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Cyclists travel experience: evaluating different approaches of data recording and exploring the potential for urban planning

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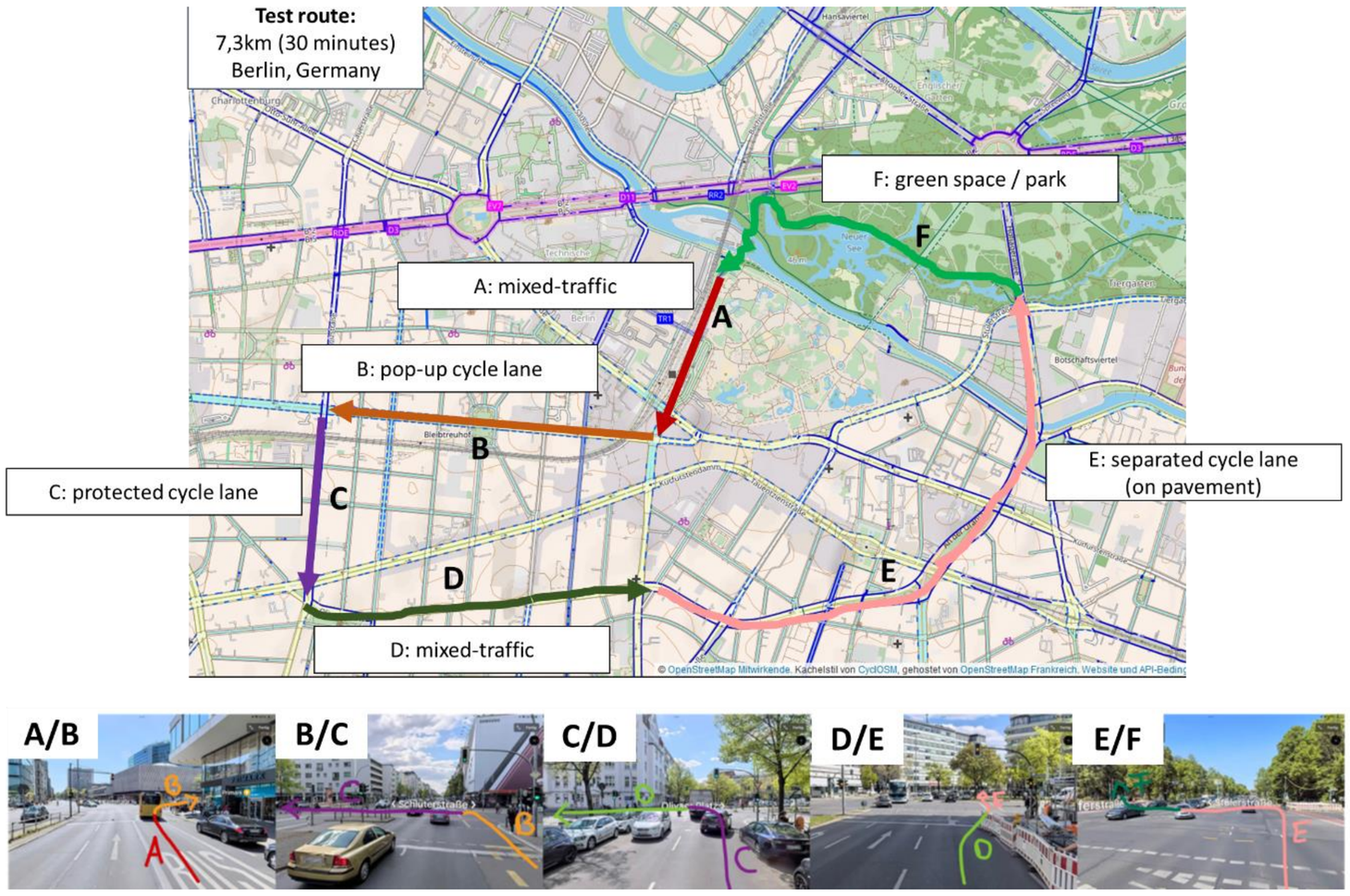


Cycling route of the pilot study through a neighbourhood in Berlin. Own source.

Background

- **Active modes of transport** for everyday mobility - especially cycling - are particularly **dependent on subjective well-being** such as perceived safety, avoidance of noise and the use of cycle paths through attractive environments (e.g. Singleton, 2019).
- Measuring the factual emotional state of the participants has **methodological weaknesses** since the **ex-post self-reporting** of perceived emotions afterwards is mainly biased in false reporting due to **incorrect recalling** (e.g. Dritsa & Biloria, 2021; Lim et al., 2022; Bigazzi et al., 2022).
- Capturing emotions while cycling, specifically in a real-world setting, is a comparatively new area of research and has gained attention in mobility research (Lim et al., 2022), thanks to the **possibilities offered by low-cost sensors** (e.g. smartwatches).
- This **geolocalised emotion detection** can help to identify areas of anxiety, stress-inducing road sections or environments that can promote well-being and pleasant mobility.

Aim & Study Design

- Offering **a conceptual lens** through which future approaches can be assessed and evaluated comparatively as well as a base for collecting **high quality data** that can give indications of what causes people to feel **stress in the urban environment**.
- Literature review: to determine which **methods** are suitable **for measuring physiological signals of stress** of people while walking and cycling in urban areas.
- Study addresses research gap by
  a) exploring, analysing and testing **different methods to gather travel experience** while cycling using a pilot study
  b) investigating if and how **decision-makers** make use of travel experience data – yet to come

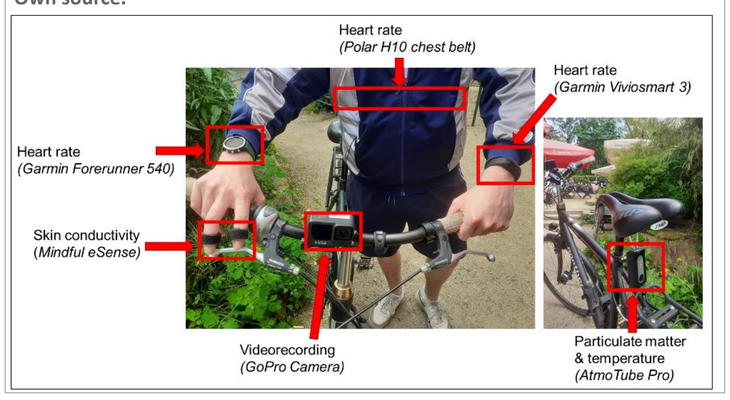
Pilot Study

Aim: identify research usability of different physiological sensor measurements while exploring **challenges and opportunities of sensor measurements on-the-move**

The pilot study consisted of:

- five probands (1 female, 4 males, age 23-32 years) who cycled for 30-minutes
- a test route through **different cycling infrastructures**: mixed traffic, pop-up cycle lane, protected cycle lane, separated cycle lane and a park
- participants measuring **heart rate, skin conductivity and air pollution** with different sensors and using a camera for **visual recording**
- participants filling out **a post-questionnaire** and **watching the video recording with the researcher** to explore the built environmental situation and related experiences, perceptions and perceived stress level
- analysis of the **geodata** collected and **visualisation** into a map

Sensors used on participants and on bicycle during the ride. Own source.



Characteristics and evaluation of different sensors for measuring physiological data of cyclists

	Polar H10 Chest Belt	Garmin Forerunner 540	Garmin Vivosmart 3	Mindfield eSense Skin Response	AtmoTube Pro	GoPro Hero Video Camera	Questionnaire
Characteristics of sensors							
Task	Mobile measurement of stress reactions with heart rate and GPS	Mobile measurement of stress reactions with heart rate and GPS	Mobile measurement of stress reactions with heart rate and GPS	Mobile measurement of stress reactions with skin conductivity and GPS	Measuring environmental stressors on-the-move	Capturing objectively the environment, traffic situation and special events	Capturing subjective perception of stress, the environment, traffic situation and special events after the route was taken
Measurement device	Chest belt and heart rate measurement device connected via Bluetooth to the smartphone	Smartwatch	Smartwatch	Sensors attached to two fingers and connected to the smartphone via wire	Laser-based sensor counting particles, noise sensor, temperature and humidity sensor	Camera	Questionnaire filled out with an interviewer on a tablet
Data received	GPS, heart rate, time	GPS, heart rate, °C, height, distance, speed, time	GPS, heart rate, , distance, time	Micro-siemens, time, duration	PM1, PM2.5, PM10, VOC, °C, humidity, pressure, GPS, time	Audio, Video, starting time, end time	Likert-scale and open questionnaire answers
Time intervall	1xsec.	1xsec.	Irregular	5xsec.	1xmin.	30 fps	-
Evaluation of data recording and analysis							
Limitations and difficulties	Converting .json to .csv necessary; must be worn on the skin under the t-shirt	Converting .fit to .csv necessary	Converting .fit to .csv necessary	No GPS data, data must be connected via time stamps; wearing sensors difficult while cycling; wire must be attached to the body not to disturb	Measuring only 1x per minute difficult to relate to second-based stress reactions	Data is very large	Post-interviews are based on retrospect memories and not the actual experience on-site
Chances and benefits	Most accurate measurement results; cannot be seen by peers	Easy to wear	Easy to wear	-	Easy to use; small and easy to attach to bicycle	Environment, traffic situation and special events can be retraced afterwards	Subjective evaluation and perception can be captured

Results

In summary, the pilot study shows that:

- Overall, **smartwatches** were easier to use whereas **chest belts** provided more accurate data.
- The Polar H10 chest strap delivers good results with a high level of accuracy and is partly comfortable to wear for test subjects.
- The combination of **measurements with questionnaires and video recordings** is necessary to place the measurements in the **situational context**.
- Further data is required to **validate** the measurement data, e.g. benchmark measurements of the respective body, personal fitness level, current mood and situational exertion (e.g. approach, increased speed).
- The **costs and complexity** of the used measurement sensors can be a limitation. Good sensors are expensive and experiences in gathering, extracting and analysing physiological data from sensors is needed.
- In some cases, sensors measured data in different variations, making it difficult to interpret the data. Wearing devices also negatively impacted cycling experiences and resulted in stress reactions overall.

Outlook

- A lot of **other data is needed** (e.g. data from (post-) interviews) in addition to measuring physiological data, otherwise it will be difficult to explain **what triggers emotional reactions** on the way.
- Future projects should be clear about the focus when measuring physiological reaction. Measurements are particularly suitable for **exploratory studies** with smaller sample sizes as complex study designs can make it difficult to recruit probands.
- **Walking** might be easier to measure than cycling due to straining nature of the latter, which can influence physiological data.
- Analysis of the data and the literature review have also shown that **co-operation or involvement** of **experts from the health sector** would be helpful in order to ensure the adequate interpretation of health-related data.

Planned for this study:

- **expert interviews with decision-makers** before the end of 2024, to explore how this data can be used in urban and transport planning and governance

Conclusion

This study gives an overview of the state of the art in this rather new field of research. We describe particularities of the methods regarding usability for probands and implications for planners.

- **Perception and emotions of bike riders** are crucial factors for strengthening bicycle planning.
- Considering **subjective and objective data** to record and georeference the experiences of cyclists is crucial when aiming to progress with bicycle research.
- The combination of **measurements with questionnaires and video recordings** is necessary to place the measurements in the **situational context**.

References

- Bigazzi, A., Ausri, F., Peddie, L., Fitch, D., & Puterman, E. (2022). Physiological markers of traffic-related stress during active travel. Transportation Research Part F: Traffic Psychology and Behaviour, 84, 223-238.
- Dritsa, D., & Biloria, N. (2021). Mapping the urban environment using real-time physiological monitoring. Archnet-IJAR: International Journal of Architectural Research, 15(3), 467-486.
- Lim, T., Kalra, A., Thompson, J., Caldwell Odgers, J., & Beck, B. (2022). Physiological measures of bicyclists' subjective experiences: A scoping review. Transportation Research Part F: Traffic Psychology and Behaviour, 90, 365-381.
- Singleton, P.A. (2019). Walking (and cycling) to well-being: Modal and other determinants of subjective well-being during the commute. Travel Behaviour and Society, 16, 249-261.

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