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Restorative and Afflicting Qualities of the Microspace Encounter: Psychophysiological Reactions to the Spaces of the City

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There is a long-standing narrative within health research that nature (or green space) is beneficial for health, whereas urban (or gray spaces) are not. This prior research often focuses on broad, often binary, nature–urban categorizations rather than the particular qualities of the microspace encounter, stimulating embodied stress or restorative human reactions. Drawing on the findings of an interdisciplinary and exploratory mixed-methods study investigating how people physiologically respond to their environment, this article discusses the microspace encounters that can evoke restorative and afflicting human responses. In doing so, this article demonstrates the strengths of combining biosensing technology with qualitative methods but stresses that narrative and psychophysiological capture only identifies a small aspect of an experience. *Key Words: biosensing, embodiment, microspatial, restoration, stress.*

The urban environment is an amalgamation of different sociospatial phenomena that can stress or relax city dwellers. It has been long argued that urban, "gray," or human-made environments typically stress the body (Simmel 1974; McLafferty 1992; Lederbogen et al. 2011; Brighenti and Pavoni 2019), whereas "natural" environments have restorative qualities and have been linked to improved health and well-being (A. C. K. Lee and Maheswaran 2011; Stigsdotter et al. 2017). Bell, Leyshon, Foley, and Kearns (2019), however, advised caution in adopting overly simplistic dose–response frameworks based on static macrocategorizations of space and health. They suggested that experiences of health and well-being emerge through dynamic encounters with the particular qualities of space that coconstitute our urban (and rural) environments, which often resonate differently for people depending on the specific meanings and competencies of the person and the (im)materialities of their surroundings (cf. Shove, Pantzar, and Watson 2012). This article responds directly to that suggestion with a discussion on people's dynamic and relational encounters within the spaces of the city.

Deploying biosensing technology as a method for capturing the in situ psychophysiological responses of forty residents of three urban areas in Birmingham, UK, this article demonstrates how microspatial features, or particular sensory qualities (like the smell of population or sounds of "nature") of the place encounter, can influence psychophysiological responses. The term *psychophysiological* is used throughout the article to describe participant reactions because it understands somatic reactions as a combination of interpreted experienced (psycho-) and biological or embodied (physiological) processes. By considering the psychophysiological responses to urban spaces, this article considers the experience of space and relational encounters through a combination of both quantitative and qualitative accounts.

The article first discusses relational encounters with the microspatial before considering the psychophysiology of stress and restoration within the body's nervous system's automatic processes. It next discusses the methodology deployed, including how the data were generated, the measures used, and how these were processed and analyzed. The article uses vignettes to explore three examples of everyday encounters with the microspatial of the urban environments and discusses how these microspatial qualities can stir the body. In doing so, this article contributes to understandings of urban stress and restoration through an exploratory and qualitative-rich

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consideration of how psychophysiological reactions unfold within microscale urban space encounters.

Encountering the Microspatial

All aspects of the city environment influence the bodies of the city dwellers, whether that is the stress induced by being on a crowded high street or the potentially soothing qualities of an urban park. There is a growing concern about the future psychological, neurological, and social implications of dense city living, especially with the ever-increasing urban population worldwide (Lederbogen et al. 2011; Abbott 2012). It is frequently argued that cities are stressful environments with which to engage (McLafferty 1992; Brighenti and Pavoni 2019). A large amount of literature, however, demonstrates the restorative powers of green space and nature in cities (Kaplan and Kaplan 1989; Ulrich et al. 1991; Bowler et al. 2010; Little 2015). Stress, as the surplus of emotional or mental pressure that exceeds personal resources, is a common and multifaceted feature of modern life (Brighenti and Pavoni 2019). In a bid to counter the city's stressful aspects, much research has focused on the city's therapeutic qualities—namely, the effects of designated urban green and blue spaces (e.g., parklands, woodlands, gardens, riverside walks, etc.). Research has shown that people across different cultures might express similar visual preferences for nature-based environments over less verdant urban environments (Milligan and Bingley 2007; Van den Berg et al. 2010; Li et al. 2011; Bell, Wheeler, and Phoenix 2017). These studies that have focused on the anxiety-reducing effects of visual exposure to natural environments offer fledging support for the notion that there might be a physiological basis for stated preferences for so-called natural settings.

With the growing interdisciplinary interest in better understanding why specific spaces can contribute to or thwart human health and well-being, little attention has been paid to the microspatial features of place encounters that encourage such health-enhancing and prohibiting responses. Thus, the term *microspatial* used throughout this article is akin to, but not the same as, the term microclimate and refers to the highly localized conditions of a space or environment (e.g., the biodiversity [both fauna and flora], elemental flows [e.g., weather], terrain and topology, sensory stimuli, and [small] materialities and nonhuman features) and the complex relationships and connectivities between them and the city dweller. This relational approach understands space as dynamic and fluid, multiscalar, and a network of various acting materialities and flows (Cummins et al. 2007). Human geographers, particularly interested in the more-than-human and relational approaches to health, have encouraged considerations of the complex microprocesses that occur when spaces influence an individual's health and well-being (Cummins et al. 2007). This relational approach to health and well-being has allowed geographers to examine some of the particulars of space encounter, such as the role of nonhuman animals (Gorman 2017), weather, and the elements (Cresswell and Martin 2012; Simpson 2019; Bell, Leyshon, and Phoenix 2019), and more-than-representational[1] flows (Duff 2016; Andrews 2018). Although this article builds on this relational work through its consideration of the microspatial, it considers and captures the minute physiological changes when a person engages with a city to identify and assess those fleeting moments of stress and relaxation.

Psychophysiology of Stress and Restoration

Stress and restoration are a combination of physiological and psychological events where a trigger or event activates an individual's unconscious/automatic nervous system (ANS; Eckstein et al. 2017). The ANS regulates crucial bodily functions, such as heart rate and digestion, as well as the fight-or-flight (stress) or rest-and-digest (restoration) responses (Kyriakou et al. 2019). At moments of stress and restoration, the body's nervous system is activated, leading the body to release hormones that trigger either the sympathetic or parasympathetic automatic response, depending on whether the situation is stressful or restorative, respectively. The sympathetic and parasympathetic responses stimulate a variety of physiological changes to reestablish homeostasis. For example, when individuals are stressed, their heart rate, blood pressure, and sweat level will increase until the trigger has ended or dissipated (Kreibig 2010; Table 1). Thus, measuring physiological changes, such as the level of sweat and heart rate, can provide insight into embodied expressions of stress and restoration.

Table 1. Some physiological changes evoked by the automatic nervous system (after Eckstein et al. 2017, 74)

Body part	Sympathetic response ("fight-or-flight")	Parasympathetic response ("rest-and-digest")
Eyes	Dilates pupils	Constricts pupils
Mouth/throat	Inhibits salivation	Stimulates salivations
Lungs	Relaxes airways	Constricts airways
Heart	Accelerates heartbeat	Slows heartbeat
Perspiration	Stimulates sweat production	
Stomach	Inhibits digestion	Stimulates digestion
Skin	Stimulates sweat production	
Bladder	Inhibits voiding	Promotes voiding

Through these measures, scholars in the affective and the biological sciences (as well as nonaffective/biological scientists who have adopted these methods) have demonstrated the various ANS activities, neurological activation(s), and physiological changes that occur during different experiences, including emotion (Picard 1997; Colombetti 2014), stress (Palanisamy, Murugappan, and Yaacob 2013; Kyriakou et al. 2019; Pykett et al. 2020; Pykett, Osborne, and Resch 2020), and memory (Mackersie and Calderon-Moultrie 2016; Osborne 2019), among others. Through these studies, scholars are increasingly able to demonstrate how people nonconsciously respond to scenarios before cognition occurs through physiological changes, chemical release, and electrical impulses throughout the major organs, the neurological network, and the brain. It is important to note, however, that the study of psychophysiology is not a new approach for the cognitive sciences, which have been using it to further understandings of the intersections between mental states, phenomena, and human biology (Davidson 2003) and have been enhanced by methodological sophistication and advances in recent years (Birenboim et al. 2019). These developments have allowed scholars to use these measures outside of a clinical setting and explore how different qualities of environmental encounters affect our bodies (e.g., Zeile et al. 2015; Osborne and Jones 2017; Chrisinger and King 2018). Indeed, there have been a variety of environmental psychologists, in particular, who have studied various biomarkers to understand the relationship between green space and stress levels, including cortisol and amylase levels (Thompson et al. 2012; Hunter, Gillespie, and Chen 2019), as well as series of physiological measures including heart rate (Gidlow et al. 2016; Mygind et al. 2019). By taking these measures outside of a clinical setting, these scholars have effectively demonstrated that people have lower stress levels after being exposed to green space. Furthermore, biosensing technologies can be used within well-established frameworks, such as Lachowycz and Jones's (2013) theoretical model for understanding the socioecological relationships between green space and health, as a way of understanding the potential mediators, specifically the aesthetic satisfaction and restoration from viewing natural features, thus, establishing a quantitative bridge between the use of green space (cf. mechanism of moderation) and the physical and psychological health outcomes.

This article builds on this work in environmental psychology, but by combining the biomarkers with geographical information systems (GIS) and interviews, it is possible to locate and discuss specific extrinsic stressors or relaxants within the green spaces. Indeed, by combining these measures with GIS, an increasing number of scholars have been able to map and identify spaces of psychophysiological significance for their study subjects (see, e.g., Resch et al. 2015; Osborne and Jones 2017; Sedenberg, Wong, and Chuang 2018). Yet, the majority of publications from these studies have focused on the methods rather than discussing the data or findings, but this is a common occurrence in the development of new methodologies (Merriman 2014). Therefore, this exploratory article attempts to build on and extend this scholarship in three ways: first, by discussing specific moments experienced by the participants with a combination of psychophysiological measures and GIS to identify microspaces of stress and restoration in cities; second, deploying established theories of health and place to explore the stressful or restorative events in the psychophysiological data; and third (and crucially), identifying and discussing some of the microspatial qualities of

encounter that stressed or relaxed these particular city dwellers in situ.

Methodology and Context

Setting and Data Collection

This study was undertaken in three urban conservation areas in Birmingham, UK: Moseley, Bournville, and the Jewellery Quarter. These three areas were selected to encompass the varied nature of the urban environment. Bournville, Moseley, and the Jewellery Quarter each have distinct histories, material and physical environments, and populations. Bournville, for example, is a verdant area with a high prevalence of arts-and-crafts architectural buildings. In contrast, the Jewellery Quarter is predominantly industrial, characterized by a collection of buildings falling into disrepair with green space designations limited to just two graveyards. On the other hand, Moseley is a heavily gentrified suburb and one of the most affluent areas in Birmingham, with an abundance of two- and three-story Victorian and Edwardian houses and large green spaces. This study's data collection period was between August and December 2016, where forty participants were asked to take an unaccompanied walk of their choosing around their neighborhoods. The participants were recruited through gatekeepers and community groups via social media linked to heritage and local history, which was the overall research project's focus. The participants, who either lived or worked in the area, consisted of nineteen men and twenty-one women with an average age of forty-one (minimum of nineteen and maximum of seventy-seven years old). The length of time that the participants lived or worked in the area varied highly from around four months to their entire lives. The residents in the Jewellery Quarter, however, typically lived in the area for a shorter period ($M = 8$ years) compared to Bournville ($M = 20$ years) and Moseley ($M = 23$ years). The participants were recruited via urban conservation groups and representatives and therefore the participants had a strong affinity for the heritage of the areas, not necessarily the greenspaces.

Each walk lasted for around forty-five minutes to an hour, during which a biosensing wristband (Empatica E4), a Global Positioning System (GPS) tracker (Garmin eTrex 10), and a chest-mounted video camera (GoPro Hero 4) were worn or carried by the participant. It was important that the technology carried or worn was subtle to allow the participants to be comfortable as possible (to avoid undue stress) while collecting all the necessary data. Following the walk, the participants undertook an elicitation interview focusing on the spaces explored during the walk, using the GoPro video footage as a prompting tool. Methodologically, the use of (mobile) video elicitation (Spinney 2011) has similarities to a walking interview (Evans and Jones 2011), where the interview is framed by the environment being explored. Yet this detached approach, without the researcher's presence during the walk, ensures that the researcher does not interfere directly with the route taken or the other measures, such as biosensing. Of course, this approach does not prevent the impact of the research on the participant's choices because they are aware that they are taking part in a research project, and this awareness might shape some of the aspects of where the participants go and what they want to "show" the researcher. Ethical approval for this research was awarded by the University of Birmingham's central ethics committee following the Economic and Social Research Council's guidelines.

Measures and Data Processing

Biosensing. The Empatica E4 is a biosensing wristband that has been designed for research and clinical purposes (Empatica 2016). The wristband has sensors to measure blood volume pulse (BVP), electrodermal activity (EDA), heart rate (HR), and skin temperature (ST) in real time. The sampling frequency for HR, EDA, and ST is 4 Hz^2 (with BVP at 64 Hz), meaning that a forty-five-minute walk generates around 75,600 physiological data points. The Empatica E4 is increasingly being used in geographical studies to record and measure stress and emotional responses (Osborne and Jones 2017; Sedenberg, Wong, and Chuang 2018; Birenboim et al. 2019; Pykett et al. 2020; Pykett, Osborne, and Resch 2020). There are some, however, who express concerns about reliability when using biosensors outside of a clinical setting because they can be easily influenced by the environment, the emotional state of the participant, and overwhelming multisensory stimulation (Osborne and Jones 2017; Chrisinger and King 2018; Foley et al. 2020). As a result of this

caution—and I want to move beyond correlation to explanation—an increasing number of social scientists have encouraged the use of a mixed-methods approach, including narrative interview data (Olafsdottir et al. 2017), postphenomenological accounts (Spinney 2015; Osborne and Jones 2017), and performative dimensions of bio-mapping (Nold 2009). Although being cautious of the results that in situ biosensing produces, this article demonstrates how biosensors can be a potentially powerful tool for understanding individuals' responses to environments in a suite of methods.

Because biosensing is still a relatively new methodology, scholars are still experimenting with different ways to approach and analyze the data. The most common practice thus far is to develop statistical models to analyze trends in the biodata (Yannakakis, Hallam, and Lund 2008; Drachen et al. 2010; Kyriakou et al. 2019) by calculating each data point's standard score (or *z* score), which represents how much the raw data point varies from the arithmetic mean. By adopting this analysis method, it has been possible for these scholars to compare the data of individual participants within the whole sample (see, e.g., Shoval, Schvimer, and Tamir 2018). It has been argued, however, that getting a statistical output from biosensing data "from hundreds of subjects is impossible and has no meaning" (C. K. Lee et al. 2005, 5523) because it removes individual difference and assumes that the participants responded in the same way to the various phenomena. A growing number of scholars have opted for a qualitative-rich approach to research with biosensing technology to mitigate these criticisms (see Osborne 2019; Pykett et al. 2020). For example, Nold (2009), who was one of the first scholars to use this technology outside of a clinical setting, used the biosensing maps as an elicitation tool and allowed the quantitative element to become a "performative technology" rather than the sole focus (Spinney 2015). By actively incorporating the participants' narratives into the examination of their physiological states, these studies can integrate matter and meaning by considering the body as a complex affective and relational entity and acknowledge the unique characteristics of the person, such as their histories with spaces and place attachment (Lupton 2012; Foley et al. 2020). This article adopts an exploratory qualitative approach where each walk's biodata were analyzed in relation to the spatial, narrative, and visual data; this study focuses primarily on the individual microspatial encounters. This multifaceted and in-depth approach does not generalize these quintessential unique psychophysiological experiences to other people but provides an in-depth exploration of some microspatial encounters to add depth of subjective meaning to existing work using biosensing technology.

GPS Tracking. Because the GPS tracker recorded location on a one-second epoch, it was possible to combine the bio- and spatial data to produce a series of maps depicting the spatialization of each participant's physiological responses. Each raw data file was imported into ArcGIS as *xy* data, where each second of data was presented on the map as a single dot. Because the biosensing wristband took a higher frequency of readings than the GPS tracker, the biodata were averaged for each second. The colors of each second were categorized either using an equal interval classification of five or by standard deviation to allow each map to spatialize the spikes and troughs and the broad patterns in each data set. The biodata in these maps were presented using equal interval, which is common in biosensing work (Nold 2009; Zeile et al. 2015; Chrisinger and King 2018), or standard deviation to allow for easy and effective comparison between different participants' maps (cf. Shoval, Schvimer, and Tamir 2018). Four maps were produced per participant to spatialize each of the biosensing measures. Though considering each walk individually was time-consuming, it was effective in considering each walk's unique characteristics (including weather, route, and topography) and the social factors (history with spaces, place attachment, etc.) in tandem.

In-Depth Video Elicitation Interviews. During each walk, the participants wore a GoPro video camera that enables the production of a rich and continuous collection and presentation of visual data. Mobile videography is an effective method for recording geographic experiences of place, situated in and around the videographer's field of vision while in motion (Spinney 2009). Though the use of filming equipment in public spaces is legal, individuals have the right to privacy in public spaces (Wang and Redwood-Jones 2001). Akin to previous work (e.g., Laurier and Philo 2006), the filming was undertaken overtly. All participants carried an information sheet to provide information about the research, how confidentially it will be addressed, and the researcher's contact details in case of queries

from passersby. Approximately thirty-four hours of footage was produced from a body-worn camera. This quantity of (and variations in) footage acted as an effective visual elicitation tool for the interviews because the video allows the researcher to partake in a process of "seeing there" and "feeling there" and acts as an effective memory aid for the participants (Spinney 2011).

The video elicitation interviews focused on the various spaces the participants passed through and how they felt about those spaces based on their past experiences and knowledge (e.g., about pollution). During this interview, a narrative approach was adopted, which allowed the participants to choose what topics they wanted to explore with minimal prompts from the interviewer (McCormack 2004). As a result, these interviews explored a variety of topics, including their social worlds, childhood, and body's reactions, and the character of the area (including history, provision, and quality of green and blue space), as well as their feelings and thoughts when walking. Thus, the narrative approach considers relational agency (cf. Gergen 2009) in terms of the microspace encounter and recognizes that choices and responses occur within individual contexts, memories, and emotional capabilities. Although it might have been more effective to accompany the participants on their walks to uncover those place-specific narrative details (cf. walking interview; Evans and Jones 2011), the presence of a researcher conducting an interview might have stressed the participants and therefore influenced the biodata. All interviews were transcribed verbatim and openly coded. During the transcription process, the identities of the participants were pseudonymized.

Analysis

To fully integrate the methods, data, and analyses, it was essential to develop an iterative analysis strategy to support substantive and rigorous conclusions. The analytical framework developed built on Knigge and Cope's (2006) grounded visualization approach. The analysis was exploratory, experimental, iterative, and recursive, considering particular instances and general patterns and multiple views and perspectives for building knowledge. The analysis involved examining three overlapping dimensions of participant experience (see Osborne and Jones 2017): physical and material qualities (led through a combination of biodata and GPS), social qualities (led through the interview data), and embodied biological qualities (led through the biodata). These insights were integrated to provide and contextualize multifaceted accounts of each participant's psychophysiological experiences within their surroundings (see Osborne and Jones [2017] for an in-depth discussion on this analytical approach).

Focusing on the microspace encounters of the participants, this article brings together the three accounts of experience (the physical, social, and biological) to demonstrate how the dynamic, material qualities of microspace encounters can invoke specific psychophysiological reactions in the body. Building on previous studies that have examined the microscale using human sensory assessment methods (e.g., Resch et al. 2015) and geonarrative accounts (Jones and Evans 2012; Bell, Wheeler, and Phoenix 2017), this study identified and mapped embodied stress and restorative responses to demonstrate how and when different microspatial encounters evoked physiological stress or restoration for the participants.

Presentation of Data

To discuss the combination of GIS, biosensing, video, and interview data effectively, this article presents and discusses the microspace encounters as short vignettes. The use of vignettes allows this article to explore individual microspace encounters deeply. Vignettes are an effective way to explore "people's perceptions, beliefs and meanings about specific situations" (Barter and Renold 1999, 4) and have been used in health research as a reliable and valid research tool (Spalding and Phillips 2007). Although this article primarily provides a thorough discussion of several microspace encounters, these will be supported by accounts from the wider sample. Indeed, these vignettes were selected after considering the full data set to epitomize the wider sample's findings. It is important to note that such a narrative or qualitative focus to biosensing research is extremely uncommon, and the method does lend itself well to quantitative analysis (see, for example, Birenboim et al. 2019; Kyriakou et al. 2019). The experimental and exploratory approach to biodata adopted in this article, however, provides a new subjective depth and crucially shows

the value of qualitative insights alongside the embodied encounters.

Foregrounding Urban Microspaces

Using a novel methodology, this article examines the microspatial encounters that shaped participants' embodied encounters with Moseley, Bournville, and the Jewellery Quarter. This article focuses on a subset of these, discussing the role of varied microspaces that catalyzed specific psychophysiological responses among participants as they encountered foregrounding urban microspaces, namely, turbulence and airflows, scent and pollution, and the multifaceted effects of water. By focusing on the dynamic sensory qualities of the urban environment, this article aims to move beyond traditional research interested in static stressful and restorative spatialities.

Microturbulences

Although there is evidence to suggest the significance of social environments in shaping levels of stress and poor health in cities (Abbott 2012), a variety of other material features of the city can affect city dweller health. Roads, as the location for a variety of pathogenic effects, are a prime example. Indeed, there has been a variety of research discussing the pathogenic impact of traffic noise (pollution; e.g., Brainard et al. 2004; Riedel et al. 2015), air pollution (Hodgson and Russell 2018; Hoffman 2018), traffic stresses (Gee and Takeuchi 2004), and other sensory experiences (Jungnickel and Aldred 2014). Previous studies have focused on the macro- or mesoscale health effects of nearby roads, with little understanding of how individuals respond psychophysiologically to more dynamic qualities of roadside encounters. The dominance of the urban road network shapes the city's microclimate by contributing to the urban heat island effect, providing channels of ventilation and turbulent air, and adding to pollution levels in cities (Cao, Li, and Meng 2015).

Michelle's walk, for example, demonstrates how traffic can affect the body through effecting constant changes in city microclimates. Michelle, a woman in her late thirties, had lived in Moseley for just under ten years at the time of data collection; she grew up in the countryside and stated that she is keen to escape from city living and engage with natural settings. She began her walk through Moseley Park and Pool before traveling down Salisbury Road, a busy road that leads out of central Moseley toward the Birmingham city center (Figure 1). Salisbury Road is a single-lane but reasonably busy road with a narrow sidewalk (~1.5 m in width) that leads out of central Moseley toward the city center, and despite not being tree-lined, there are large front gardens, making the road feel open and verdant. In Figure 1, there is an apparent and reasonably low EDA (<2.92 μS) recorded (demonstrating a low level of sweat on the palm of her hand and inferred stress; cf. Kyriakou et al. 2019) while she was walking through Moseley Park, but of interest here are the recordings along Salisbury Road. Along this stretch, there are fluctuations between high EDA (red: >3.65 μS) and moderate EDA (orange: 2.93–3.64 μS) levels. Although these recordings are higher than those in the parkland, the fluctuations primarily occurred when there was a vehicle driving past Michelle:

> I'm now out on Salisbury Road and it is quite busy, although not as busy as I thought it would be. … You are just aware that there is traffic and it's quite fast. I would normally avoid it on the bike because of the hills, so I come up a different road. I'm not inclined to do that road as a pedestrian either, and I also found out that it is a lot longer than I anticipated. The bus was interesting because I saw that coming towards me and there is that sphincter muscle clenching moment [gasps] when something like that is coming towards you. It's actually a few seconds after when you get buffeted by the slipstream of the bus, you know you get hit by the air, and that is actually the bit that makes you gasp. (Interview with Michelle)

Using the timestamped biodata and the video footage, Figure 2 demonstrates that the EDA peaks (red: >3.65 μS) coincided with instances of a vehicle passing Michelle on the nearest side of the road. Indeed, the average percentage increase in EDA when a car passed Michelle was 17.7 percent and 39.9 percent following the bus's passing. Additionally, the prolonged instances of high EDA (for more than a couple of seconds) occurred when a heavy vehicle, such as a bus, passed her. Although nine other participants across the three areas did have similar (high) fluctuations in EDA while walking along the roads corresponding with passing vehicles, Michelle's account indicates that it was not only the noise of the vehicles that caused the

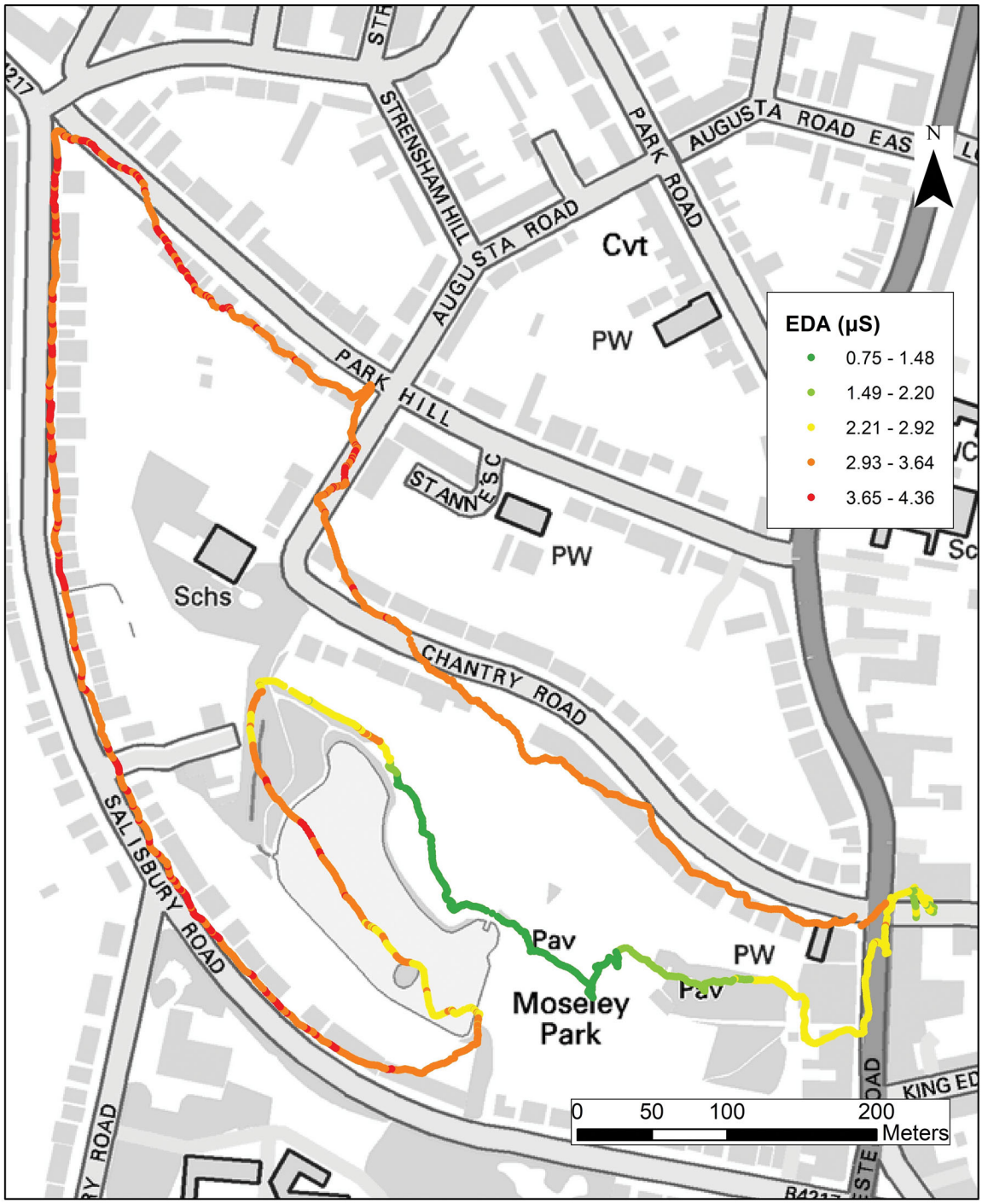

Figure 1. Michelle's EDA map. EDA = electrodermal activity.

physiological reactions but also the turbulence in the environment from the vehicles, including the wind created by the wake of the vehicles once they had passed.

Crucially, Michelle's reaction to walking along Salisbury Road could be seen as a fully embodied and cognitive experience; not only does Michelle sense the environmental changes through her body but her body reacts to those changes. Her embodied (re)actions also feed (and might even respond to) her cognitive recognition of that feeling, however. As such, Michelle's experience of Salisbury Road demonstrates how conscious perception arises from sensory stimulation grounded in the sensorimotor

Figure 2. Annotated version of Michelle's EDA map (after Figure 1) using video stills focusing on Salisbury Road. EDA = electrodermal activity.

processes of the body. Therefore, intention and consciousness related to that perception depend on experiences of the body with different sensorimotor capabilities within broader biological and psychological contexts.

Pollution Triggering the Body

In addition to the turbulent/haptic microenvironments created by passing vehicles, many participants reflected on and were affected by the road vehicles' (potential) pollution. Rachel, for example, reflected on the "freshness" of the air in Bournville:

> Rachel: [Bournville] is my little utopia because everything is green and pretty. … No matter what angle you come in it's just this beautiful green and fresh-smelling place. Yeah, it smells different.
>
> Interviewer: How does it smell different?
>
> Rachel: It smells clean. From walking that little bit up Linden Road, on the main road, you start to smell the cars, the traffic, and the heavy exhausts, and then you step off onto Bournville Lane and back towards the center, and it's free and fresh. Lots of parks; it's just fresh. (Interview with Rachel)

This reflection on the freshness of the air is reflected in her EDA biomap (Figure 3), where there is an apparent increase in the EDA recording when she is walking along Linden Road. Although considerably quieter than Bristol Road, which is the main road connecting the M5 and Birmingham city center, Linden Road is often used as a cut-through as well as the road that services the Cadbury Factory and Cadbury World. Consequently, there are often many heavy vehicles along the road (cf. "Whereas Linden Road has very heavy traffic especially at rush hour"; interview with Dan). This increase in EDA occurred not only when Rachel is walking along Linden Road but also while she was close to the road while in the parkland. An increase in EDA near roads was a common occurrence among the residents of the three areas, especially in the Jewellery Quarter, which was experiencing traffic diversions during the data collection period, resulting in increased noise and traffic fumes.

Consistent with the findings of Henshaw (2013), the smell of traffic fumes, such as that described by Rachel, is a disliked scent that is frequently associated with urban environments. Furthermore, along with the environmental disturbances discussed previously, traffic affects individual assessments of air quality and therefore the participants' sense of health. Rachel's experience of the roads in Bournville suggests that the smell of cars contributes to the afflicting qualities of a landscape and allows people to consider the effects that air quality can have on their and their families' health. Indeed, many participants in Moseley spoke about keeping their children away from the main road (Alcester Road) during the school run because it is well known that the road has high levels of pollution: "I guess people are getting more aware of pollution, even before that show. There are lots of parents walking their children to school along the back streets instead of Alcester" (interview with Esther).[3]

Whereas most studies that have examined perceptions of pollution have tended to focus on the visual qualities of smoke or fumes emitted from cars (Horlick-Jones, Sime, and Pidgeon 2003; Bickerstaff 2004), this study foregrounds how the smell of traffic pollution might stimulate a negative influence on participant experiences of these urban microspaces (Figure 4):

> I was just coming to the top of Chantry Road, and I turned around the corner. There were two huge lorries, and lorries use the A435 as a cut-through off the M42 to the city center. Therefore, you have a lot of heavy traffic using this main road a lot of the time, including the local residents and the taxis. It adds to the pollution which is not great for our health but also leaves this lingering smell which isn't pleasant. (Interview with Pauline)

As Figure 4 demonstrates, Pauline had increased levels of EDA (orange and red: $>0.5\sigma$) and periods of increased fluctuation in BVP ($\leq -2\sigma$ U $\geq 2\sigma$) along Alcester Road. Although BVP is not commonly used as a stand-alone biomarker, Kreibig (2010) showed how considering different measures can infer a variety of emotions; Table 1, for example, suggests that an increase in EDA combined with an increase in fluctuation in BVP could imply a state of disgust or joy. Because disgust and joy are very different emotional responses, it is paramount to correlate these moments with subjective narratives. Indeed, Kyriakou et al. (2019) correlated their algorithm of stress from biosensors using supplementary reported and video-recorded data. Pauline, unlike Michelle, did not describe the unpleasant feeling of a passing vehicle—maybe because the pavement is wider along Alcester Road compared to Salisbury Road—but

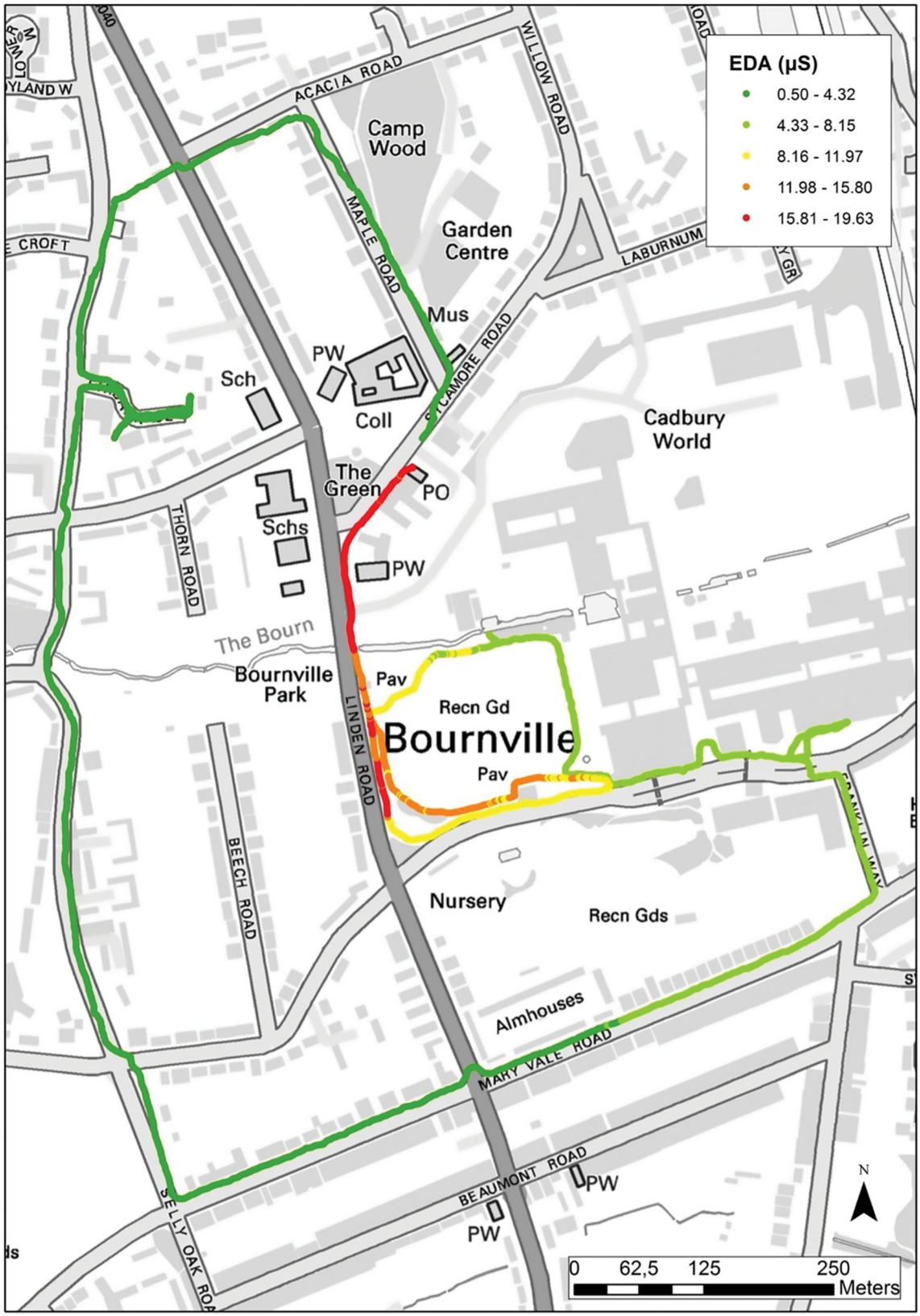

Figure 3. Rachel's EDA map. EDA = electrodermal activity.

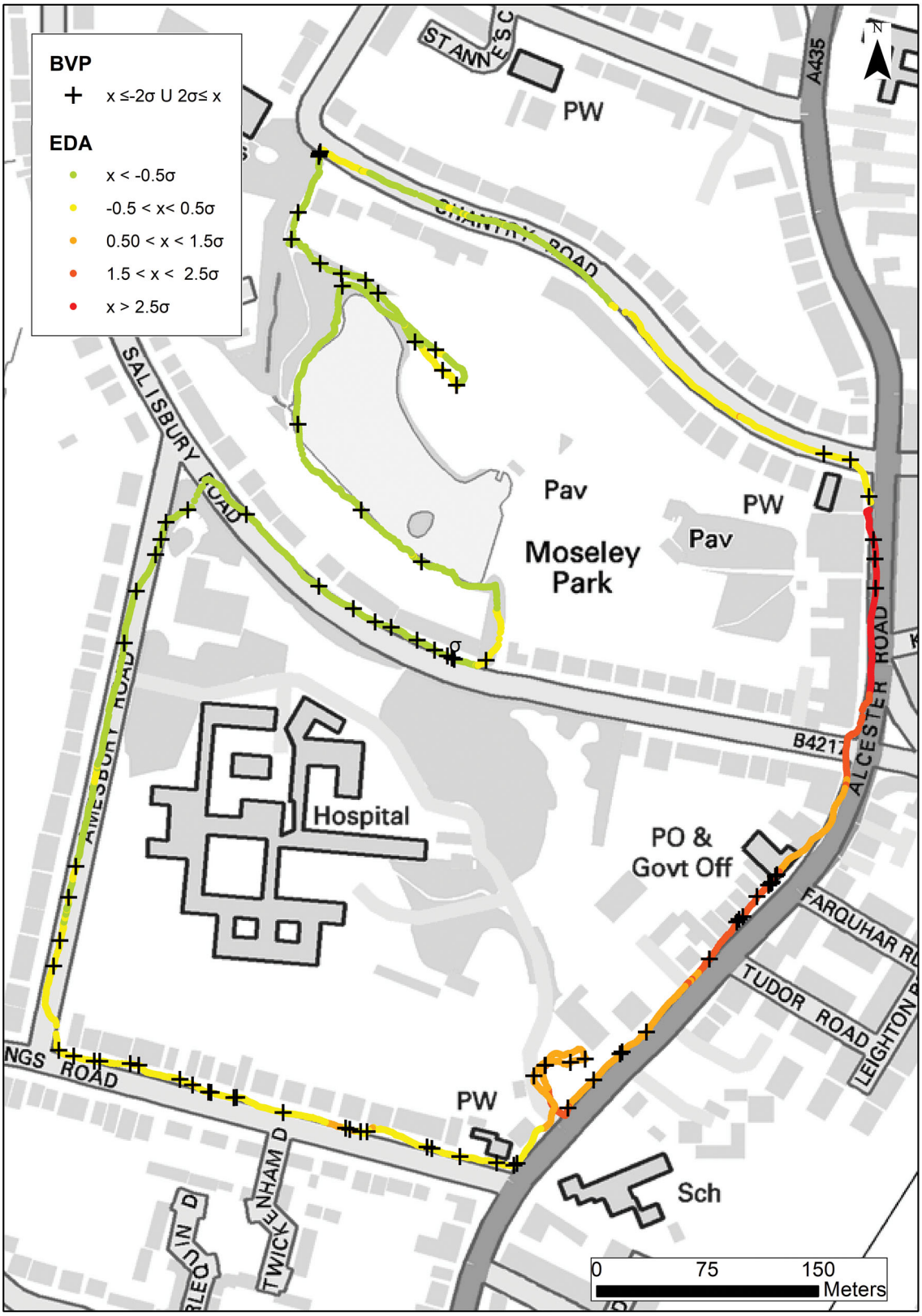

Figure 4. Pauline's EDA and BVP map. EDA = electrodermal activity; BVP = blood volume pulse.

instead focused on her displeasure from the lingering smells along the road. Crucially, this focus on air quality and pollution demonstrates that it is not solely being present in an urban environment that stresses the person or is detrimental to their well-being; it is the smaller features (e.g., pollution) that had a significant effect on the participants across the study.

Hearing the City

Although Pauline and Rachel considered the smell of pollution as an unpleasant (and a potential stressor), it is important to remember that the micro-space encounter is a multisensory sensation that considers turbulence (e.g., Michelle), smell (e.g., Julie and Rachel), but also sound. The residents from the Jewellery Quarter, for example, demonstrated how unwanted sound could be seen as a nuisance and an environmental stressor (Stansfeld and Matheson 2003). Owen, for example, experienced a high stretch of EDA levels ($1.5 < 2.5\sigma$) when he was passing a noisy building[4] site for a new apartment complex in the Jewellery Quarter (Figure 5).[5] Furthermore, when this research took place, the Jewellery Quarter had increased levels of traffic because of a nearby redevelopment. For Martin (Jewellery Quarter resident), the noise from the traffic affected his attention: "I recently counted how many buses go down our road each day, and it's 1,045 a day. No wonder I get distracted sometimes when I work at home with all that noise."

Aside from the negative psychophysiological response (inducing noises found primarily in predominantly gray spaces), there are audible qualities of an environment that can soothe and relax an individual. For example, many of the Bournville residents ($n = 13$) commented on how the "natural" sounds of Bournville Park, with the trees and the brook, were a relaxing quality for them. Indeed, this moment was particularly relaxing for Alan, whose EDA recording declined when he was in Bournville Park. Alan spoke about the noise of the wind blowing through the tree foliage and how it has a "calming rustling sound" (interview with Alan, 4 August 2016) that was "not in your face like the noises from the road." Dale, who similarly said that he preferred the quieter spaces of green and blue, had lower EDA scores (green: $<0.5\ \sigma$ when he was in green spaces compared to the busier roads; orange and red: $>1.5\ \sigma$ in Bournville; Figure 6). Natural sounds, such as those described by Rachel and Alan, have been shown in the environmental psychological literature to simultaneously encourage appreciation of natural environments and promote a positive psychophysiological response. For example, psychologist Björk (1986, 1995) took psychophysiological readings while playing a variety of sounds to participants. These experiments showed that the sounds of water and birdsong (not including alarm calls) induced a psychophysiological state of relaxation.

Water Bodies and the Multifaceted Nature of the Encounter

In addition to experiencing the turbulence and scents generated by the city's road network, many of the participants were affected by the urban water bodies' microspaces, including Valley Parkway's Boating Lake and the Bourn in Bournville. Barry and Max, for example, both stopped to look at the Bourn Brook during their walks because one "like[d] the look of running water" (interview with Barry), and the other stopped to take a picture. Although it was impossible to gauge precisely what Barry and Max found attractive in this particular instance, the fascination and salutogenic qualities are well established in health research (Foley and Kistemann 2015) and, as such, demonstrate that the presence of water generates positive psychophysiological reactions.

Indeed, Figure 7 clearly demonstrates that Julie and Max had low EDA and ST measures when walking around the Valley Parkway Boating Lake. Whereas the decline in EDA would imply that Max and Julie were experiencing minimal psychophysiological stress, the decline in ST might imply that the person felt negative emotion (e.g., anger, anxiety, fear, distress, or sadness; Table 2). In their interviews, however, both expressed that Valley Parkway Boating Lake was a space of beauty and relaxation:

> Interviewer: What was your favorite place on the walk today?
>
> Julie: Probably the yachting pool actually, it's lovely … all the ducks were out, and the geese. It's just a nice place to be. It was really relaxing. (Interview with Julie)

Without further research, is it impossible to provide a rigorous explanation for these contradictory results. Existing literature does provide some suggestions that could be explored, however; namely, the

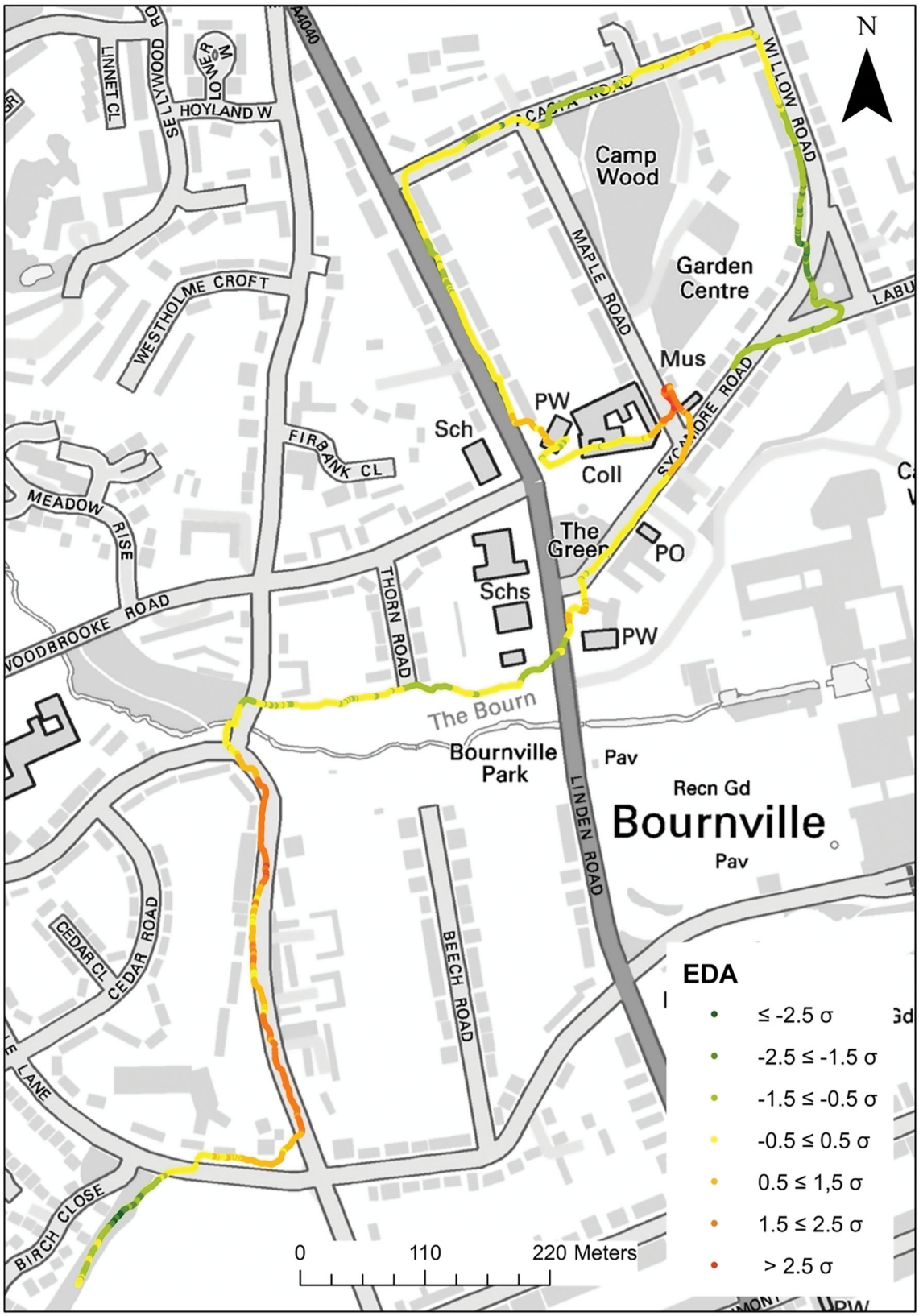

Figure 5. Owen's EDA (σ) map. EDA = electrodermal activity.

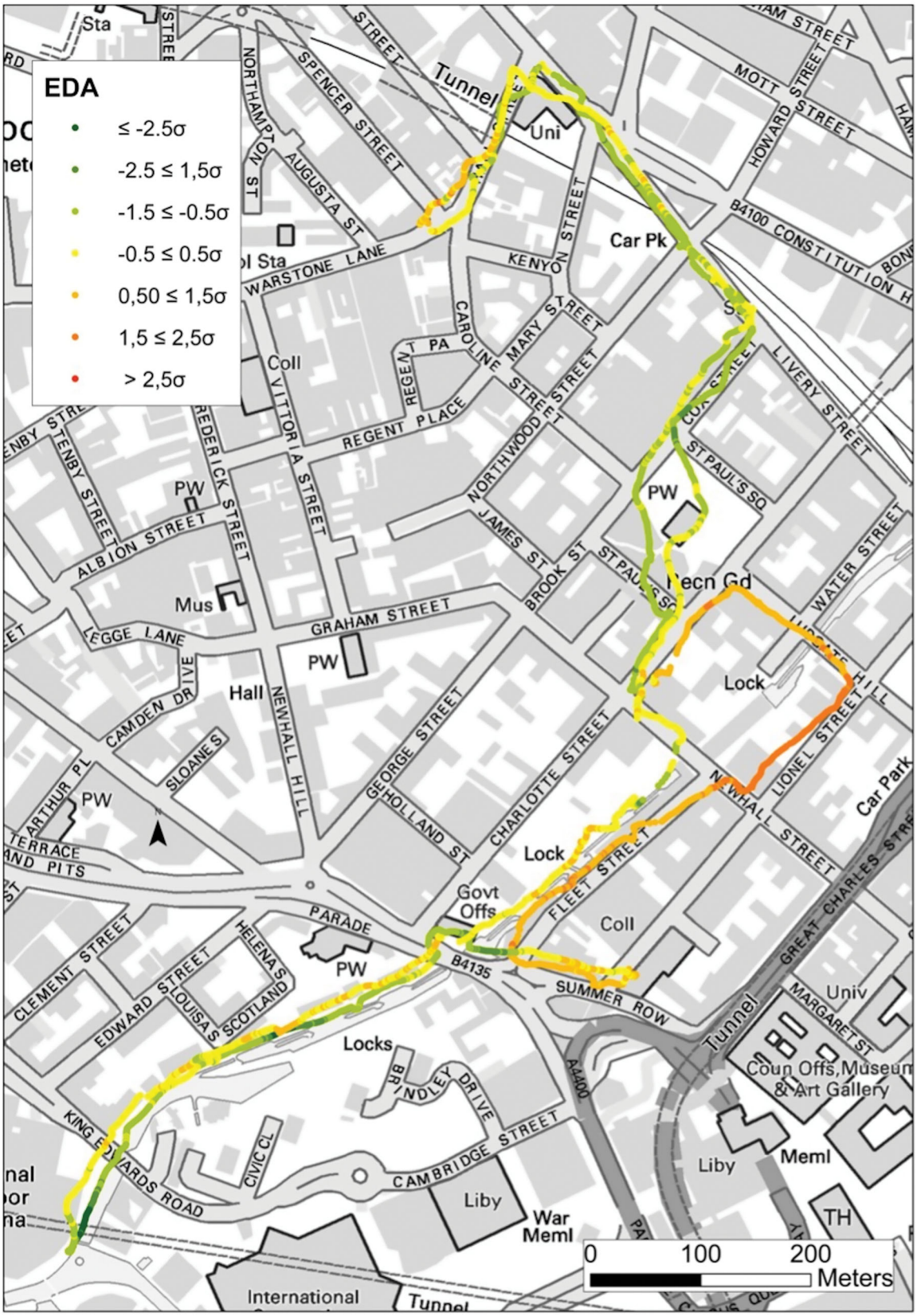

Figure 6. Dale's EDA map. EDA = electrodermal activity.

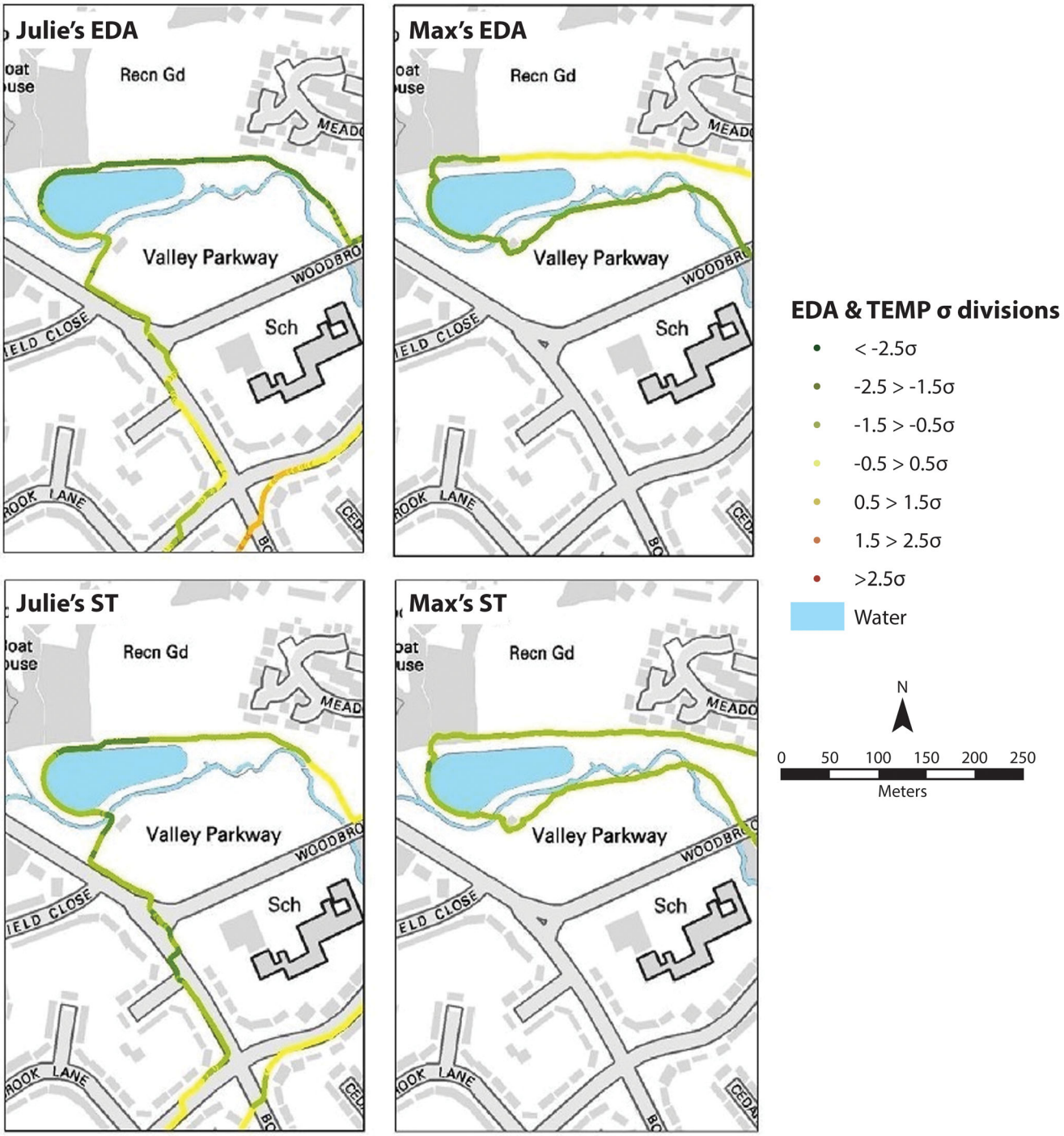

Figure 7. Julie's and Max's electrodermal activity and skin temperature around the Valley Park boating lake. EDA = electrodermal activity; TEMP = skin temperature.

cooling qualities of blue space. Many scholars in physical geography have demonstrated the cooling qualities of blue space in urban areas (see, e.g., Bowler et al. 2010; Coutts et al. 2013). Because most of the data collection occurred in the height of summer, the cooling qualities of the water body *could* have reduced the ST and sweat levels on an individual. Regardless, Max's and Julie's encounters with the blue space demonstrate the complexities that occur in the microspace encounter and consequently (re)stresses that scholars should exercise caution when interpreting the data from biosensors outside of a clinical setting (see Wilhelm and Grossman 2010).

Table 2. Emotional responses inferred from biosensing readings (after Kreibig 2010; from Osborne 2019, 71)

	Anger	Anxiety	Disgust	Embarrassment	Fear	Sadness	Amusement	Contentment	Happiness	Joy	Pride	Relief	Surprise	Suspense
HR	↑	↑	↑	↑	↑	↑		↓	↑	↑	↓↑	↑	↑	↓
BVP	↓	↓	↑	↓	–	↓	↑	↓↑	↓	↑	–			
TEMP	↓	↓	↓↑		↓	↓	–		↑				↓↑	
EDA	↑	↑	↑		↑	↓	↑	–				↓		

Note: Arrows indicate increased (↑), decreased (↓), or no change in activation from baseline (–) or both increases and decreases (↓↑). HR = heart rate; BVP = blood volume pulse; TEMP = skin temperature; EDA = electrodermal activity.

The exploratory narrative approach, however, was able to begin to tease out the relationship between the psychophysiological and the multifaceted nature of the encounter. Thus far, I have discussed some particular microspatial encounters and problematized the use of psychophysiological measures without narrative accounts and relational contexts. By effectively incorporating the individual's experiences and opinions in the cross-examination, it is possible to explore the diversity of the microspatial encounter. Michelle, for example, chose to walk around the entirety of Moseley Pool (Figure 1), which she often does when she visits the park:

> Michelle: So, this is my usual circuit of the park, and you know how you always end up gravitating to the same seat and stuff. Well, I always seem to go around the pool in the same direction and take the same route. This side is a lot nicer than the other side. Look at that; it is a gorgeous day. I do like the water, it's very picturesque. There are some good birds on the lake usually. I can say that this is the best bench.
>
> Interviewer: Why is this bench the best?
>
> Michelle: I like this bench because of that view, and it's kind of the furthest point of the pool, and it's furthest away from where you get people doing BBQs or playing guitars or whatever. It's just a nice quiet little haven. Isolation is not quite the right word, but it's a good place to sit alone. Occasionally there are fishermen over there, and sometimes you have to share the same space with them. It is lovely, so it was nice to sit there and chill. It's wonderful medicine. (Interview with Michelle)

For Michelle, the bench is a surprising space of solitude away from the social locales in the park that stimulates a positive emotional reaction for her (Figure 8). Indeed, Duff's (2016) work on recovery describes "spaces of solitude" as one of the potential recovery-enhancing aspects of outside space. Just like Duff's (2016) experience of an "affective transition of wellness" when he encountered the human and nonhuman bodies of the botanical gardens, Michelle is exposed to a particular space of relaxation including material forces (the bench, the lake), sensory encounters (quiet, picturesque water), and bodies (the fisherman, trees).

Discussion: Moving Toward the Micro and the Personal

This study has investigated the microspatial encounters that shape people's embodied encounters with the urban environment. By focusing on these embodied encounters, this article moves beyond "visual collage of what is observed," what Toila-Kelly (2013, 154) referred to as "surface geography" (also see Forsyth et al. 2013), to consider the underlying or hidden relations and processes both within the body through the physiological measures and within specific urban spaces with the focus on the microspatial. Indeed, it was possible to identify the particular moments of physiological stress in Michelle's walk along Salisbury Road, where (heavy) vehicles caused turbulence in their wake. This "movement out of the permanent order" (Cresswell and Martin 2012, 520), which activated Michelle's fight-or-flight response, occurred at specific moments, not the whole time by the side of the road. Although prolonged time in an environment (e.g., along a road or a park) might lead to an overall increase or decrease in psychophysiological stress, these accounts demonstrate how important it is to reflect on the particular features that encourage those reactions, such as perceived freshness, sensory experiences, and, in Michelle's example, atmospheric turbulence.

Furthermore, this article demonstrates that people do not merely move across "surfaces" but are immersed within an environment of elemental mediums, textures, sensory stimuli, and other dynamic qualities. Discussion around the effects of

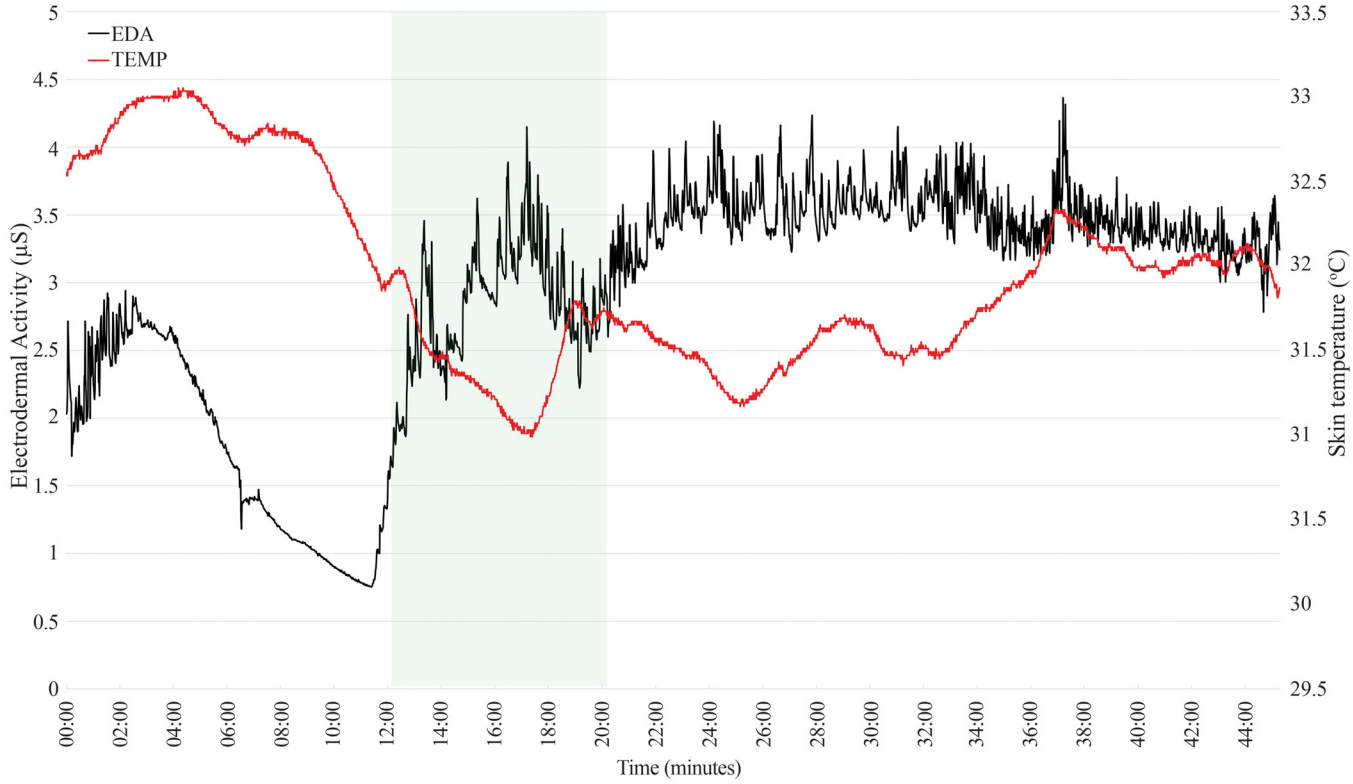

Figure 8. Michelle's EDA and TEMP biodata. The highlighted area shows a decline in EDA alongside an increase in TEMP, indicating that Michelle was feeling content or happy. This highlighted area coincided with when Michelle was walking around the lake. EDA = electrodermal activity; TEMP = skin temperature.

these intangible microspatial elements is rare because "for many scholars, aerodynamics, gravity, light, buoyancy, texture, friction, weather systems or vibrations may be too banal, physical or perhaps 'unsocial' to include" (Merriman 2012, 9). Although there have been scholars who have considered specific materialities of landscape in relation to health (e.g., Lovell et al. 2014; Brown 2017), this study has extended beyond a discussion on the human body's relations with nonhuman materialities to consider these microspatial elements that we cannot immediately see. Indeed, Pauline's and Julie's responses to the effects of pollution and water, respectively, show that stressful and restorative qualities of space arise from real and imagined reactions to the environment. Pauline's acknowledgment of polluted air from vehicles stimulated a sympathetic response. Although the air might be seen as an immaterial entity, the microscale materialities (nitrogen, carbon dioxide, and carbon monoxide particles, among others) enter the body and affect the physical health of the individual (Anderson, Thundiyil, and Stolbach 2012). In contrast, this article tentatively suggests that perception of pollution can evoke psychophysiological stress. Further research could build on this hypothesis and other aerial factors linked with car infrastructures. The combination of these two processes generates a pathogenic microspatial encounter that harms the person's physical and mental health.

It is still essential, though, to recognize that encounters with the urban environment are multifaceted and multisensory experiences. Although this article has primarily focused on the microspatial (e.g., turbulence and sensory experience), this discussion around water and road encounters demonstrates and speculates on the diversity of the relationship between psychophysiology and the urban environment. It shows the importance of "mov[ing] away from viewing place as a physical landscape, and toward a relational view in which space is implicated as human activity or vice versa" (Williams 2002, 148). As such, I suggest that research that has used biosensing technologies to identify and measure spaces of restoration, stress, or both provides a limited account of the experience. In contrast, the exploratory and qualitative approach used here can consider the societal, sensory, and imaginary

contexts. Even so, it is crucial to consider that applying biosensing technology within a qualitative approach cannot provide a full account of human experience. I have shown that different sensory stimuli can influence the physiological and narrative data and demonstrated that future research in this area with an explicit focus on specific elements (e.g., air quality, weather, and sound) would be fruitful.

Conclusion

By combining psychophysiological measurements with established theories around health and place, this article has identified how dynamic microspatial qualities of space can evoke stress or relaxation among city dwellers. Specifically, the visuality and sounds of nature-based features (e.g., water bodies and parkland) were shown to have a positive psychophysiological response. The discussion on water bodies, however, has demonstrated that biosensing considered alone is limited because the physiological reactions give an inclination of what is happening, not an objective truth: "Biosensing data taken in isolation tells us the what but not the why" (Osborne and Jones 2017, 168). Furthermore, using biosensing technology outside of a laboratory setting does add "noise" and complications to the biosensing recordings (Foley et al. 2020). As such, caution should be exercised when presenting the findings from research using biosensors. In an attempt to mitigate these issues, this study has considered the environmental, audiovisual, and personal aspects of each individual walk through GIS, wearable video, and in-depth mobile video elicitation, respectively. By adopting this innovative and exploratory methodological approach, this study was able to identify and discuss the dynamic microspatial sensory qualities of encounters that evoked psychophysiological responses. Furthermore, this article has shown how the use of biosensing technology can provide new knowledge about the perception and reception of the environment by an individual, especially when used in tandem with the mobile video elicitation, which allowed the participants and the researcher to explore the more-than-visual dimensions of experience by "seeing there" and "feeling there" (Spinney 2011). Indeed, Michelle's fluctuations of physiological stress resulting from passing road vehicles would have only been possible to identify using a combination of the biodata, video, and GIS simultaneously.

The interdisciplinary mixed-methods approach adopted for this study is an effective means to investigate aspects of environmental encounters that can relax or stress an individual. It could therefore be used and adapted in future research to advance health and well-being insights beyond the static macrocategorization of space as intrinsically healthy or unhealthy and to explore the more dynamic ways in which people interpret, embody, and respond to their surroundings. For instance, this approach could be combined with other atmospheric measures, such as air temperature, humidity, and air pollution, to delve deeper into the effect of microclimates on the body, especially regarding blue space. Additionally, by identifying these microspatial features, it might be possible to advise small-scale changes to the urban environment to combat the growing challenge of urban stress, such as wider pavements to avoid such close proximity to polluted and turbulent air or strategic vegetation to buffer specific noises or pollutant flows.

By moving beyond considerations of the stressful and restorative macrocategorizations of space, this exploratory article has shown how microspatial features, or particular qualities of place encounter, can cause or encourage psychophysiological responses of stress and relaxation. Not only does this article broaden the person–environment relationship by considering the often "hidden" physiological responses to local environments, but it also contributes to understandings of urban stress and restoration by considering how psychophysiological reactions unfold within microscale urban space encounters.

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Notes

1. More-than-representational is an umbrella term for phenomena that cannot be brought effectively into representation and includes "more-than-human, more-than-textual, multisensual worlds" (Lorimer 2005, 83).
2. Hertz (Hz) is a unit of frequency per second (e.g., 4 Hz = four times per second).
3. Around the time of data collection, there was a television show on air pollution in cities that had Alcester Road as a case study.
4. The noise from the building site was picked up from the video feed from the body-worn camera.
5. Alongside the noise disturbance, Owen also expressed frustration at the "heartless" new builds in a historical area (Osborne 2017).

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