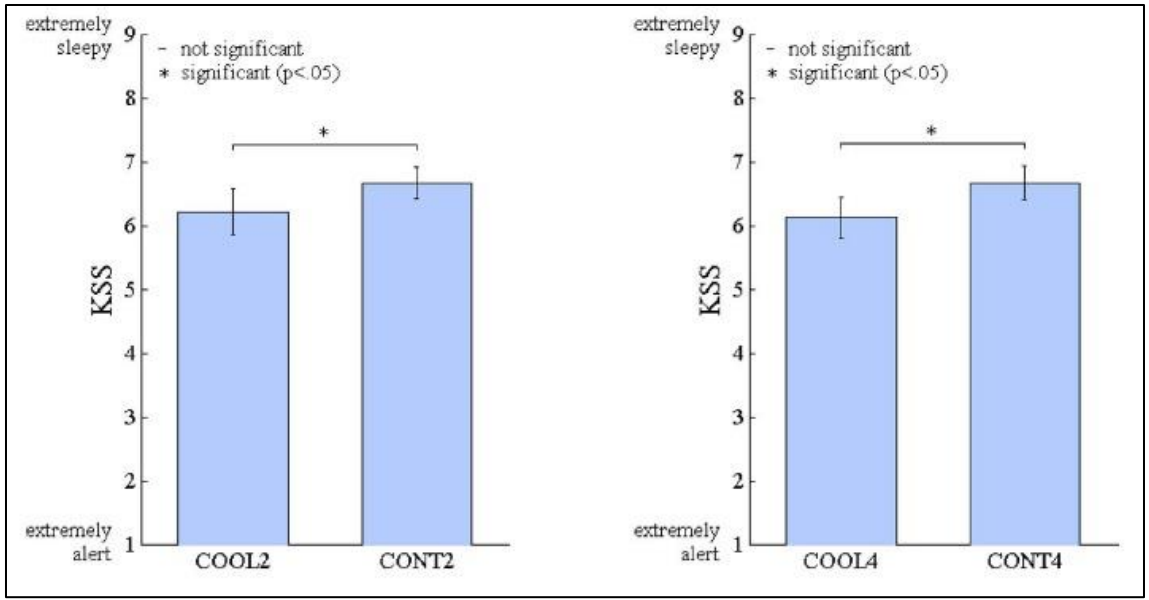


Interventions are helpful in:

- Reduce breathing speed
- Transform daily driving time into a mindful experience
- Reduce stress
- Increase psychological wellness

Pablo E. Paredes et al Just Breathe: In-Car Interventions for Guided Slow Breathing, Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 2018

Reduce Fatigue by cooling the system



Means and standard error of the average KSS (Karolinska Sleepiness Scale) ratings. Comparing directly the COOL2/COOL4 (2/4 mins of facial cooling) and CONT2/CONT4 (Control-setup no cooling) sleepy metric is much lower in COOL setting than CONT setting.

E. Schmidt et al: "Mitigating passive fatigue during monotonous drives with thermal stimuli: Insights into the effect of different stimulation durations," Accident Analysis & Prevention, vol. 126, pp. 115–121, 2019.

Reduce the Effects of In-Vehicle Frustration, Stress

Three scenarios where a system needs to adapt to a stressed driver

1. Packed City
- Inform about the delay and whether the destination will be reached on time
- Explain cause of blocking events / provide larger pictures
- Send automatic “I am delayed” messages to colleagues
- Reroute

2. No Parking Spot
- Inform about number of free parking spots
- Communicate where the parking spots are available
- Communicate in advance what time is good to park in that area
- Automated solutions to find a parking spot

3. Take over request (TOR) in automated driving
- Remind the user to do tasks that do not require 100% attention
- Stabilize car after TOR
- Provide information about situation early

A. L¨ocken, et al: “Towards designing affect-aware systems for mitigating the effects of in-vehicle frustration,” 9th international conference on automotive user interfaces and interactive vehicular applications adjunct, 2017.

Comparison between Articles

Mode	Year	Strategy	Biofeedback/ interface used to regulate emotions	Driving time/ no. of drivers	sensors	Driving Scenarios
Music [1]	2014	Validating driver anger after playing the music	Music system	53 drivers, tested drivers emotion after 15mins of music on	Empatica E4 to capture heart rate, electrodermal activity, and skin temperature of the driver	Traffic, Angry, Stressful situation
[2]	2016	Detecting emotion, music plays by framework	The framework of driver emotion recognition and adaptive music playing system	30 drivers, when driver state is anger music turns ON for 10 minutes.	Empatica E4 to capture heart rate, electrodermal activity, and skin temperature of the driver	Traffic, Angry, Stressful situation
Speech [3]	2013	communicate with the driver and provide the needed information to the driver	speech-based interface	15 minutes driving simulation	speech system	main scenario is - traffic
[4]	2005	Improve driver performance by speech recognition system	speech controlled systems	60 drivers, 20 minutes for each participants	Simulator driving hardware including pedals for an automatic car, steering wheel and car seat	traffic jam, narrow road
Light [5]	2014	Giving the information about overtake the car or not, through Ambient Light without disturbing the driver	Ambiant light system	5 persons, 90 minuts (2 sessions)	Door lights	Used when over taking the car, when need to know the gap-size between cars
[6]	2019	Display the light as per driver emotion	Giving feedback through light color (Blue - good, orange-warning)	12 drivers, 6 minutes each	heart rate sensors, bio-electric sensors	traffic, during overtake, during stressful driving scenarios

Mode	Year	Strategy	Biofeedback/ interface used to regulate emotions	Driving time/ no. of drivers	sensors	Driving Scenarios
Relaxation Techniques [7]	2019	Slow Breath atleast for 30 seconds in stressful conditions	Seat mat configuration	60 drivers (20 - 69 years age), tested for 30 mins - 2 hours but 2 mins for slow breating in middle	Seat mat configuration	Traffic, closed circuit (useful for old age drivers) under stressful condition
[8]	2018	Breath slowly to change driver state	Haptic System	24 participants (18 - 64 age), 6 minutes - 2 mins interventions, 2 mins breath, 2 mins normal breath total for 30 mins.	physiological sensors (ECG, breathing rate harness, EDA bracelet)	stressful condition, anger (during negative emotion), traffic
Reappraisal [9]	2011	Select route, time to not get frustrated during driving	Voice Interface	36 participants (18- 24 age), 6 minutes	None	traffic signal, pedestrians, cyclists, other cars
Temperature Control [10]	2017	Reduce fatigue using thermal stimuli	thermal stimulation	33 drivers, 2 mins and 4 mins thermal stimulus (15 öC)	temparatur sensors, sensory stimulation	fatigue drivers (no sleep,heavy work drivers)
[11]	2017	by cooling on the perceived sleepiness of car drivers can able to reduce fatigue	Thermal Simulation	34 drivers, 3 minutes	Not specific sensors	During fatigue, sleep
Manage stress [12]	2014	it describe how stress of drivers can be measured through different types of interactions	affect-aware in-vehicle system	5 drivers	physiological signals such as heart rate variability or electrodermal activity these sensors they used to measure stress	stressful drivers - packed city, no parking spot

Conclusion

- It is important to effectively monitor and provide feedback to the driver through various means such as light, speech, music, breath and temperature
- Taking slow breaths during stressful situations like traffic jams would help to reduce stress, reduce breathing speed etc,..
- Reducing fatigue by providing cool air to the driver's face can greatly improve the driving experience
- It is also crucial to pay attention to one's thoughts while driving and to consciously switch to positive thoughts when negative thoughts arise,
- Overtaking other vehicles should be done carefully based on the signals provided by their door lights

Future Work

- Multimodal Emotion Detection: Combining multiple modalities such as facial expressions, body gestures, speech, and physiological signals to enhance the accuracy of emotion detection.

- Emotion-Aware Vehicle Control: Implementing a control system that can dynamically adjust vehicle parameters based on the detected emotional state of the driver.

- Cross-Cultural Emotion Detection: Improving the robustness of emotion detection systems in the presence of cultural differences (distinct social, religious, economic, and political practices, nationality, location) in emotional expressions.

1. S. M. Fakhrhosseini “If you’re angry, turn the music on: Music can mitigate anger effects on driving performance,” https://dl.acm.org/doi/pdf/10.1145/2667317.2667410
2. Y.Zhu et al “Recognizing and releasing drivers’ negative emotions by using music: evidence from driver anger,” https://dl.acm.org/doi/pdf/10.1145/3004323.3004344
3. H. Harris et al H. Harris, “Emotion and emotion regulation considerations for speech based in-vehicle interfaces,” https://link.springer.com/chapter/10.1007/978-3-642-39262-7_64
4. C.M Jones at al, “Detecting emotions in conversations between driver and in-car information systems,” https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e20f2b85ad294baf1529990c769dada0d663f8fd
5. A. L¨ocken et al, “ should i stay or should i go?” *http://dx.doi.org/10.1145/2639189.2670268*
6. *M.* Hassib, et al, “Detecting and influencing driver emotions using psycho-physiological sensors and ambient light,” https://hal.inria.fr/hal-02544538/file/486811_1_En_43_Chapter.pdf
7. *S.* Balters, J. A. Landay, and P. E. Paredes, “On-road guided slow breathing interventions for car commuters,” https://dl.acm.org/doi/pdf/10.1145/3290607.3312785
8. P. E. Paredes, et al , “Just breathe: In-car interventions for guided slow breathing,” *https://dl.acm.org/doi/pdf/10.1145/3191760*
9. H. Hari et al, Emotion Regulation for Frustrating Driving Contexts *https://dl.acm.org/doi/pdf/10.1145/1978942.1979050*
10. E. Schmidt and A. C. Bullinger, “Mitigating passive fatigue during monotonous drives with thermal stimuli: Insights into the effect of different stimulation durations”
11. E.Schmidt, et al, “Psychophysiological responses to short-term cooling during a simulated monotonous driving task,”
12. J. Hernandez et al, “Autoemotive: bringing empathy to the driving experience to manage stress,” https://dl.acm.org/doi/pdf/10.1145/2598784.2602780
13. A. L¨ocken, et al, “Towards designing affect-aware systems for mitigating the effects of in-vehicle frustration,” https://dl.acm.org/doi/pdf/10.1145/3131726.3131744

Questions