

Understanding Cyclist Attention in Urban Traffic Environments

Master's Thesis of Awwab Hassan

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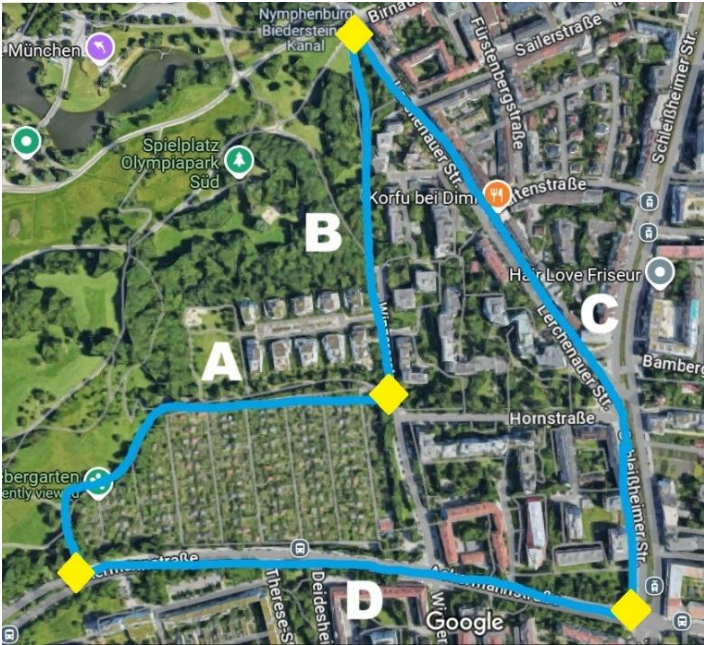


Figure 1: Scenario 03 - Cycling Route with Sections (Olympia Park)

Introduction and Objectives

Urban areas are evolving rapidly with increasing population density, demanding sustainable and efficient transportation solutions. Cycling, as an ecological and healthy mode of commuting, plays a critical role in meeting these goals. However, ensuring cyclist safety and understanding their behavior remain significant challenges. Investigating the attention patterns of cyclists and perceived stress levels on urban roads is essential to making cycling a safer and more attractive transportation mode.

This thesis aims to understand how cyclists interact with complex urban traffic environment as can be seen in **Figure 1**, focusing on attention patterns and stress levels. The study contributes to enhancing safety measures and promoting cycling as a sustainable transport mode.

To achieve this aim, this thesis addresses three research questions:

- What factors significantly affect cyclists' attention in urban traffic environments?
- How do stress and personality traits influence attention patterns?
- What are the effective parameters and calibration methods for eye-tracking to investigate cyclists' attention patterns in real-world studies?

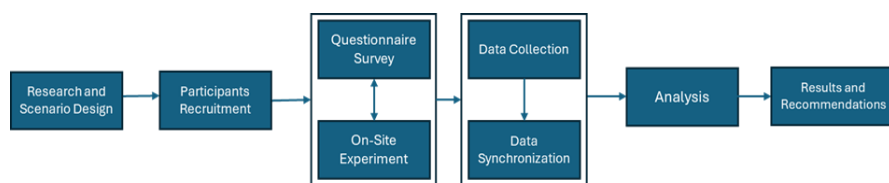


Figure 2: Methodology Flow Chart

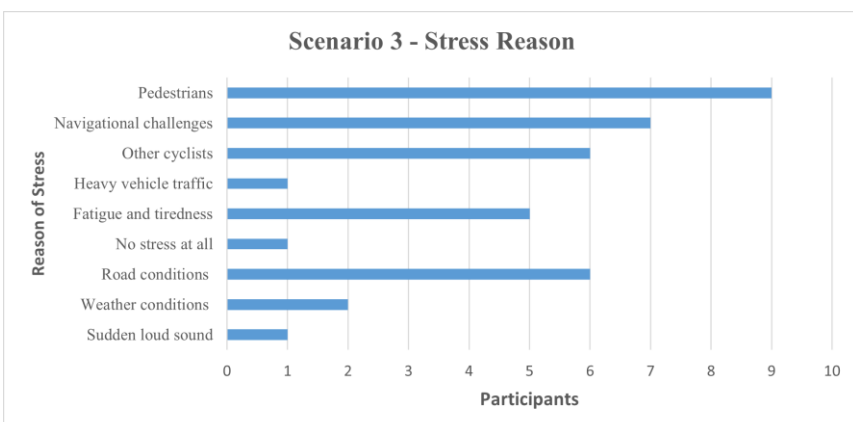


Figure 3: Factors affecting the cyclists

Methodology

A mixed-methods field experiment was conducted with 16 participants (23–42 years) to investigate cyclist attention and stress in real-world urban environments. A synchronised multi-sensor system; Tobii Pro Glasses (Eye-tracking), Empatica EmbracePlus (EDA, BVP, Temperature), Firstbeat HRV monitors, and AdMos GPS captured gaze, physiological, and spatial data across three scenarios: (1) Seated baseline in a Park, (2) Traffic observation at an intersection, and (3) Active Cycling on a predefined urban route divided into four sections (A–D). Pre- and post-experiment questionnaires provided subjective insights on stress, distraction, and coping strategies. All data streams were timestamp-synchronised and analysed using descriptive statistics, event-based triangulation, and non-parametric tests (Friedman, Wilcoxon). Visualisation techniques (heatmaps, time-series, bar graphs) and qualitative feedback ensured a robust interpretation of cognitive and physiological responses. This comprehensive approach allowed the study to capture both conscious perceptions and hidden physiological reactions.

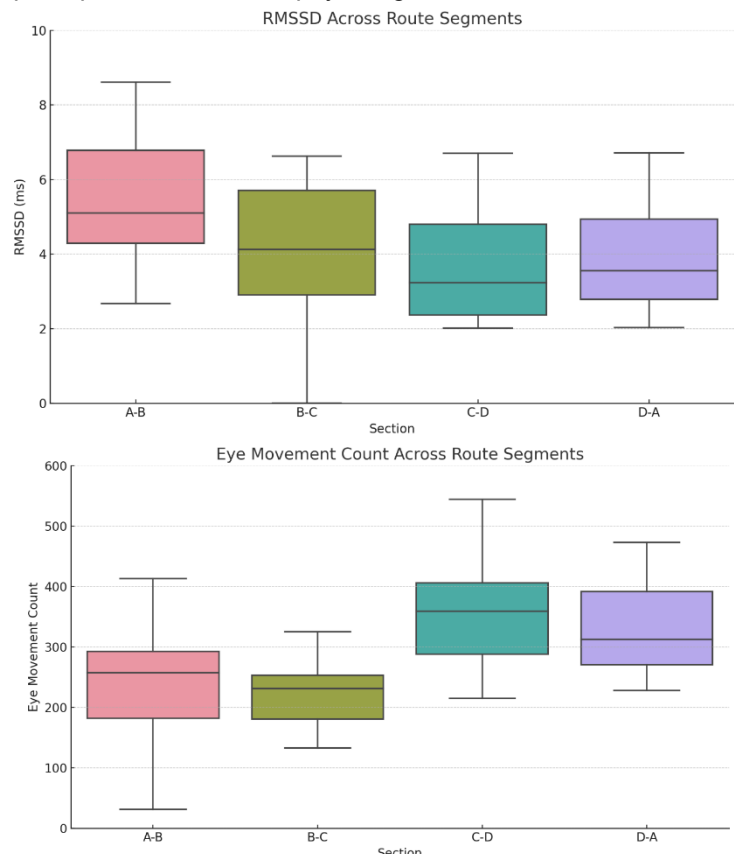


Figure 4: Box Plot Visualization across Route Sections (A-D)

Results and Conclusion

The results show that cyclists' attention and stress is strongly affected by events like interactions with other cyclists, pedestrians, and road hazards, which influence both their thinking and how they look around, see **Figure 3**. Eye-tracking heatmaps highlighted concentrated gaze in calm settings, wider scanning at intersections, and fragmented, adaptive patterns during cycling. Section-wise analysis, see **Figure 4**, showed peak stress (Low RMSSD) and high Eye Movement Counts in high-interaction zones (Section C-D & D-A), while residential/park sections (A-B & B-C) were more relaxed. Using eye-tracking, along with careful real-time calibration and validation, was important for collecting accurate and reliable attention data in real-world conditions. These insights underline how cyclist attention and stress are shaped by environment, personal traits, and lived experience. The relationship between how the environment is designed, how cyclists process information, and how they handle stress, truly impacts cyclists' safety. Link between urban spaces and cyclists' stress and attention gives important considerations and practical guidance while designing safer, more comfortable cycling spaces and shaping policies that improve the overall cycling experience.