

NAVIGATING URBAN HEAT IN PUBLIC SPACE

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INTRODUCTION

Cities are facing more frequent, severe heat extremes that affect comfort, mobility, and psychological well-being. This feasibility pilot quantifies how thermal exposure during urban wayfinding relates to shade-seeking, route efficiency, pauses, and stress (physiological and perceived), using synchronized wearable and microclimate sensing to inform a validated protocol and a future heat-aware navigation tool.

BACKGROUND

- Heat-related physiological strain can occur even without explicit discomfort (Lan et al., 2022) and impair cognition (Thompson et al., 2024).
- Microclimate (shade, solar exposure) shapes route choice and perceived walking cost (Basu et al., 2024; Melnikov et al., 2022), but routing can be inflexible (Derakhshan et al., 2025).
- Behaviour reflects interactions among exposure, cognitive load, perceived comfort, and physiological stress (Boulton et al., 2023).

This pilot tests the feasibility and direction of associations between thermal exposure, wayfinding performance, physiological strain, and subjective experience in a real urban environment.

RESEARCH QUESTIONS

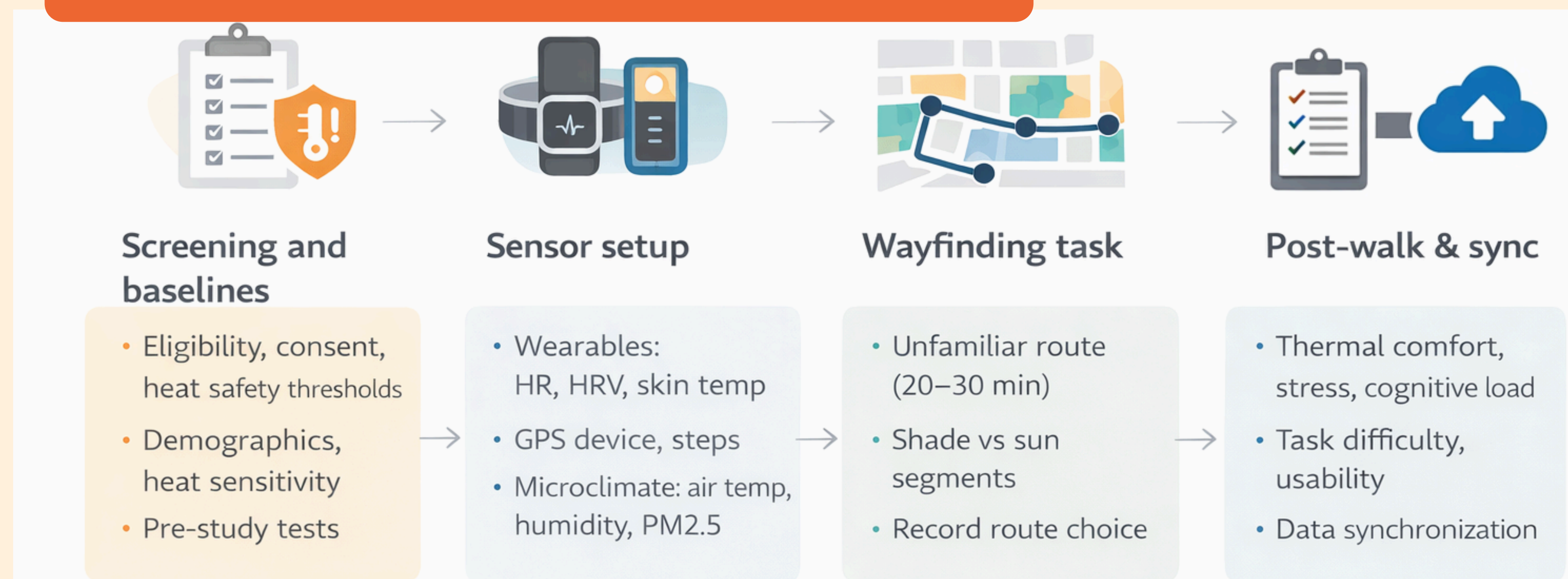
- **RQ1:** How does thermal exposure relate to physiological strain (HR, HRV, skin temperature) during navigation?
- **RQ2:** Does higher heat increase shade-seeking, route inefficiency, pauses, or detours?
- **RQ3:** How do perceived thermal comfort, stress, and cognitive load co-vary with exposure and observed behavior?
- **RQ4:** Which sensors and metrics are most reliable for quantifying heat-related behaviour?

METHODS

We are piloting a protocol to link thermal exposure during an unfamiliar wayfinding task to cognition, behavior and stress. Following screening and baseline, participants are fitted with wearables capturing heart rate, heart rate variability, and skin temperature as well as a GPS device logging position, movement, and step count. Portable devices log air temperature, humidity, and PM2.5. All variables will be time-synchronized. Participants then complete a wayfinding task on an unfamiliar route (20–30 min) with decision points across shaded and sun-exposed segments. We capture the walked trajectory, route choice at nodes, and pauses, then administer post-walk questionnaires on perceived thermal comfort, stress, cognitive load, and task difficulty, followed by data synchronization. Trajectories are matched to street segments with shade/sun attributes derived from building footprints. Wayfinding outcomes include route choice, proportion of time spent in shade, route inefficiency (actual distance divided by the shortest path), and pauses. Additional measures capture perceived thermal comfort, stress, and cognitive load.

We expect that higher thermal exposure will lead to more shade-seeking and greater route inefficiency, alongside increases in perceived and physiological stress.

PILOT FIELD STUDY PROTOCOL



ANALYSIS

We will assess associations between segment-level solar exposure and behavioral and physiological responses using multivariable models incorporating stress (HR, HRV), perceived stress/thermal comfort, cognitive load, and wayfinding behavior. If feasible, route choice at decision points (shade vs. sun) will be modeled with adjustment for time of day, air quality and weather conditions.

Feasibility will be evaluated through data completeness and synchronization, agreement between modeled and observed shade, and participant burden. We will also examine measurement performance by comparing analytic specifications, assessing reliability and signal-to-noise, and evaluating missing data.

STUDY PROSPECTS

This pilot will refine exposure and outcome definitions, covariate selection, and modeling strategy, and identify what works to optimize the protocol.

The improved protocol will then be applied in a larger study including vulnerable populations (e.g., older adults and individuals on heat-sensitive medications), and extended to a second European city to compare climatic and urban conditions.

Findings will also inform a prototype navigation tool to support heat-aware route choices, with initial evaluation of its usability and benefits.

LITERATURE

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