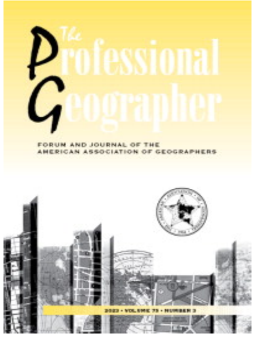

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Communicating the Urban Experience through Biosensing: A Participatory Approach

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Advances in biosensing technologies have led to the commercialization of novel lightweight wearable devices, which have been praised by urban scholars for offering the possibility to quantify emotions in real-world settings, something that had proven to be very challenging until now. Although many studies mix biosensing with qualitative methods to provide a clearer picture of what physiological data might mean in terms of emotions, there has been little exploration of how people interpret their own biodata. Following calls for greater attention to participation in biosensing studies, this article explores the nuances of the interpretation of biodata by research participants. Drawing on the findings of a study in which participants were invited to reflect on and discuss their own biodata during and after a walk in a high street in Lisbon, we show how exposing participants to biodata creates moments of bounded interference that foster in-depth reflection about the urban experience. With this in mind, we discuss how bounded interference can be a generative driver for more detailed discussions about spatial experiences. **Key Words: biosensing, electrodermal activity, participatory methods, spatial experience, urban geography.**

There is increasing interest in the potential of biosensors for the study of the urban experience, namely its emotional contours. Devices such as electrodermal activity sensors, electroencephalograms, or eye-tracking glasses have become popular tools to study emotional and cognitive reactions to urban environments (Aspinall et al. 2015; Beljaars 2020; Pykett et al. 2020b). It has been argued that the advantage of using these tools lies in the fact that their measurements are more objective and precise than the self-reported data that stem from interviews and surveys by questionnaire (Birenboim et al. 2019). It has also been noted, though, that it is often difficult to establish a direct relation between environmental stimuli and biodata measurements (Osborne and Jones 2017; Shoval, Schvimer, and Tamir 2018a, 2018b; Reif and Schmücker 2021). Taking this into account, a significant part of biosensing studies have mixed biotracking with qualitative methods, with the purpose of contextualizing physiological reactions in geographical terms (e.g., Kim and Fesenmaier 2015; Reichert et al. 2018; Stadler, Jepson, and Wood 2018).

Despite these advances, these studies have used qualitative methods mostly to provide a clearer understanding of what biodata means, but the question of how people interpret biodata and how such data might provoke more profound reflections and dialogues on the urban experience has not been sufficiently approached. This question is, however, crucial in the context of the introduction of biosensing in urban design and planning (Hollander and Sussman 2021; Sussman and Hollander 2021; Willis and Cross 2022; Willis and Nold 2022). Biosensing approaches might threaten participation in urban policies if they are not designed to include citizens in the process of making sense of both biodata and the city.

This article addresses these issues by exploring how research participants interpret the biodata of their own walks in urban space. We draw on a study in which participants wearing electrodermal activity sensors during a walk in a high street in Lisbon were invited to interpret and discuss their own biodata during and after that walk. In this study, we draw on the concept of bounded interference, which refers to the phenomenological relationship between humans and machine interfaces in which interfaces can persuade humans to rethink their own experiences, but humans retain an agential superposition over the meanings of such interfaces (Fazio 2022). We show how allowing subjects to interpret biodata creates moments of bounded interference and we discuss the potential of exploring these moments in urban research.

This article is divided into four sections. First, we review recent discussions on the advantages and limitations of biosensing methods and suggest new possibilities to explore biodata as a trigger for more in-depth discussions about the urban experience by attuning to moments of bounded interference. Second, we describe the methodology of our case study in greater detail. We then turn to the present and discuss three ethnographic vignettes of different forms of bounded interference that emerged in our study. We conclude the article by reflecting on how bounded interference can be a generative driver for more detailed discussions about spatial experiences.

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The Advantages and Limitations of Biosensing

In the last decade, following a series of advances in biosensing technologies that have led to the commercialization of novel lightweight wearable devices, social scientists have produced a significant number of studies on urban emotions using physiological data. These studies have been varied. Tourism scholars have engaged with biosensing mainly to study emplaced or virtual tourism experiences (Li, Scott, and Walters 2015; Matsuda et al. 2018; Moyle et al. 2019; Osborne 2019; Shoval and Birenboim 2019; Bastiaansen, Oosterholt, et al. 2020; Reif and Schmücker 2021), but also territorial marketing campaigns (Li et al. 2018; Bastiaansen, Straatman, et al. 2020). Scholars working at the intersection of health and geography have been applying biosensing techniques to study the impact of urban environments in the human body (Aspinall et al. 2015; Spinney 2015; Engelniederhammer, Papastefanou, and Xiang 2019; Foley et al. 2020; Pykett et al. 2020b). Thus far, the relation between mental health and the urban environment (Birenboim et al. 2019; Beljaars 2020; Winz and Söderström 2020; Winz et al. 2022) and the detection of moments of stress (Thompson et al. 2012; Olafsdottir, Cloke, and Vögele 2017; Kyriakou et al. 2019; Lee et al. 2020; Pykett et al. 2020a) have been the most prominent topics of research. In addition, urban scholars have also engaged with biosensors as a method to understand cognitive and emotional responses to specific features of the urban environment (Resch, Sudmanns, et al. 2015; Resch, Summa, et al. 2015; Hijazi et al. 2016; Zeile et al. 2016; Kiefer et al. 2017; Nold 2018; Shoval, Schvimer, and Tamir 2018a; Hollander et al. 2019; Pykett, Osborne, and Resch 2020).

The emphasis in these studies has been mostly on the possibilities of measuring emotions (Kim and Fesenmaier 2015; Shoval, Schvimer, and Tamir 2018a; Stadler, Jepson, and Wood 2018; Caruelle et al. 2019). Indeed, biosensors have been mostly praised for the possibility to quantify emotions in real-world settings, something that had proven to be very challenging until now. For instance, Birenboim et al. (2019) claimed that ambulatory biosensing measurements facilitate the study of people's physiological signals during their daily routines in real-life situations and are more objective than self-reported assessments. The authors argued that wearable biosensors significantly reduce the burden on research participants, as they are no longer required to repeatedly complete surveys or undertake long interviews. In this sense, there is a dangerous erasure of the subject across several biosensing studies, as people's subjective experiences are reduced to the device's biodata.

In addition to this, despite the positive views on the potential of biosensing methods, other studies have unveiled significant limitations to the exactness of biosensors. On the one hand, difficulties in standardizing data have been reported, due to the significant differences in data across age, gender, and other social and personal characteristics (Shoval, Schvimer, and Tamir 2018b). On the other hand, it has been noted that biosensing "can capture the 'what' but not the 'why,'" because it is difficult to establish a direct relation between an environmental stimulus and a bodily response (Osborne and Jones 2017, 162). Thus, several studies are now mixing biosensing techniques with traditional qualitative techniques, including mental maps (Paül I Agustí, Rutllant, and Lasala Fortea 2019), behavioral experiments (Bastiaansen, Straatman, et al. 2020), interviews (Kim and Fesenmaier 2015), photo elicitation (Stadler, Jepson, and Wood 2018), video (Reif and Schmücker 2021), and diaries (Reichert et al. 2018). There are significant challenges to these approaches, as asking participants to explain their own biodata can pose the "risk that they might ascribe false meaning to the data in order to make sense of it themselves" (Osborne and Jones 2017, 161).

Indeed, although these mixed-method studies have provided a better context to the biodata, allowing greater understanding of the body–environment relation, they have also further underlined the limitations of biosensing techniques. It has been noted that it is difficult to assign a certain event to biodata unambiguously (Shoval, Schvimer, and Tamir 2018a; Reif and Schmücker 2021), as physical activity influences biodata, making it difficult to distinguish emotionally driven from activity-driven data variations (Pykett et al. 2020b; Reif and Schmücker 2021). Some researchers have tried to develop methodologies to minimize the presence of motion and electronic artifacts in the data that might suggest erroneous interpretations of human–environment interactions, but it has proven difficult to completely eliminate them in ambulatory settings (Taylor et al. 2015; Kyriakou et al. 2019). Furthermore, biosensors might not detect low-intensity changes or be sensitive to differing cultural understandings of emotions (Pykett et al. 2020b). For this reason, Reif and Schmücker (2021, 290) concluded that it is often challenging to even assess the "what" of biosensing, let alone the "why."

Rather than leading us to believe that biosensors are too flawed for urban research, we suggest that these shortcomings should instead motivate researchers to further explore the potential of biodata for qualitative methods, following recent calls for making biosensing studies more participatory (Willis and Cross 2022; Willis and Nold 2022). More precisely, we are interested in exploring how the reported ambiguity of biodata can be generative in the sense that the controversies that it causes might lead to more profound discussions about worldly experiences. That is, we contend that it is worthy to take the discussions regarding biodata as seriously as the biodata itself. Osborne (2022) already showed the value of focusing on participant narratives about their own biodata, by using video and biodata elicitation in postwalk interviews to understand how microspatial encounters invoke specific psychophysiological reactions. Rather than focusing on the biodata itself, Osborne (2022) unveiled the affective relations that people establish with microspaces by exploring the participants' individual narratives that stem from the elicitation of biodata. There is more to explore, however, regarding how looking at biodata might change or deepen the way people remember, reflect about, and express their own spatial experiences.

Here, we draw on the concept of bounded interference to describe the possibilities of reflecting on and reinterpreting spatial experiences by questioning biosensing. Fazio (2022) described the relationship between humans and mobile technologies as one of bounded interference. For Fazio, human–smartphone interactions take place within thought fields in which the relationship between humans and machines is composed by two asymmetries. On the one hand, Fazio drew on Stiegler's (2009) understanding of hypomnesis, which refers to the externalization of memories and subjectivities into technology, to argue that smart devices function as hypomnesic devices. That is, smart technologies such as the smartphone or biosensors are used to externalize our memories and subjectivities. By doing so, a sense of intimacy between humans and machines arises, which ultimately offers mobile technologies the capacity to persuade humans. On the other hand, Fazio believed that humans maintain an agential superposition over the machine. Although Fazio contended that both asymmetries coexist, he described their relation as one full of interferences (in a Deleuzian–Guattarian sense). For Plotnitsky (2012), Deleuzian–Guattarian interference can be understood as "the addition or superposition of two or more waves that results in new wave patterns" (22). In this sense, interference involves the resonant encounter between different affective tones, which leads to a rich play of amplification that results in often unpredictable new affective tones (Plotnitsky 2012; see also Ash et al. 2018; Ash and Simpson 2019; Paiva 2020).

Here, we argue that the biodata stemming from biosensing methods can be understood as a hypomnesic device, as it captures affective phenomena even beyond conscious experience, which can participate in producing moments of bounded interference. In such moments, biodata can persuade participants to rethink their own spatial experiences, but participants retain an agential superposition over the biodata that has been produced. Such bounded interference means that the encounter between hypomnesic biodata and agential subjects results in new interpretations of past spatial experiences. Therefore, through bounded interference, biosensing becomes a generative method. In the next sections, we present how bounded interference during a biosensing study has led to novel, in-depth discussions about the spatial experiences of participants.

Method

The purpose of our study was to understand how people interpret the biodata of their own walks. Whereas other studies have drawn on qualitative methods to contextualize biodata (Stadler, Jepson, and Wood 2018; Reif and Schmücker 2021; Osborne 2022), our purpose is to focus on the way that biodata suggest certain interpretations of those data or how personal interpretations might contradict or deepen the data.

The study was composed by two steps. In the first step, participants were invited to undertake a walk through a main street in Lisbon wearing an Empatica E4 wristband. This device records electrodermal activity (EDA), which can be described as the electrical phenomena in skin, including "all active and passive electrical properties which can be traced back to the skin and its appendages" (Boucsein 2012, 2). There are several factors that influence EDA, including individual factors such as age, gender, ethnicity, anxiety levels, or medication, and environmental factors such as temperature or humidity, but EDA can also be used as an indicator of emotional arousal (Osborne and Jones 2017; Shoval, Schvimer, and Tamir 2018a, 2018b; Reif and Schmücker 2021; Osborne 2022). Although EDA has been used to identify spatial points of emotion (Osborne 2019; Reif and Schmücker 2021), it must not be confused with mood, affect, or emotion itself. It must be underlined that EDA data, as a hypomnesic device, record a physiological signal that varies according to the flows of mood, affects, and emotions in the body (and other variables). For this reason, it is an interesting trigger to spark conversations about these topics, but these are complex constructs that require qualitative inquiry to be addressed. In our study, participants understood EDA as a register of different humoral, affective, and emotional phenomena, and, given our focus on the participant's biodata interpretation, we present their constructs.

Before the walk, participants had a five-minute rest period wearing the wristband to allow proper calibration of data. Participants were also given a brief explanation about the purpose of our research, the methodology of this experiment, and what EDA is, and then signed an informed consent form. In addition to the wristband, participants were given a

Huawei MediaPad T5 tablet that displayed the Empatica wristband's real-time EDA raw data through the E4 realtime app. They were encouraged to look at the raw data display during the walk to become acquainted with how EDA fluctuates during their walk. Most participants mentioned that they looked at this interface for brief periods of up to one minute and then placed the tablet on their handbag, after realizing how responsive it is.

The walk was conducted in Avenida da Igreja, a consumption-oriented main street in Lisbon. The retail mix is dominated by clothing stores, restaurants, pastry shops, and banking and real estate agencies. Although Avenida da Igreja is a main road in the neighborhood, the public space is pedestrian-friendly, with large sidewalks and twenty-five public benches distributed across the 525-m-long avenue. The urban landscape is, however, quite consumption-oriented, as the street contains billboards, bus stops, and street kiosks with large advertisements. Nineteen participants were invited to walk up and down the avenue, leading to a 1,050-m walk, which they completed in between fifteen to thirty minutes.

In the second step, an interview was conducted immediately after the walk. The interview comprised two parts. In the first part, participants were invited to describe their walk, and to identify significant moments, namely (1) elements of the urban landscape that caught their attention; (2) positive experiences and feelings during the walk; (3) negative experiences and feelings during the walk; and (4) moments of personal memory. In the second part, the participants were shown a graphic with the raw EDA data of their walk containing timestamps on a tablet. Participants were then asked to identify the moments of attention, positive feelings, negative feelings, and personal memory in the graphic. No video or Global Positioning System (GPS) data were recorded during the interview, so that participants could focus on their interpretation of the raw EDA data. Nevertheless, most participants were able to pinpoint their significant moments in the graphic, although three participants expressed that the task would be easier with the aid of video. Given the use of raw data in this experiment, the data contained motion and other artefacts that made it impossible to relate data variations uniquely to affective or emotional responses. Rather than sorting out these artefacts, we were also interested in understanding to what extent participants would be able to present and discuss different causes that might explain data variations. In line with Osborne (2022), we intended to "move beyond correlation to explanation" (1465). With the information that stemmed from these interviews, we created graphics of the EDA data for each participant and transcribed the interview data to relate them to the significant moments on this graphic using text boxes.

The nineteen participants involved in these walks resided in the Lisbon Metropolitan Area and their age ranged from eighteen to sixty-six years old. Education levels were generally high, ranging from secondary education to a master's degree. The sample was balanced in terms of gender (53 percent female, 47 percent male). Seventeen participants were Portuguese and two were Brazilian. In the next section, we approach the processes of interpretation of biodata that have emerged in our study by presenting three vignettes of bounded interference.

Bounded Interference in Urban Biosensing

As hypomnesic devices, biosensors register the remnants of affective and physiological phenomena. Although such remnants are not the human experience itself, they can help create or re-create narratives of past experiences. When the raw data of the biosensor are graphically represented in temporal or spatial terms, they tell a story. The narratives that biosensors create, however, might differ from the narratives of the subjects involved in the experience, not only because biodata might register nonrepresentational affects that go unnoticed in urban walking (Buser 2014; Simpson 2020), but also because biodata contain artefacts (Taylor et al. 2015; Kyriakou et al. 2019). Allowing subjects to interpret such data creates moments of bounded interference in which biodata can persuade humans to rethink their own experiences, but humans retain an agential superposition over the meanings of the data (Fazio 2022). In this section, we describe and discuss three forms of bounded interference that have emerged in our study, providing a practical example for each form. First, we show how data anomalies can lead to "glitchy" contestations that reveal the personal significance of specific experiences. Second, we describe how emotional states are layered into variations in and interpretations of biodata. Third, we explore how data ambiguity can also reveal emotional ambiguity.

Data Anomalies

Maria[1] is walking through Avenida da Igreja during a slightly rainy and windy day in June. The temperature outside is about 22 °C. She is wearing an Empatica E4 wristband and looking at the real-time EDA data through the Empatica realtime app. Maria finds it strange that EDA data remain perfectly stable, as she was expecting EDA to peak during moments of active attention. She starts testing her own reactions by going inside stores, where she expects to have more immersive experiences. She goes inside two stores, but the data line does not

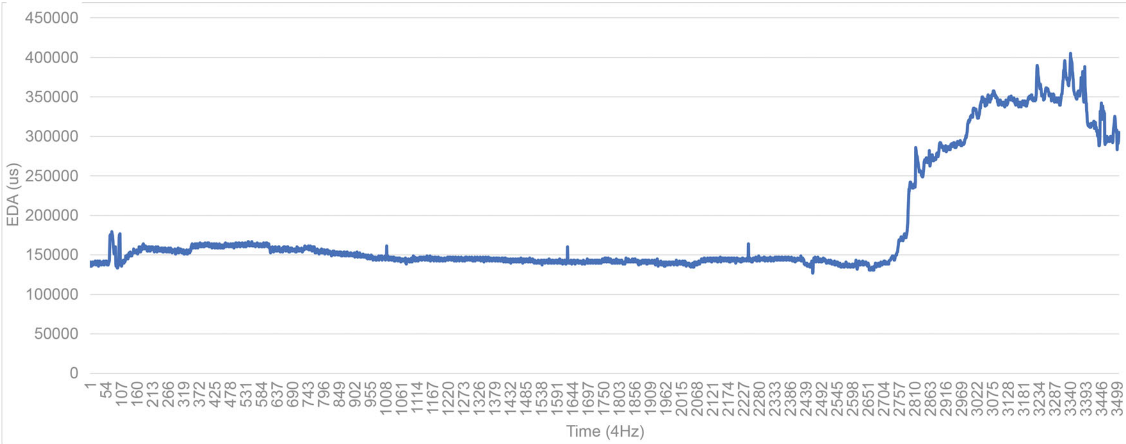

Figure 1 *Electrodermal activity (EDA) of Maria's walk in Avenida da Igreja (Lisbon), 2022. Data collected with an Empatica E4 device.*

budge. Then, she makes one last attempt. In her words:

> So, at this point I go into another store, and I see the values doubling up! It was like a store of household items. And it smelled like strawberries.

When Maria looks at the EDA data graphic at the end of her walk (Figure 1), she is puzzled:

> I don't know what this means, but this is my whole path until I get to the store. But then I go inside the store, and it is not like there is anything there that is particularly interesting to me. But then the values really went up. The store was very colorful, and the scent was much more pleasant than the street. It might be because of that that the values went up so much, but I am not sure.

We ask Maria how long she was at the store, given that the values remain high until the end of the walk. She states that she was there only for one minute, and that the values remained high even after leaving the store. We talk about the possible effect of the temperature on her EDA values, given that it was somewhat cold outside and warmer in the store, and this might have influenced her values. Indeed, Maria describes other significant sensory stimuli during her walk outside that did not correspond to any peak in the data. She mentions the scent of the grilled chicken takeaway restaurant as a positive stimulus and the noxious smell of car exhaust as a worrisome sign of urban pollution. Maria's encounter with her EDA data shows that the fact that biodata might come across as anomalous as they vary according to multiple factors can be generative in terms of how people rethink and communicate their own experiences in face of values that seem glitchy. Following Leszczynski and Elwood (2022a, 2022b), we can consider these glitches as generative fissures that open up spaces for dialogues between subjectivities rather than discard them as abnormal matters that should not count in objective urbanism (see also Pallett 2022). In this sense, there is a limit to the narratives that biodata suggest, but it is such a limit that activates Maria's agential superposition. Maria plays with data during her walk to understand how it works, she contests the "silences" in her data, and she reflects on the multiple meanings of data peaks. In this sense, data become meaningful through the glitchy relation of interference that Maria establishes with it.

Layered Data

EDA biodata provide a one-dimensional data set that can be used to understand emotional engagement, but such data are not sensitive to the complexity of emotional states, which also contain a cultural dimension (Pykett et al. 2020b; Reif and Schmücker 2021). This means that EDA data variations might not correspond to the effect of a single emotion. Instead, these variations might emerge from layers of emotions, feelings, and underlying moods. Magda's walk is a significant example of this. The EDA graphic of Magda's walk shows two quite different moments (Figure 2). EDA data are gradually diminishing during the first half of her walk but increase and become spiky during the second half of the walk.

Magda starts by recognizing that taking a walk through that street at that time was a relaxing activity, as she had a busy morning that day. Then, she identifies three significant positive moments during her walk:

> The shop windows. A pharmacy window got my attention, with a series of creams and products. The clothing store windows as well. … A restaurant that I had never seen also got my

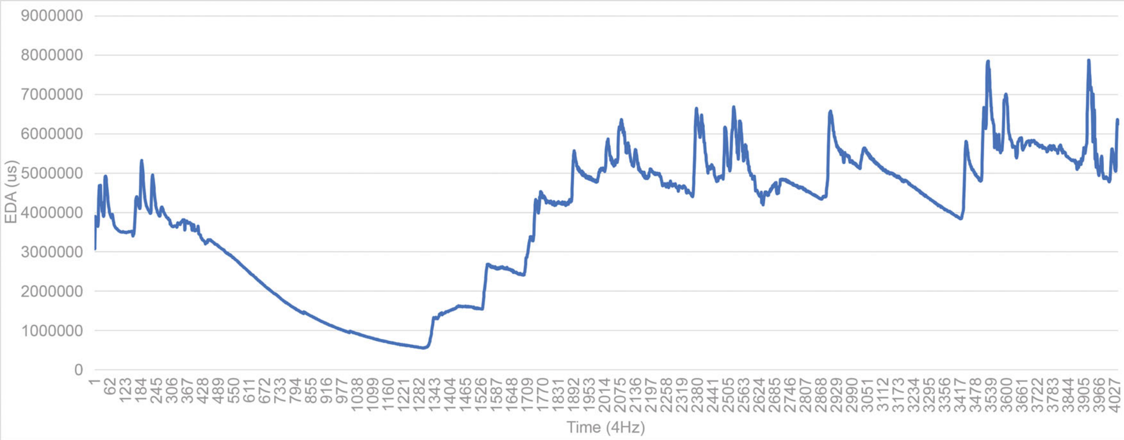

Figure 2 *Electrodermal activity (EDA) of Magda's walk in Avenida da Igreja (Lisbon), 2022. Data collected with an Empatica E4 device.*

> attention. I know the area, but I had not been here, at least on foot, for a while. … Perhaps it's a stretch to say that this is an affective memory, but I actually passed by a *churrasqueira*,[2] which I think has the best chicken in Lisbon. And as I passed by, it reminded me of my friends with whom I ate chicken there last time.

Magda can associate the emotional event at the *churrasqueira* to a data spike, but the first two took place during the first half in which her EDA was gradually decreasing. When asked why she thinks her second half of the graphic is much higher than the first, she reflects and makes a personal confession:

> It's not related to the street. I am not sure if this will make much sense for the study that you are doing. Because I am having some negative thoughts, nothing to do with the walk, it's my own stuff. And I felt that during the walk, because when a person winds down, it is easier to start thinking about stuff. I felt this in the second half. Because in the first half I was more distracted, with the shop windows and everything. In the second half, I was ruminating. This makes sense because when I went the first time, I was super distracted with what I was seeing, and I was super calm, and then when I got back, I was more involved in my own thoughts.

Magda's reflection led her to understand and communicate the interaction between her mood and emotions, and how they were affected by both the act of walking and the urban features that she encountered. Rather than simply communicating a one-way relation between a perceiving subject and a perceived object, which the interview script also implies, Magda came to realize the complex interactions between her mood, emotions, and the urban experience. Magda's realization also demonstrates how layers of mood and emotion are interwoven in biodata (Osborne 2019; Pykett et al. 2020b). Rather than highlighting the ambiguity of such data, however, Magda's case shows how reflection about layered biodata can help communicate complex emotional relations with the urban space in greater detail, beyond the subject–object dichotomy. In this case, biodata suggested a narrative quite different from Magda's own narrative, and persuaded her to rethink her own experience. Even so, Magda retained the agential capacity to explain and assert the meaning of the diverging biodata.

Emotional Ambiguity

In addition to concealing layers of moods and emotions, biodata might also conceal ambiguous emotions, as data peaks (high and low) refer to emotional intensity, but not to emotions themselves. This means that ambiguous or contradictory emotions regarding events remain hidden in such peaks. Nevertheless, data peaks often suggest a more in-depth reflection that leads participants to engage with contradictory emotions regarding urban spaces, and these reflections also lead to new interpretations of data peaks.

When Pablo looked at his data after his walk through Avenida da Igreja, it was very easy for him to relate the peaks in his data to his own atmospheric perception during the walk. His data graphic (Figure 3) shows a series of high peaks in a rhythmic cadence, and Pablo explains why that happened:

> The streets that intersect with the avenue … each time I stopped to cross the street I enjoyed taking a moment to appreciate those other streets and buildings as they are, because I found them pretty and organized. … When I walked by, I felt good. I think the model of the houses reminded me a lot of some houses in Brazil. So, I could see myself, my childhood somehow on those streets. And while

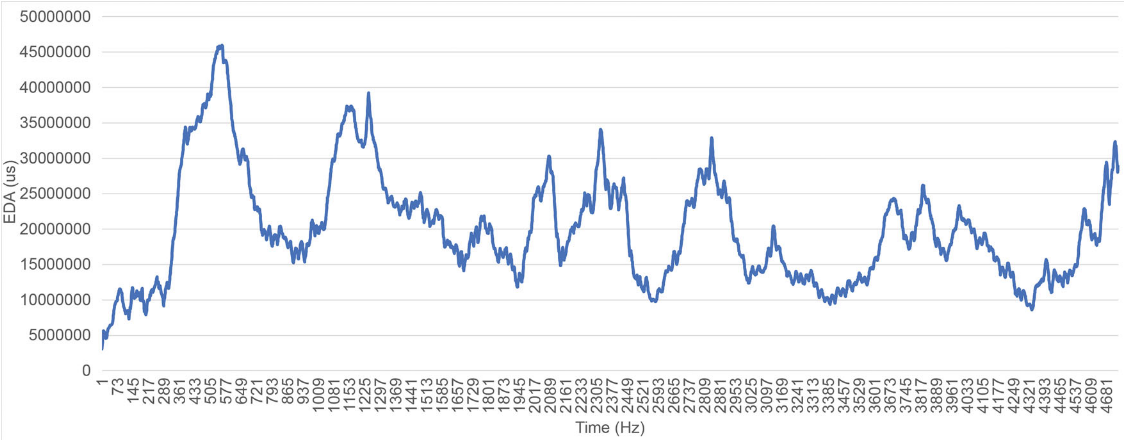

Figure 3 *Electrodermal activity (EDA) of Pablo's walk in Avenida da Igreja (Lisbon), 2022. Data collected with an Empatica E4 device.*

> the avenue is not too packed, not too confusing, those streets were like a calmer funnel, with not too many cars. I was like, "wow, how beautiful."

Pablo could not only relate the high peaks in his data to significant moments of awe, but he also was able to associate low peaks with boring or unpleasant moments. In particular, he mentions the lowest point in the middle of the graphic as the moment when he was crossing a roundabout, which he found annoying "because there was no shade and no trees." He continues: "… so it was worse. My eyes were hurting. The roundabout was a nuisance. Due to the sun, due to the light, it was too open."

After looking at the data, however, he wonders why that seems to be the lowest point of his data. He then remembers an encounter he had during that moment. In his words:

> But it was very funny because, even here when I felt uncomfortable, I was crossing the street and a gentleman came to talk to me. Not really talking to me, but I was waiting for the traffic light to change and he made a gesture like "Come quickly, you have time to cross." And I thought that interaction was funny.

In this case, the presence of a low point in the biodata suggested a more careful examination of a specific moment to Pablo. This careful examination unveiled a moment of ambiguous emotions in which Pablo was both bothered by the urban environment and entertained by a social interaction. In this sense, the interference of data in Pablo's account of his experience, instead of merely confirming or refuting his account, led to a new interpretation of such data, as Pablo retained an agential superposition over the data (Fazio 2022). Therefore, the advantage of biosensing, in this case, is not related to a higher precision or objectivity as claimed by authors such as Birenboim et al. (2019), Bastiaansen, Oosterholt, et al. (2020), or Shoval, Schvimer, and Tamir (2018b), but to the generativity of the subjective process of bounded interference.

Conclusion

The three events of bounded interference that we identified in our study show that the glitchy anomalies, layers, and the ambiguities of biodata can be generative drivers for deeper and more detailed discussions about spatial experiences, rather than leading us to dismiss such data as biased or inaccurate. Although it has been demonstrated that the elicitation of biodata in postwalk interviews is fundamental for the contextualization and the analysis of such data (Stadler, Jepson, and Wood 2018; Pykett et al. 2020b; Reif and Schmücker 2021; Osborne 2022), we have also shown that biosensing can be rethought as an elicitation technique that can be integrated into established qualitative and participatory methods in urban studies to generate more profound reflections and conversations. In this regard, we highlight the notion of the agential superposition that research participants retain over the data (Fazio 2022). The data suggest a certain interpretation of their spatial experience, but participants have been able to contest or expand the story that data tell. They question data, reflect on them, and explore and provide alternative explanations. Here, it must be taken into consideration that there is a delicate balance between the extent to which biodata can persuade participants and their own agential superposition. In some cases it is the limits of the biodata that activate the participants' agential superposition, but in other cases the biodata can persuade participants into rethinking their own experiences and exploring alternative narratives, although participants retain the ability of constructing and making sense of those alternative narratives themselves. In any case, the bounded interference caused by biodata can be a generative driver for deeper and more detailed discussions about spatial experiences.

Taking this into account, future research should take a step further and explore how biodata can be employed to elicit in-depth discussions in the context of participatory urban planning and design projects. As biosensing is gradually introduced into urban design and planning (Hollander and Sussman 2021; Sussman and Hollander 2021), objective approaches focused on data accuracy (in the line of Kim and Fesenmaier 2015; Shoval, Schvimer, and Tamir 2018b; Birenboim et al. 2019) can threaten participation in urban policies if they exclude citizens from the process of making sense of biodata and the urban experience (Willis and Cross 2022; Willis and Nold 2022). Focusing on the potential of biodata to improve the capacity of urban citizens for reflecting and communicating their own urban experience is therefore a crucial step to guarantee that biosensing approaches can contribute toward more inclusive cities. ■

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Notes

[1] The study was conducted in strict confidentiality. All participant names are fictitious.

[2] Traditional Portuguese grilled chicken take-away restaurant.

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