Bio Mapping: How can we use emotion to articulate cities?

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Introduction

How does the city make us feel, and how can we use our feelings to make cities? In the text 'Lynch Debord: About Two Psychogeographies', the artist Denis Wood describes two opposing approaches from the 1950s and 60s towards visualising people's experiential maps of the city.[1] The first is a performative psychogeographic method for making desire in the city visible via intoxicated walks, while the other was a cognitive method for making sensation legible as mental maps for formal urban planning. These two approaches while both interested in the intangible city of the body and mind, involved radically different conceptions of what mattered. These two methods have become contrasting traditions within urbanism for bottom-up or top-down ways of transforming the city. This text explores a continuation of this conflict into contemporary mappings of emotion using digital technologies and methods. Rather than using pencils and what Wood called 'human instruments', these approaches use sensing technologies to articulate the body in relation to the city. The majority of the text focuses on the author's Bio Mapping art project, which uses physiological sensors to allow people to describe their relationship with the environment as an alternative urbanism, while the Urban Emotion approach uses sensors and crowdsourced data to build an emotion layer for real-time urban planning.[2] The text evaluates these approaches using the paper 'How to Talk About the Body?' by the philosopher Bruno Latour, where he argues that research can only be articulate if it manages to arouse interest in others and create unexpected connections.[3] This approach identifies that despite using similar technologies, these two methods offer radically different potentials for articulating significance, organising collectively and transforming cities.

Can machines measure emotion?

When we think of a lie detector (polygraph), we think of a machine, a needle moving across paper creating jagged lines that describe the breathing rate and sweat level of a subject strapped into a chair. The lines trace a subject's physiological arousal while the interrogator is asking them control questions as well as about the real topic of concern. The assumption of the lie detector is that if a person is guilty their body will generate a stronger physiological stress response to the relevant questions, than an innocent person. The machine is said to visualise the subject's true internal state and allow the interrogator to tell whether the subject

is lying. Yet, while it is easy to detect physiological arousal, it is difficult to associate it with a definitive cause and make it meaningful. The consensus amongst psychologists is that 'polygraphic lie detection is not theoretically sound, claims of high validity for these procedures cannot be sustained, the lie test can be beaten by easily learned countermeasures'.[4] This makes the lie detector notoriously difficult for establishing objective truths and is rarely admissible in a court of law. Thus law-enforcement professionals do not use it as a scientific instrument, but rather as an interrogation technique to intimidate the subject into confessing their guilt.[5] What matters with the polygraph is not what the machine is measuring, but how it can make the subject talk. Thus, the lie detector is not just a machine that functions on its own. Rather, it is only one part of a larger performance of interrogation that consist of a coercive setting, an interrogator, a subject, the spectacle of measurement and the subject's fear about what their body might disclose. In such a context, the subject's articulation is not just done by a human subject, but something that occurs in conjunction with these multiple other elements. This is to say that these physical and nonphysical elements are all a critical part of the whole performance of articulation. In this text, I will be referring to different ways of organising these various elements as 'staging'.

This text doesn't aim to define what emotion *is*, but rather to explore what emotion can *do* when its measurement and articulation are organised using different methods. My starting point for creating the Bio Mapping project was the idea of removing elements from the lie detection performance and inserting new ones. In this way, it might be possible to stage another kind of performance that allows people to speak differently about themselves and their environment.
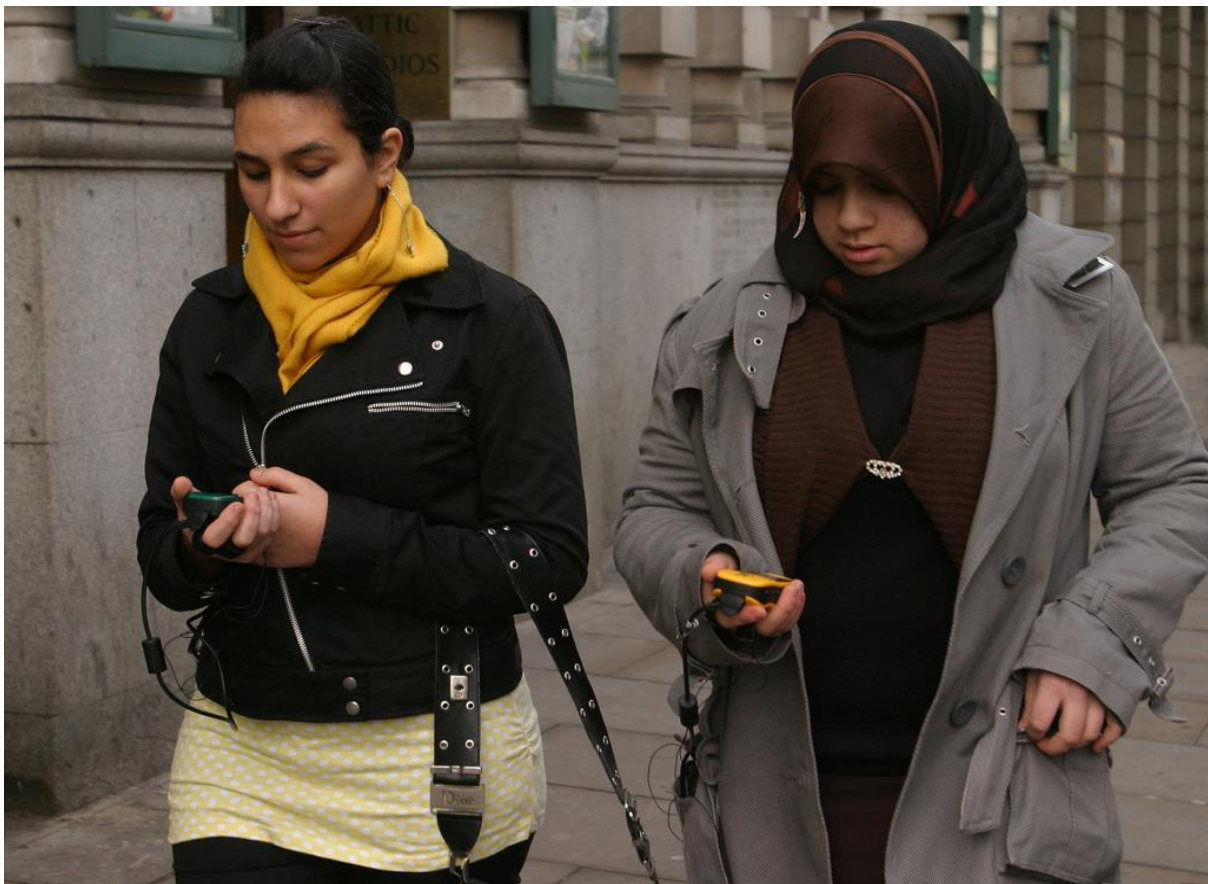

Figure 1 Two participants wired up with the Bio Mapping devices

Bio Mapping

The Bio Mapping project consists of a dozen specially created micro-controller devices and accompanying visualisations.[6] The device consists of a finger-cuff sweat sensor that measures galvanic skin response (GSR) like a polygraph, as well as a Global Positioning System (GPS) that record the wearer's geographic location. Instead of the coercive setting of trying to detect lies, Bio Mapping stages emotion as a relationship with geographic location. By visualising GSR and GPS together, this association becomes a means for people to reflect on their body-data in relation to their environment. The project aims to transform the lie detector into a different way of staging physiological arousal that facilitates a new kind of urban body articulation that becomes a participatory urbanism. Over the last decade, the project has involved thousands of people all over the world in participatory workshops hosted by cultural organisations. Each local project involved around 100 residents in each area and functioned as small workshops of ten people at a time that often didn't know each other. Each workshop took half a day and was split into two parts. In the first part, participants were asked to go on walks exploring the local area whilst wearing the device and return within an hour. In the second part, each participant would take turns discussing their walk using the gathered arousal data. When I showed the participants the devices, I also explained their functional similarity to the lie detector sensor. When first connected to the device, most people reported feeling awkward, which during the walk often became a state of heightened awareness of themselves, the technology and the environment.
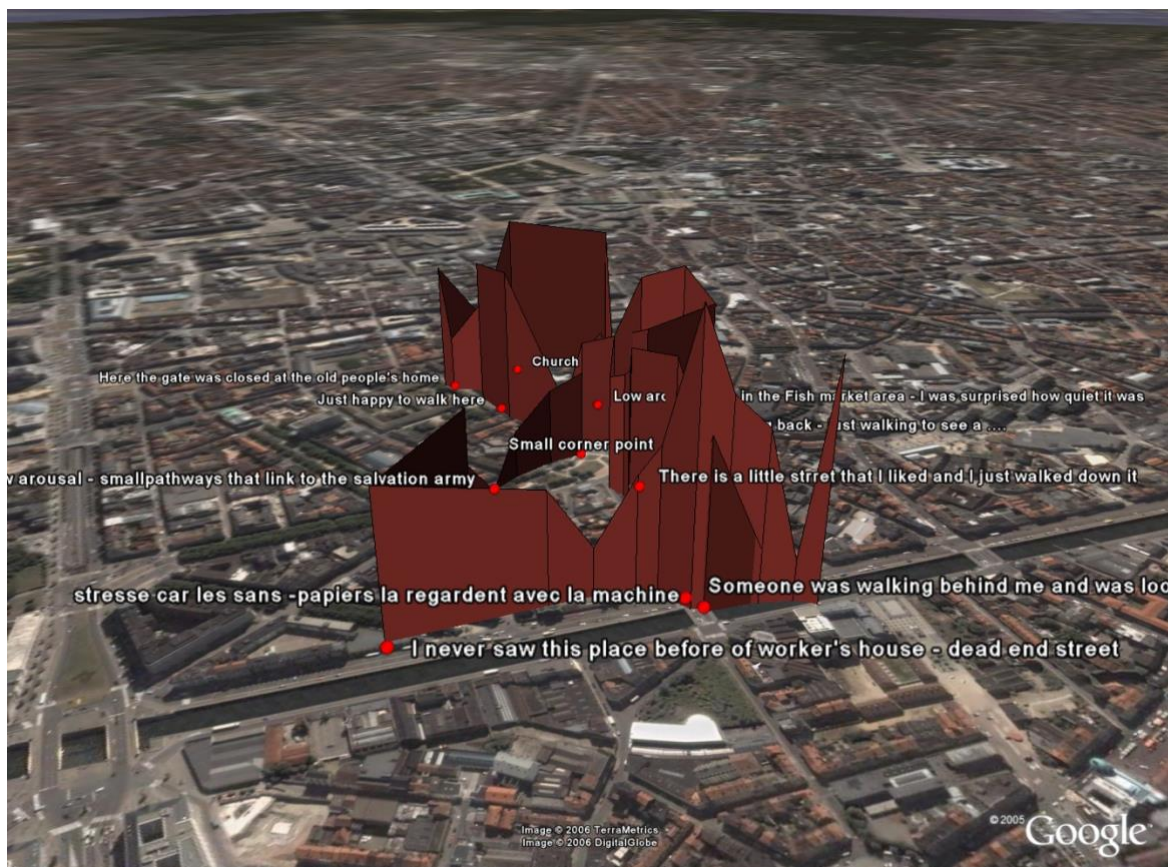

Figure 2 An individual Bio Mapping track from a workshop in Brussels

Emotions as significant events

In the second part of the workshop, the data was downloaded and projected into Google Earth as three-dimensional traces that snaked across the landscape. The device recorded the rate of change in the wearer's electrical skin conductance, with quick changes being represented as peaks, indicating points of significant physiological arousal. The data was relative and normalised for each person, so that the tallest peak in a person's track would indicate the location where they had the largest change in skin resistance. An individual track looked like a spatialised cardiogram, a medical vision of the body's internal state projected onto an external landscape. The participants then took turns to tell the group about their journeys while looking at their track. Seeing the visualisation, some people were hesitant, while others immediately grabbed the computer mouse and started navigating the spikes and troughs of their track. Most participants talked about their walk as a series of discrete events such as 'nearly got hit by a cyclist" and "ooh a post box, I need to post something and I wasn't looking where I was going'. People tended to articulate their sensations as events where significant interactions with the environment took place rather than talking directly about their feelings using an overtly emotive language.

My role would be to transcribe these verbal descriptions while a participant was talking and locating them as waypoints on the track. When I tried asking people to describe their walk before they had seen their data track, it was remarkable that they usually had little to report. Yet once they saw their arousal track, the participants reported that the track reminded them of events and stimuli that they would have otherwise have forgotten. For example, many people identified arousal spikes when they were turning the corner of a road, which they interpreted as their surprise response to seeing a new view ahead of them. Participants said this process highlighted aspects that they would have thought were too insignificant to share publicly. For others, it identified private memories that they chose to share with the group such as, 'walking under the fire escape which reminded me of my first night with my ex when I disturbed an intruder'.[7] This process of improvisation often became clearly enjoyable for the narrator who would direct it as a performative process that held the group's excited attention.

The workshop participants could see the abstract-looking physiological data transforming in front of their eyes into a surprising representation of themselves and the local area. The people were not narrating by themselves but were performing together with the spikes of the arousal data to make sense of what they had seen, heard and felt on their journey and to share it with the group. In this way the sensors, visualisation and setting all functioned together to construct a narrative representation of the area that was full of interesting details and dynamics that would not have existed without these elements. In this way, the Bio Mapping project functioned similar to the lie detector interrogation, in that they both use physiological measurement not to determine the level of arousal but to utilise the performative qualities of visualisation to move the subject to articulate. This movement is both an affective shift in enthusiasm as well as a cognitive pulling together of associations to create a narrative. This is not to suggest that the physiological sensors did not detect anything important, but rather that the process allowed the subject to co-articulate this significance in conjunction with the sensors, setting and other people present. Where the lie detector and Bio Mapping radically differ is in the intent and practical liberty they afford the participants to creatively respond or refuse to participate.

Figure 3 Feedback session from a workshop in Greenwich (UK)

Emotions as intertwined with the environment

Many participants reported being surprised by the process since it made them reflect on their relationship between the mind, body and environment in a way that was new to them. Crucial to this was the way the participants used the arousal data to compare the relative effects of different kinds of stimuli. The surprising aspect for many participants was that this inverted their expectations and transposed mundane aspects into having newfound significance. For example, a participant in Nottingham stated that he was astonished that his physiological response to drinking a sugary soft drink was so strong that it eclipsed the sights and sounds of his urban walk. On another occasion, a geography teacher was shocked that his arousal points coincided with encounters when he was laughing and joking with other people. He was confused, since he thought laughter was rather trivial and that he ought to be responding to the architectural features of the town. This made him reconsider the way he conceived of laughter, 'it is an emotion, but it's not an emotion I ever kind of recognised in myself because I see it something like a physical action'. In Greenwich, two people who were both wired up were walking together while deeply immersed in a

conversation. When they analysed their tracks, they noticed a pattern of alternating arousal peaks and troughs between the two tracks, which they associated with taking turns to speak and listen. They were amazed that the dynamics of their conversation had become externalised as a geographic trace following the bank of the river. The project allowed the participants to compare the arousal data amongst other group members who had all seen the same event such as a 'half-naked bodybuilder running with weights', which led to lots of laughter and speculation about what might be causing individual differences. Taking part in the project allowed participants to see both their own and other people's different reactions to stimuli and events such as encountering urban graffiti, which led the group to discuss where 'emotion' might be located, whether inside their minds, their body, as social relations with others or in the external environment. In these discussions, the participants described a blurring of mind and body, inside and outside, individual and group where it was hard to tell these categories apart. In this way, the project acted to stage a lively intertwining of emotion, where the environment was affecting people, while they were also affecting others in the environment.
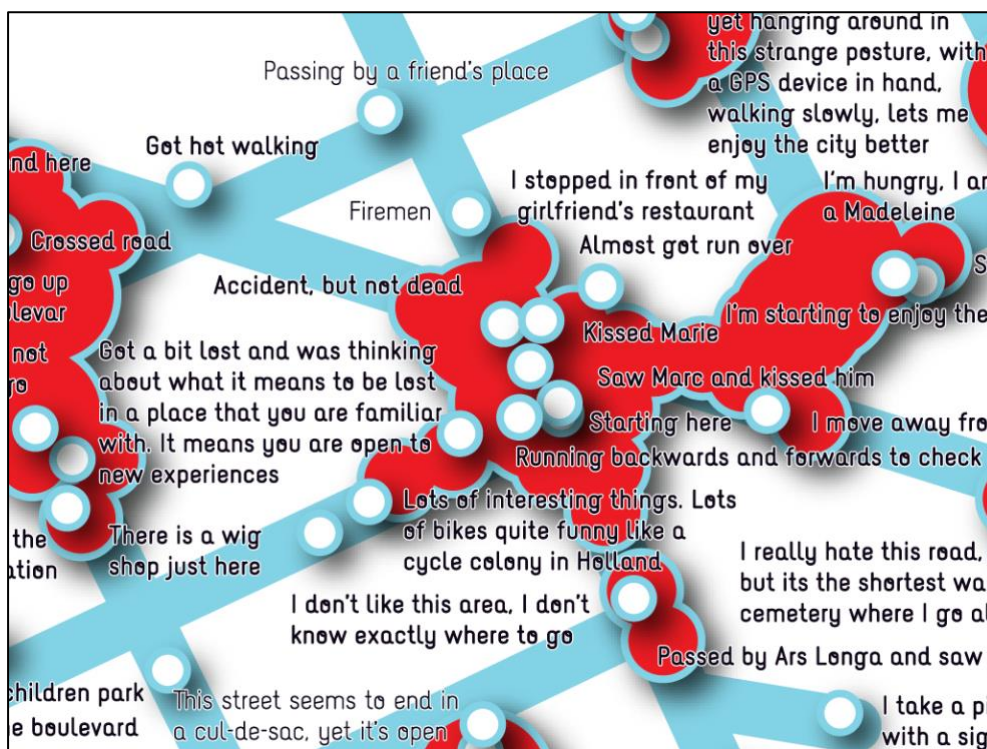

Figure 4 Detail of the East Paris Emotion Map

Emotions as collective issues of concern

One common pattern across the workshops was that personal observations would become catalysts for a group discussion about broader local issues and dynamics. In Stockport, a person who walked near an old air raid shelter told the group that the 'toilets used to have original WW2 semaphore graffiti which the council has recently removed'.[8] The narrator

argued that this was symptomatic of a process by which the historic roots of the town were being obliterated. As the narrator was talking about their memory, this triggered references to the way the shopping area was built to cover the whole length of the local river. In this way, the narrator created a chain of associations that demonstrated a broader pattern of local transformation. In Greenwich, a participant talked about an arousal spike caused by seeing a wind turbine on a large supermarket, which he described as, 'the windmills are not going – never really worked – ecology con' and attributed this to the local process of gentrification. In these discussions, the specificity of these observations acted as evidence for allowing the narrator to make propositions about general patterns of change.[9] Hearing this, the rest of the group often nodded and responded with listing their own examples that strengthened this line of argument. Since the narrator was referring to well-known local points, this allowed the group to naturally and comfortably join a collective discussion about broader political dynamics.
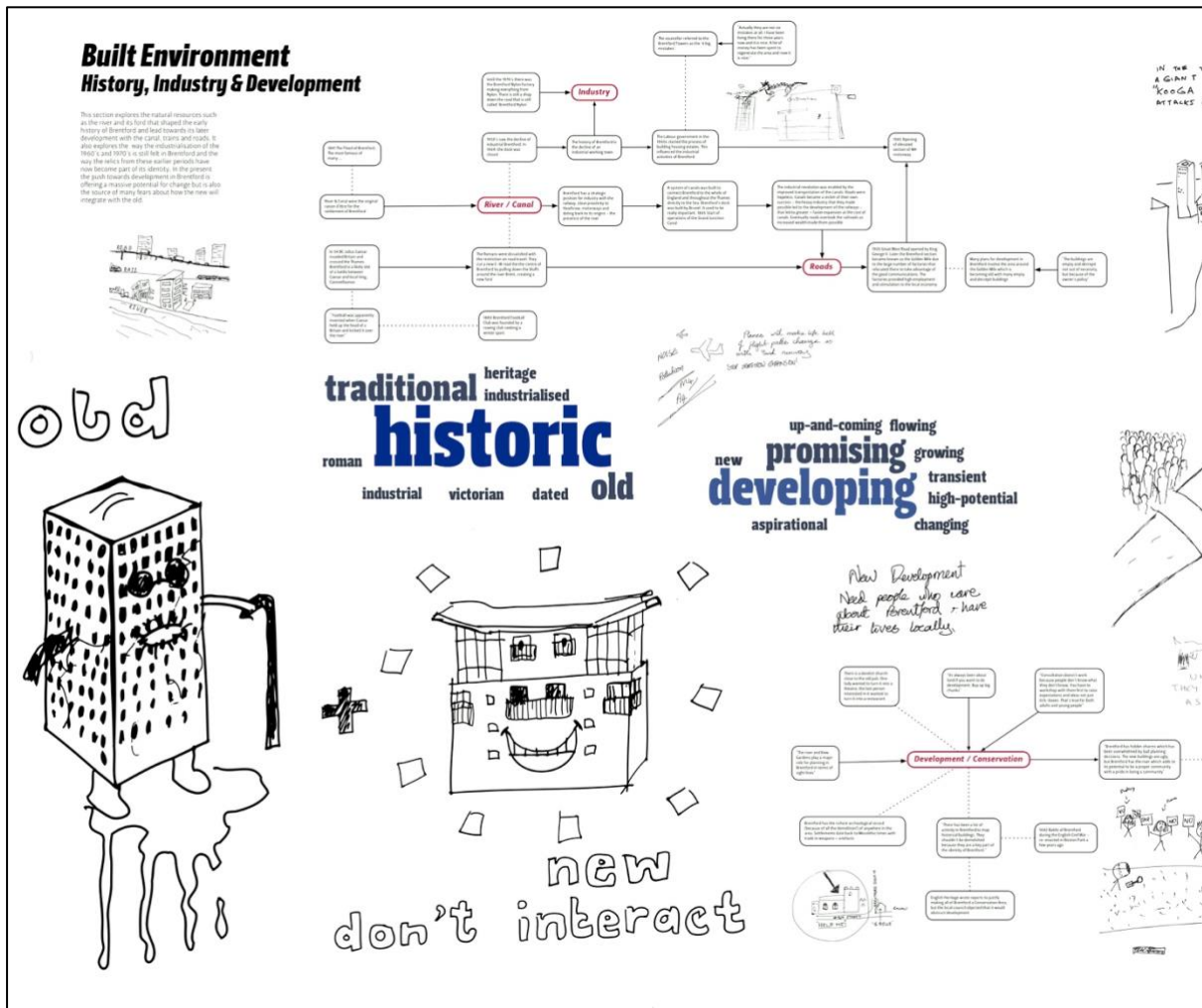

Figure 5 Detail of the 10-meter-long Brentford Biopsy map (UK)

In many towns, these discussions led to pinpointing sites under threat that needed to be protected, such as a rundown cafe in Greenwich, which was one of the last social hubs in the area. At the end of a project when around 100 people had taken part in workshops, the

map was covered in a dense mass of spiky paths and textual annotations. My collaborators and I would then analyse this material to design into a printed 'emotion map' that would highlight both collective issues of concern whilst also representing the different narratives. Each designed emotion map used a different representational style to try to capture the specificity of that place. The Greenwich Emotion Map, which covers the Prime Meridian, uses geographical contours to interpolate different people's arousal data to produce a contiguous geographical surface. The San Francisco Emotion Map uses a Web 2.0 visual style to display arousal data as clusters that highlight the rigid American city grid. The Stockport Emotion Map looks like a Victorian era map that is constructed out of local people's drawings, which are interspersed with three dimensional standing stones that represent the arousal data. These designs suggest emotion as an interweaving of people and environment, yet this relationship is different in each of these cities. The maps are thus not just technical data visualisations but aim to create symbolic representations of these places. Yet at the same time the maps are not just codification of each place but propose that place is constructed out of interactions. The geographer Gavin MacDonald suggests that, 'these maps are therefore not representations of a static concept of what constitutes a place; rather, they are snapshots of place as an affective system, relational and always emerging'.[10] This approach suggests the resulting emotion maps are not just frozen representations of a place but are system diagrams of local mechanisms in flux.

Emotions as autonomous public urbanism

The workshop participants and members of the public who saw the final emotion maps, as well as politicians and urbanists, were all keen for these processes to feed into official decision-making. Often local councillors would suggest submitting the maps like any other report to the planners and officers of an area committee. When we tried giving an emotion map to the council, this resulted in them exhibiting it in their building, yet without taking any further action on the issues identified on the map. The problem was that the maps talked about urban life in an unfamiliar language of emotion and significant events. On one map, we described this experience of looking at the maps like trying to read a foreign language newspaper;

> we recognise a lot of the words such as local landmarks and we can understand the photos and illustrations, yet there is a lot we are missing. We feel a sense of frustration at not being able to understand everything. Yet if we make the effort to grasp the logic behind it, we get amazing insights.[11]

For the maps to be an effective part of institutional decision making, they required translation. Yet the challenge was how this process should take place and who should do it. Often, I was requested to make the maps comprehensible for the planners, yet I was wary of creating an authoritative interpretation that would eliminate the complexity and specificity of the material. For the Stockport Emotion Map, my collaborator and I took on the challenge and experimented with categorising the gathered data in order to describe collective patterns without forcing a definitive interpretation. Despite the fact that the Stockport project had been commissioned as a hybrid between an art project and a public consultation, the funders deemed the final map to be 'too political to be art' because it did not censor the local problems the residents had identified. The funders refused to distribute the map and

threatened us with legal action. Interestingly, it was the local Samaritan organisation that had been actively using the Emotion Map within their organisation, who came forward to offer to distribute the maps in the local area. Due to these negative experiences with trying to translate Bio Mapping into institutional planning, I adopted an approach of using the project itself as a site for alternative local politics. For the Brentford project, the gallery was fitted out with an industrial printer and turned into a public map production studio. Visitors who came to the gallery could take part in organised activities like Bio Mapping, Sensory Deprivation Mapping and create drawings of what Brentford might look like in the future. In the exhibition, the participants would add information and drawings to the 10-meter long printed map as well as edit existing content. The whole map was then scanned and printed again as an iterative process. This meant that designing the map and translating it became a collective process with the participants. On the map we argued that, 'rather than asking for or offering action points for local change, we ought to accept the difficult process of dealing with differences in making our own translations'.[12] In this way, Bio Mapping shifted from articulating individual sensation towards collaborative structures for a public urbanism that can build the city from the body upward. The final Brentford Biopsy captures classic planning issues such as housing and transport but also documents people's fears about environmental destruction and climate change.

This approach of using Bio Mapping as an autonomous public urbanism was surprisingly successful in getting institutional stakeholders to join the process as equal participants alongside the residents. In Bethlehem (USA), the project involved the university, local government, economic development group and multiple civil society groups as well as 250 residents. Bethlehem is a small town with clear urban problems that the local government was hoping to target. The local newspaper reported that,

> Bethlehem is hoping Nold's work can serve a practical purpose. His visit comes at a time when the city is trying to gauge how pedestrian-friendly it is. […] So the city is committed to Nold's work, she said. So much so that Mayor John Callahan has agreed to be the first person to wear one of Nold's devices when the group meets again.[13]

The project managed to instigate a long-term collaboration between residents, academics, local government and civil society groups to work on problems of pedestrian and food access in the town, which were identified during the workshops. Key to the success of bringing these stakeholders together was allowing them to experience first-hand the way the process allowed collective issues to emerge from the articulation of emotion. This allowed the stakeholders to trust the process of public translation and thus precipitated a collaboration between local organisations that had not worked together before.

Urban Emotion as a universal layer

As Bio Mapping garnered global media attention over the years, I received hundreds of enquiries from commercial and research organisations wanting to utilise the project. There were advertising agencies and property developers trying to identify emotion hotspots for marketing spectacles, as well as museums and shopping malls wanting to plan visitor routes. Despite the diversity of these interests, the common goal was to visualise emotion as

a data layer within a computer system that could be overlaid onto buildings, cities and the whole world. I observed a generation of urban planners, smart city and internet of things researchers trying to recreate the Bio Mapping technology. For them, the project was a demonstration that emotion could be extracted by machines, yet critically they ignored the reflexive methodology I had carefully developed over the years. In this approach, technology was not a way of staging emotion but a way of harvesting it. Throughout the text, I use the term 'Urban Emotion' coined by Peter Zeile to encompass this approach. [14] Its aim is to capture the public's perception of urban space in order to use it for utilitarian purposes. Abdalla and Weiser suggest a public emotion layer can make the computer game SimCity 3000 into a practical reality.[15] For them, the emotion layer acts as a dashboard for real-time urban planning by reflecting the mood of citizens. The layer identifies urban problem spots and enables a feedback loop so that local authorities can experiment with interventions to see how they affect the public. The concept is that this layer will function as public evaluation and accountability of the planners, since

> an increase of the average mood of an area in the long term may also be interpreted as a sign of improved living standards. This can give the planners confidence about their decisions taken for the area.[16]

The Urban Emotion concept imagines that such a system can be scaled-up to cover the whole earth with an electronic skin that will 'probe and monitor cities and endangered species, the atmosphere, our ships, highways and fleets of trucks, our conversations, our bodies--even our dreams.'[17] In this approach emotion is treated as modular and interoperable data that can be combined with any other kind of real-time urban metrics.[18]

The key quality of this approach is that it frames *people as sensors*.[19] The aim is to transform people's subjective feelings into quantifiable emotion data. By measuring their physiological arousal their sensations become an objective entity that can be used. Resch and others suggest this approach can replace interviews and surveys of the public that are 'complicated, error-prone, and unreliable'.[20] The idea is that 'human sensors can thus complement—or in some cases even replace—specialised and expensive sensor networks'.[21] The intension is

> that test persons do not just add subjective impressions as suggestions to planning processes, but objective measurable, physiological response data, which reflects the somatic-emotional condition in the urban context.[22]

This vision aims towards a kind of cybernetic democracy where the public function as 'sensors' that makes public-planning an objective and rational process. Thus, sensing emotion and perceptions become a way of replacing politics and disagreement. In practice, this involves small-scale tests using physiological sensors and smartphone applications that ask people to self-quantify their sensations. [23] For example, the 'People as Sensors' app asks the user to rate the intensity of their emotion using a graphical slider (1–100) and pick from a list of six emotions: *pleased, angry, afraid, sad, surprised, shocked*' and five contexts: traffic, safety, advertisement, tourism, other.[24] The app interface acts a conduit for translating people's subjectivity into a constrained taxonomy of predefined words and numbers. Without the funnelling of the interface, the complexity and disagreement of the world could not be turned into a technical encoding for the researchers to treat as a *measurement* of emotion.

Without this radical flattening and modularity, it would be impossible to imagine creating an emotion layer that universally blends across people to cover the whole earth.

How should we use emotion in urbanism?

In order to highlight the differences and political potential of the Bio Mapping and Urban Emotion approaches, I now turn to the paper 'How to Talk About the Body?' by the philosopher Bruno Latour.[25] The text presents an innovative framework for comparing the quality of scientific and political practices by highlighting the generative potential of measuring and articulating the human body. In the text, Latour argues that the problem we face when trying to talk about the body is a modernist dualism that runs throughout science and politics. This dualism creates a division between a world full of material objects on the one hand, and human subjects as an essence on the other. Latour suggests this division creates an artificial hierarchy between the scientific measurement of objects and the articulations of people. The result is a split between the

> primary qualities – what science sees but that the average human misses – on top of which subjects have simply added mere secondary qualities that exist only in our minds, imaginations and cultural accounts.[26]

The argument is that in a modernist approach, people's accounts are constantly compared against the incontestable accuracy of machines. The result is that human narratives are delegitimised and given no authority to transform the world. The alternative is to avoid making a distinction between objective (primary) and subjective (secondary) and to treat technical processes and human subjects as both making *propositions*. In contrast to statements, which are merely true or false, propositions are articulate or inarticulate suggestions for the way they would like the world to look. Latour suggests,

> an inarticulate subject is someone who whatever the other says or acts always feels, acts and says the same thing. […] In contrast, an articulate subject is someone who learns to be affected by others – not by itself.[27]

Thus, a proposition is *articulate* when it visualises an aspect of the world that was previously hidden and can arouse 'interest' in others and thus create unexpected relations. In contrast, inarticulate propositions cut off connections with other entities by invalidating alternative explanations of the world. According to Latour, what matters is creating difference,

> a subject only becomes interesting, deep, profound, worthwhile when it resonates with others, is effected, moved, put into motion by new entities whose differences are registered in new and unexpected ways.[28]

To summarise, this framework suggests that good science and politics needs to create 'interest' in others by highlighting previously hidden or neglected aspects of the world and create unexpected relations with others. By contrast, bad practices will invalidate alternative accounts of the world, whilst offering no means to challenge their own propositions. I use three of Latour's criteria to compare the two methods of articulating emotion:

1. Is the process interesting for the participants as well as the researcher and are the resulting articulations interesting?

It seems that the key differences between the two approaches, are the dynamics they attribute to emotion. During the years I spent developing the Bio Mapping process, I discovered that looking at somebody else's raw arousal data from the GSR sensor was essentially meaningless and uninteresting. It only becomes engaging once the participant who experienced the walk, starts interpreting and narrating the data. What makes this narration engrossing for others, are the significant events where the narrator demonstrates the interaction of being affected by the environment and affecting others. What makes emotion itself interesting is that it puts entities into a dynamic of action, reaction and interaction. In contrast, the Urban Emotion concept stages emotion as a generalised essence that is extracted from large quantities of emotion data. It is only via a process of generalisation that a geographical grid square can be said to have 'emotion' and be made interoperable with other datasets. This process renders specific emotion events as inert abstractions that are cut off from their causation and capacity to affect other entities. There is an unintentionally funny episode in one of the papers about the Urban Emotion approach that highlights this difference. The paper describes an incident where 'a group of tests persons went around in a park area, in which they should have no stress reactions. Some of them stepped into a big dirt, and the result was, that the stress level boosted'.[29] The researchers appear to be frustrated that the 'big dirt' in the park triggered stronger arousal than the urban structures they were attempting to target. They suggest this incident illustrates the problem of trying to obtain universally valid statements about the feel-good value of individual areas.[30] This episode shows that the Urban Emotion approach is based on the crude assumption that valid emotion coincides with the structural pattern of the city while ephemeral incidents such as stepping into dog excrement is 'invalid' emotion. Someone using the People as Sensors app might have reported this incident as: emotion = 'angry' context = 'other' and intensity = 87. Such a reductive encoding obliterates the causation, context and nuances of emotion and make it impossible to communicate the significance of events. Using Bio Mapping, dog fouling is actually a topic that participants across the world were highlighting as significant. Putting it on an emotion map often became a way of trying to put pressure on local authorities to deal with the problem. This episode demonstrates that the Bio Mapping allows chains of association to be constructed between physiological arousal and narratives of significance in order to articulate collective issues of concern. In contrast, the Urban Emotion approach is fundamentally inarticulate about what matters within experience.

2. Does the process render talkative what was previously mute?

The Urban Emotion approach adopts a dualistic division between the accurate measurement of emotion by machines and fallible human articulation of emotion. Its central premise is to replace interviews and surveys of the public with more reliable technology. Zeile puts it bluntly when he states that due to the reliability of new technologies, 'the use of self-reports of test-persons to their emotional reactions could be ignored now.[31] Urban Emotion tries to use sensor technologies in a naive way - as machines that claim to speak the truth about subjects. Yet at the same time it claims to 'enable a new citizen-centred perspective in planning processes'.[32] Urban Emotion thus emerges as a cynical co-option of the rhetoric of citizen empowerment, while on the contrary, rendering the public as mute data artefacts. Scanning across the Urban Emotion literature, it becomes clear that its interest is in the technical workflows that create the emotion layer such as *SensorML/SPS - SOS/SAS/CEP - WFS - WPS - WMS/WFS*.[33] It is the technical infrastructure of the universal data layer that

Urban Emotion tries to make talkative. Yet this chain of acronyms is only communicative to a small group of technologists. Using Latour's framework, we can see that a universal emotion layer is actually an inarticulate proposition that does not create new connections in the world. In fact, this approach only becomes possible by removing the agency of emotion and displacing human accounts of emotion. In contrast Bio Mapping does not accept a split into objective measurement and subjective human interpretation. It appropriates the sensors of the polygraph and transforms them into a performative opportunity for critical reflection, where physiological data and people's narratives become a conjoined articulation without hierarchy, where neither displaces the other. In this way, the Bio Mapping project becomes a plaster that tries to glue the objective and subjective of emotion back together into a single unified articulation. The result is that emotion itself becomes an articulate force for connecting entities around issues of concern. The key to this is the staging of the workshops. The geographer Gavin MacDonald argues that 'far from simplistically mapping emotion, the physiological side of Nold's device in fact provides the grounds for such a mapping which occurs in the group workshops'.[34] Emotion is thus not disclosed by machines but emerges during the workshops as an encounter between multiple elements: myself as instigator, the sensor data, the workshop participants and the local area. Together they create a collectively staged performance where they all speak simultaneously as emotion.

3. Does the process maximise its own disputability?

With this question, Latour is asking whether a project allows the participants and the objects of study to challenge the process. Latour suggests the way to identify *disputability*, is when participants are allowed to bring their own interests to the process, apply their own categories or refuse to engage. In the Urban Emotion concept, its assumptions are embedded into the design of the technology and workflows as non-discursive and non-negotiable. Its literature offers no discussion of mechanisms for participants, the public or even other researchers to challenge its assumptions. This failure to provide a means to refute its approach makes it inarticulate. In contrast, Bio Mapping has evolved gradually over a decade of iteration. It has been shaped by the stubbornness of emotion as a phenomenon and the direct feedback of thousands of participants as well as arguments about framings with project hosts and funders. Key to this process was staging emotion as a performative and critical potential during the workshops. When the participants were wired up with the Bio Mapping devices, they were told about the association with the lie detector in order to setup an uneasy relationship towards the technology. This fostered an atmosphere where the participants could challenge what the device could and could not measure. The initial starting point for each workshop was the proposal that emotion, technology and environment were tightly connected, yet the specific content and process of a workshop were open for each group to renegotiate. In a fascinating workshop in Munich, all the participants refused to be wired up with the sensing devices, while one of the participants went away and returned with a thick stack of legal documents from 1930's Germany. As a result, the workshop morphed into a discussion and textual analysis of the biopolitics and laws that govern people's bodies. Similarly, with an intergenerational Bangladeshi group in London, the Bio Mapping process became a discussion about technologies of racial profiling. These diversions from the template of a Bio Mapping workshop are evidence that the participants were able to challenge the process and technologies and take ownership of the project to make it meaningful for their group and context.

Discussion

This text has explored what emotion can *do* in relation to the urban environment rather than trying to define what it *is*. It has done this by contrasting two methods of staging emotion using sensors in relation to the urban environment. Using Latour's framework, the text has identified that these approaches offer radically different potentials to articulate significance, organise collectively and transform the world. Bio Mapping is *articulate* in the way it foregrounds the surprising interactions of emotion and creates unexpected links with urban processes and develops them into a collective urbanism for local change. In contrast, Urban Emotion attempts to replace people's articulation with a universal emotion layer that speaks in inarticulate ways on their behalf. This analysis has shown that the issue is not one of valuing human expression over technology but rather about the quality of the sociotechnical systems and methods that we use to stage the articulation of collective emotion. In the 21st century, we cannot imagine that sensation will only be articulated through *human instruments* but will involve increasing amounts of technical instrumentation. [35] Emotion will continue to involve co-articulation between people, environment and technologies. This means we need to make critical and normative choices about the design of the instrument practices we want to use to articulate emotion and build our cities. The specifics of design and methods matter. Do we want to imitate command and control visions of top-down emotion planning, or move towards methods that allow bodies, sensors and human reflection to work together as an iterative urbanism? The fundamental choice is whether we split reality into objective measurement and subjective perception or stage emotions as articulate propositions that can move us to create cities we want to live in.

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