32

Bioethnography: A How-To Guide for the Twenty-First Century

Elizabeth F.S. Roberts and Camilo Sanz

This chapter describes our efforts to develop what we call "bioethnography," a research platform that combines data derived from biological and ethnographic methods to arrive at a better understanding of the larger histories and life circumstances that shape health, disease and inequality. Bioethnography is intended as a contribution to the growing insistence across the social sciences on the relationality of phenomena instead of the autonomy of objects (Barad 2007; Mol 2002; Strathern 2004). The bioethnographic research platform discussed here is made possible through our collaboration with environmental health scientists involved in a longitudinal, pregnancy-birth-cohort, chemical-exposure study ongoing for nearly 25 years in Mexico City, and collaboration between ourselves (Roberts and Sanz)—two medical anthropologists at different career stages. Platforms are raised—level surfaces on which to stand.[1] We are working to develop a platform, so to speak, combining two different methodological bundles—ethnographic observation and biochemical sampling—in a synthetic, symmetrical analysis that understands environment-body interactions as always relational, contingent and constructed phenomena.[2]

We are modeling our bioethnographic platform on forms of knowledge production distinguished, not by their objects of study, but by their methods

E.F.S. Roberts (✉)
Department of Anthropology, University of Michigan, Ann Arbor, MI, USA

C. Sanz
University of Indianapolis, Indianapolis, IN, USA

M. Meloni et al. (eds.), *The Palgrave Handbook of Biology and Society*,
https://doi.org/10.1057/978-1-137-52879-7_32

for knowing the world (Mol 2002, 153). With this methodological focus, we conduct analyses that suspend in advance prevalent domaining practices that designate some phenomena (like blood-lead levels) as biological/natural, and others (like family meals using lead-glazed ceramics) as social/cultural. Our bioethnographic platform allows us to regard a phenomenon such as lead exposure and its effects as knowable through methods of both blood-lead measurement and observation of household mealtimes. Within bioethnography, then, we work against separating phenomena such as blood-lead levels and household dynamics, BMI and class hierarchy, police violence and circadian rhythms, as well as biostatistical data and coded ethnographic data. Instead, we are focused on how these phenomena emerge in coordination with each other.

Coordination, which we take from Annemarie Mol (2002), is an apt description for our attempts to bring together biostatistical and ethnographic data. In the *Body Multiple, Ontology in Medical Practice*, Mol argues that diversity of objects that go by a single name, like in her case atherosclerosis, or in our case lead exposure, involves various modes of coordination. Mol demonstrates how atherosclerosis is "enacted" through different practices such as clinical findings, blood pressure measurement, social inquiries, statistical data and angiographic images—and brought together in a patient's file. Ideally, our bioethnographic platform will coordinate the knowledge making practice of lead exposure, sleep and neighborhoods and so on, so that practices and relations involved in enacting these objects are accounted for.

Coordinating knowledge making practices while accounting for their enactment is a slow process. Inspired by the philosopher of science, Isabelle Stengers's call for a "cosmopolitics" that "slows down" "the construction of "the common world," we understand bioethnography as a method, to slow down knowledge making practices about bodily conditions. In slowing down the reasoning that makes knowing, cosmopolitics brings together disparate practitioners and practices, constituted through "multiple divergent worlds" that contribute to the making of knowledge about an issue at stake (Stengers 2005, 995). The focus on *an* issue makes the process specific, not general, as it is focused on the concrete situations in which the practitioners operate, which of course are always political. We understand bioethnography then as an exploratory cosmopolitical attempt, in which environmental health scientists' and anthropologists' obligations and hesitancies, their politics, slow down and then open out into different practices that might eventually resonate (or not) with one another (Stengers 2010). This chapter focuses on the logistics and (dis)agreements through which distinct scientific worlds (Knorr-

Cetina 1999) might be brought together into a collaborative and symmetrical work we call bioethnography.

The fact that bringing these worlds together is such a slow process makes the title of this chapter jokingly grandiose. In reality, we have much more work to do in order to engage in meaningful bioethnographic analysis. A more accurate but less tantalizing title would be "A Detailed Description of the Endless Logistical Minutiae Involved in Building a Bioethnographic Research Platform." Although Roberts has been working on the project since 2012 and Sanz since 2016, it seems as if this logistical work has only just begun. In the future we plan to write a more comprehensive guide addressing both life scientists and social scientists. In this chapter we reflect on a few key issues that have arisen so far using rather mundane examples from three specific bioethnographic investigations within the larger project (neighborhood dynamics, sleeping and eating), to provide some preliminary thoughts for other social scientists contemplating similar projects.[3] The central and simple point running throughout our discussion is that within bioethnography, logistics and methods are always theoretical and theory is always logistical and methodological. In other words, the logistical minutiae and methodological challenges we encounter along the way—such as the difficulties of meshing blood-lead levels with field notes about lead-glazed dishes in working-class households—are themselves relational phenomena that must somehow be coordinated in order to understand the relational, contingent and constructed phenomena that shape health and disease.

ELEMENT and Mexican Exposures

In l993 a team of US-based environmental health researchers partnered with research scientists and public health officials in Mexico to form ELEMENT (Early Life Exposure in Mexico to ENvironmental Toxicants). The project—primarily funded through successive NIH awards, and with administrative and some financial support from the state-funded Instituto Nacional de Salud Pública (INSP) in Mexico—aimed to study the effects of chemical exposures, particularly lead, on fetal and childhood growth and neurological development. Mexico City provided a relatively easy location to recruit cohorts that likely had some exposure to lead. Since then ELEMENT project staff have collected and conducted molecular epidemiological analysis of blood, urine, hair, toenails, breast milk and teeth samples drawn from nearly 2000 participants, mostly working-class mother-and-child pairs recruited through *Seguro Social* clinics in Mexico City. As ELEMENT continued, its scope expanded to collect data on additional toxins (e.g., bisphenol A or BPA, mercury and fluoride) and new health concerns (e.g., premature sexual maturation and obesity), using new methods (e.g., epigenetic[4] and telomere[5] data analysis) (Afeiche et al. 2011; Ettinger et al. 2009; Tellez-Rojo et al. 2013).

In 2012 Roberts began conversations with project PIs about the possibility of conducting ethnographic observations of study participants in Mexico and the study itself, because ELEMENT's long history, vast bio-repository and current research questions appeared to offer the opportunity to develop a relational understanding of the larger histories and life circumstances that shape health, disease and inequality. ELEMENT Project PIs, Karen Petersen and Howard Hu, were intellectually welcoming of Roberts's exploratory mode and soon after she began observing ELEMENT staff meetings and spending time in ELEMENT laboratories at the University of Michigan. In March 2013 she began to conduct observations of interactions between project staff and project participants in Mexico City. In 2014 Roberts obtained NSF and Wenner-Gren funding for a 3-year project entitled "Mexican Exposures: A Bioethnography of Six Urban Families." Mexican Exposures involved 14 months of ethnographic research with ELEMENT study participants and then 2 years of follow-up work to develop a bioethnographic research platform with which to combine her ethnographic findings with biostatistical ELEMENT data. The title of the project, "Mexican Exposures," reflected Roberts's aim to expand the concept of exposure through ethnographic work, not only with ELEMENT study participants but the project's scientists as well (Roberts 2015a; Roberts 2017).

The "cosmopolitics" of Mexican Exposures so far has been shaped by the fact that Roberts came to ELEMENT nearly 25 years after its inception, meaning that her efforts have necessarily involved enrolling ELEMENT researchers in an agenda that is not their own. As we describe throughout this chapter, the "enrollment" process (Latour 1987) of environmental health scientists into a symmetrical bioethnographic research platform has been slow and full of expected asymmetries that involve divergent resource ecologies, academic positioning (i.e., hard and soft sciences) and the time the ELEMENT research team had already spent with the project. Perhaps ideally, life scientists and ethnographers would form bioethnographic projects together, finding common ground from "the ground up", so to speak, and some similarly conceived projects already have (Eisenberg and Trostle 2013). Nevertheless, the temporal and resource asymmetry that comes with collaborating with ELEMENT scientists has provided 25 years of data gathered and analyzed by intellectually innovative scientists, collected from the bodies of people in Mexico City, where Roberts had long-term interests and commitments. Thus, developing bioethnography with an already existent project had has several advantages.

In 2014–15 Roberts worked with six ELEMENT participant families living in two different working-class neighborhoods in Mexico City. Her participatory observation focused on household and neighborhood environments and histories relevant to the production of the bodily states of these families and their neighbors. While the scope of Roberts's observations was broad—what she came to call *todologia* (described below)—much of her participatory fieldwork observations centered on the relationship of economic conditions, urban infrastructures, neighborhood environments, religious practice, kinship relations and eating to participants' well-being.

At the same time, Roberts examined the process and effects of scientific knowledge production of ELEMENT itself in accord with a fundamental science-technology studies (STS) insight—that phenomena do not merely mark the epistemological inseparability of "observer" and "observed," technology and experiment; rather, phenomena are produced through the looping ontological inseparability of "agentially intra-acting components" (Barad 2003, 815). Intra-action means *action from within* (*intra*) and refers to the mutual constitution of entangled elements, by contrast to the *inter* of interaction, which means "among" objects that maintain a degree of independence. Put another way, instead of presupposing interactions between separate entities derived from nature/culture or micro-/macrodualisms where some set of factors *determines* others, Mexican Exposures focuses on intra-dependence "between people, situations and practices (regardless of their presumed scales)" (Jensen 2007, 845). The question of what public health researchers discover about exposed bodies cannot be separated from the way researchers ask questions. Taking intra-dependence seriously meant that Roberts documented how participants' lives were shaped by their involvement in ELEMENT research (and her own), and how ELEMENT data is shaped in turn by participants' life conditions, which have been shaped by their involvement with ELEMENT.

The ultimate aim of Mexican Exposures is to develop a bioethnographic research platform that will allow us, together with ELEMENT investigators, to ask new kinds of research questions that could not be asked with ethnographic or biological data alone. From the outset it has seemed that our anthropological approach to the interplay of specific life conditions and bodily states in particular neighborhoods in Mexico City would generate a novel kind of data for ELEMENT, which, like most epidemiological studies, had previously paid relatively little attention to the specificity of participants' bodies and life worlds as located in larger histories, neighborhoods and geopolitical processes. Additionally, as in most environmental epidemiological, health-exposure studies, ELEMENT researchers have tended to investigate the mechanisms of ill health through the linear examination of the effects of single-chemical variables within individual bodies understood as universally the same (Lock 2013). We hope that our bioethnographic platform will transform standard linear data analysis models like these, which examine one variable (e.g., exposure event, telomere length or methylation pattern) at a time, by conducting multivariate analysis (data analysis that assumes that phenomena are caused by more than one variable), allowing for an understanding of how phenomena, including geopolitical processes and participant's life conditions, are created through intra-active looping, examples of which we describe below (Barad 2007; Hacking 1999; Miller and Page 2007).

In 2015 Roberts returned to the University of Michigan and soon after recruited Camilo Sanz to work as a postdoctoral fellow for the project. Together Roberts and Sanz's—our—first tasks were to set up systems to organize and manage the Mexican Exposures data collected in Mexico City and identify key directions for developing a bioethnographic research platform. This time- and personnel-intensive process involves seeking new funding sources, and constant and ongoing consultation with ELEMENT researchers about how the Mexican Exposures ethnographic data might be productively deployed to ask more nuanced research questions. Additionally, Roberts has continued fieldwork in Mexico City and incorporated Sanz into this ethnographic research.

Currently we are developing a variety of directions with an aim of combining Mexican Exposures' ethnographic data with ELEMENT's biostatistical data. We describe three of these projects (neighborhood dynamics, sleeping and eating), briefly here to give a sense of the potential for bioethnographic research.

Neighborhood Environments and Biomolecular Markers

During fieldwork in Mexico City, Roberts found that while the working-class neighborhoods of ELEMENT participants might share similar socioeconomic status (SES), differences between neighborhood environments seemed to matter in shaping bodily being. Roberts made the, perhaps, counterintuitive observation, concerning the two neighborhoods where she lived, that some forms of toxicity might be protective. In the first neighborhood, toxic boundaries such as a sewage-filled dam, cement factories and a freeway interchange served to keep out police, who are arguably the most acute threat to the well-being of working-class people in Mexico City today. In the other neighborhood, where boundaries are unmarked and easy to cross, residents felt deeply insecure because of the constant circulation of the police.

Working with a subset of ELEMENT researchers possessing expertise in epidemiology, environmental exposure, telomeres, and epigenetic data, we are developing a method to carry out multivariate analysis that deploys ethnographic insights like these, about neighborhood differences. This will be the first time ELEMENT data will be used to examine how specific neighborhoods shape chemical exposures, allowing us to ask questions of ELEMENT's stored biological samples in novel ways. We will examine how specific conditions like social cohesion, housing stability, the presence or absence of police violence and the built environment affect the uptake of chemical exposures and produce biomarkers that index underlying physiological processes, such as stress, diabetes and sleep deprivation. In order to accomplish this task, we will conduct a neighborhood assessment scale that characterizes all of the neighborhoods where ELEMENT participants live. Currently, converting neighborhoods into numbers seems necessary for the coordination of ethnographic with biostatistical data, but we also feel hesitant about the kinds of simplifications this process will involve. We also wonder how making these correlations will complicate our sense of neighborhood environments, possibly compelling us to reassess the anthropological truism that numbers only simplify and decontextualize.

A Bioethnography of Sleep in Mexico City

In response to clinical and behavioral research that demonstrates that sleep is fundamental to our well-being,[6] ELEMENT investigators have begun to focus on sleep patterns in Mexico City. They are now in the midst of gathering and analyzing accelerometry[7] data and sleep questionnaires, seeking to examine possible links between sleep, micronutrients and smoking. In the specific case of smoking, ELEMENT postdoctoral fellow Erica Jansen has found a correlation between girls reporting having tried smoking and shorter sleep duration. If this correlation holds, physiological mechanisms might explain it, but there are also a myriad of socio-economic and neighborhood environmental conditions that might *intra-act* to shape sleep that would also serve to reshape normative scientific concepts such as "sleep quality," "sleep deprivation" and "normal sleep time."

We are now working to coordinate ELEMENT participants' sleep data to our ongoing ethnographic observations and our anthropologically informed sense that sleep itself is a contingent relational process, varying in place, time and among differently situated sleepers (Ekirch 2006; Koslofsky 2011; Williams 2005; Williams 2011; Wolf-Meyer 2012). Roberts collected some ethnographic data on household sleep patterns during 2014–15. Her observations have already informed ELEMENT sleep questionnaires that were initially developed with measures based on US-based instruments, which tend to assume that household members have their own bedrooms and beds. With bedrooms and beds shared between siblings, parents and children, sleep in working-class households in Mexico City is often a less solitary experience than in the USA. Additionally, the predominance of informal-sector work that takes place at all hours of the day means that many working-class families have sleep patterns that would be considered nonoptimal or exceptional by normative US-based standards, but crucial for these families' well-being.

In our future ethnographic work with the six families, and with their neighbors, we plan to focus more specifically on how sleep is organized within households, when it happens, with what patterns of sleep and wakefulness. Several of the households' sleeping spaces are roomy enough that we can spend time there while inhabitants are sleeping, to observe sleep dynamics. Our bioethnography of sleep will incorporate prenatal lead exposure, phthalate levels, sleep diaries, people's abiding fears about receiving extortion calls, emotional stress resulting from job instability, use of electronic devices (smartphones, tablets, etc.), and interactions with each other during the night and day. Our goal with this research is to better understand the *intra-actions* that produce the embodied, daily rhythms of working-class life worlds in Mexico City.

Eating in Mexico City: A Bioethnography

Although the central focus of the ELEMENT study has been toxicant exposure, understanding participants' diets has been core to ELEMENT's investigation since its inception. Not only diet can be a direct source of toxicants, it can also affect the body's uptake of toxicants (e.g., calcium affects the uptake of lead). Furthermore, diet is connected to anthropometric outcomes such as obesity, which is especially relevant in the context of Mexico's designation as the world's fattest industrial nation by the WHO in 2013. Currently ELEMENT gathers diet-related data through food frequency questionnaires and anthropometric measures like BMI and body fat indices.

Roberts spent much of her fieldwork with ELEMENT participants engaged in food-related activities such as shopping, meal preparation, and eating. She noted that in a precarious world, sharing cheap sugary and fatty foods (increasingly available through globalization) is central to forming and maintaining the social density *necessary* for survival (Roberts 2015b). Meanwhile, the Mexican public health apparatus exhorts working-class people to make "better food decisions" by halting their consumption of these types of so-called *unnecessary* foods. Roberts's qualitative data, in its documentation of everyday life in working-class Mexico City, provides insight into how the transformation in food landscapes transforms eating.

Recently ELEMENT postdoc Erica Jansen, began working with Hannah Marcovitch, an anthropology undergraduate in our Mexican Exposures data analysis lab, to bring together Mexican Exposures ethnographic data and ELEMENT epidemiological data in order to more fully understand eating among ELEMENT participants in Mexico City. The two of them are developing a way to manage, code and categorize the data that Roberts gathered and thus to provide a broader understanding of eating, food preparation and sociality. Although this effort is still in the preliminary stages, Jansen and Marcovitch are exploring different ways to coordinate these data sets into a diet analysis that examines both statistical trends and eating environments. This joint analysis will also help to identify future ethnographic focus areas for continued research with the six families involved in the Mexican Exposures project. In particular, Jansen and Marcovitch plan to trace corn in all its Mexican and globalized iterations (e.g., tortilla *masa*, corn syrup and corn snack foods, all produced at different scales (Lind and Barham 2004)) as a specific benchmark for understanding eating in contemporary working-class Mexico City households.

Building a Bioethnographic Research Platform

Building a bioethnographic research platform that will allow us to carry out projects like those described above is slow partly because the platform's development involves the epistemic, temporal and logistical coordination of disparate and differently positioned intellectual research environments. Our bioethnographic endeavor requires that we follow how lead is relationally enacted in different sites and across them, for instance, as it travels from participants' accounts about their eating habits and family meals, to blood samples and biostatistical databases and graphs. In each site, this toxicant is enacted differently and represented through various technologies; as beans are cooked and served on lead-glazed ceramics, which makes them sweeter, then eaten during family meals in Mexico City; later lead is located inside milliliters of frozen blood inside a test tube, which are shipped to the University of Michigan for biochemical analysis; then as free-floating microscopic particles in blood's plasma that are counted by lab technicians through specialized equipment and measuring devices; then, biostatisticians "do" lead by populating their databases with these numbers, creating graphs and tables for further epidemiological analysis. At different points in this chain, families maybe be notified if their children have high lead levels, enacting lead within households in whole new ways.

The coordination of these enactments resonates with one of our key commitments as bioethnographers: foregrounding the specificity of life in working-class households in Mexico City in relation to ELEMENT data. We do this, not to prevent the production of generalist knowledge about health, but instead to slowly allow for the comparative production of knowledge about bodily states as relational and contingent phenomena across time and space. As with lead exposure, we seek to coordinate sleep, through accelerometer data, participants' sleep diaries and ethnographic field notes—and work to understand how and why these phenomena are difficult or impossible to coordinate. We hope to investigate how sleep, as a relational phenomenon, is enacted across biostatistics and anthropology, thus satisfying, to some degree, the epistemological requirements of each world while also transforming them.

In addition to coordination, we also deploy a fractal approach that presupposes complexity regardless of the scale on which one focuses (Callon 1989; Jensen 2007; Latour 1999; Strathern 1991). Fractals are geometrical images that can be infinitely broken into smaller parts, each of which will retain similarity with the original. With a fractal approach to ELEMENT and Mexican Exposures data, we refrain from relying on a specific prioritized scale with which to evaluate how toxic substances like lead shape bodies. Instead, we work with both biostatical data about bodily phenomena and anthropological data about the same phenomena without assigning in advance a scale to either. Through fractals that assume complexity at every site, we can zoom into the microscopic particles of chemicals found in participants' blood or urine, for instance, and zoom out into people's practices. Lead, for example, may emerge not only as a conglomerate of particles embedded in bone tissue, reflecting chronic exposure, and blood, reflecting acute exposure, but also as a player in quotidian household activities—from the dinner table where household members eat beans served in lead-glazed ceramics to the couch where breastfeeding mothers may transmit lead to babies through their milk.

It is through the coordination of isomorphic fractals that our bioethnographic work emerges. ELEMENT biological sample data and data about people's daily lives can take many forms. Instead of analyzing each kind of data as disparate and as either more or less complex than the other, we focus on the complex relationships that produce each kind of data as we work to combine them. Below we outline four phenomena that require us to coordinate complex worlds as we work to assemble a research platform that will, eventually, allow us to conduct bioethnographic analysis. Our discussion of this coordination does not fall in any order of importance, because each phenomenon is embedded within complex fractal relationships that loop back on each other intra-actively. As we described above, intra-action insists that these phenomena do not precede their relations. Rather, they emerge through them (Barad 2003, 2007).

Variable Research Ecologies, Temporalities and Concepts

Mexican Exposures and ELEMENT are located in two specific, disparate research environments that can be difficult to coordinate, spatially and temporally. Most of the ELEMENT researchers in the United States are located in the University of Michigan School of Public Health, where they work incessantly to bring in large grants for team-based research that generate vast amounts of mostly numerical data. These grants fund a wide array of master's and PhD students who provide labor for these team efforts. Faculty researchers in public health have no undergraduate teaching responsibilities (although that is about to change with a new undergraduate major in public health) and relatively few formal teaching requirements, although they do spend much of their time training students who work on their own larger projects.

Roberts and Sanz are located in a relatively well-resourced anthropology department in the College of Literature, Science, and the Arts at University of Michigan. The effort to develop a bioethnographic research platform that combines Mexican Exposure and ELEMENT data is much larger than most projects in cultural anthropology, which tend to focus on individual production and analysis of qualitative data. While Roberts's professorship is divided between teaching, administration and research, Sanz's postdoctoral work is primarily dedicated to developing bioethnography. Roberts's teaching focuses on undergraduate liberal arts education and the teaching and training of PhD students who must carry out research independent from that of their advisers. These teaching responsibilities do not provide an ideal environment for bioethnographic research: the coordination and quantity of the Mexican Exposures data alone is beyond one person, and student labor is not readily available. One solution to this labor problem has been for us to establish a qualitative coding laboratory, using Mexican Exposure data, where we can train undergraduates, who receive course credit for their efforts. We will discuss the workings of this laboratory below, but a key point is that the project could not exist without this student labor, and the lab could not exist without Sanz's work paid for by grant funding, because the logistics of lab coordination are so extensive.

In moving our bioethnographic endeavor forward, we face other temporal pressures unusual for cultural anthropologists. To carry out a project of this magnitude, we need to spend much of our time seeking funding for nonstandard anthropological research. We also spend a large percentage of our time at the School of Public Health attending ELEMENT meetings, as a means to understand ethnographically and participate in ELEMENT's research endeavors. These meetings demonstrate how the temporal patterns embedded in each discipline (anthropology and public health) can be difficult to coordinate. Even though ELEMENT is a long-term study, it has been funded in short-term, 3–5-year chunks that require proof of publishing productivity to receive more funding (Jackson et al. 2011). Thus, publishable results come from the analysis of biostatistical data at a faster pace than we are accustomed to in anthropology. Since ethnographic data gathering and analysis proceed at a slower pace, it might appear to ELEMENT researchers that we have few results to show after 3 years of effort. The work of coordination, once again, is useful for understanding these different temporalities. There is an enormous amount of rhythmic action going on at any time in collaborative work; knowing what, where and when the action is can be an enormous challenge to us, both as researchers attempting a novel kind of collaboration and as anthropologists trying to theorize collaboration across different methodologies.

Our observations and experiences at these meetings suggest that the world of collaborative science is in fact full of such mismatches and that many of our efforts (small and large, local and systemic) to coordinate, manage or to simply live with these mismatches are constitutive of bioethnographic analysis. This means that assembling a bioethnographic research platform requires what feels like a series of compromises, and frequent acceptance of the subjection "of our work and interests" to the interests of our environmental health colleagues "in which we seek to entangle them" (Callard and Fitzgerald 2015, 105). At the same time that it feels like we must relinquish some of our own intellectual commitments (at least temporarily) to go forward, we can also see willingness on the part of ELEMENT researchers to create a more expansive and critical approach to ELEMENT data. Thus, for now: we are willing to use BMI (body mass index) as a measure to compare body size across neighborhoods despite the biopolitical moralism embedded within it (Wright and Harwood 2009); we are willing to translate our findings to the service of making better questionnaires to speak to ELEMENT scientists, even though translation diverges from the intra-active looping that guides our efforts; and we are willing to try to turn thick descriptive Mexican Exposures ethnographic data into numbers in order to coordinate it with ELEMENT data—although it can feel like numbers deplete context. At the same time, ELEMENT researchers have been willing to reassess their use of standard individualizing public health concepts like "food decisions" and "sleep quality" as they explore with us questions of how specific neighborhood environments might affect chemical exposures or how geopolitical processes like NAFTA might contribute to diet and bodily conditions like diabetes.

A Problem of Scope and Scale: The Ethnography of *Todologia*

With over 25 years of data and counting, ELEMENT is an enormous project with researchers, staff, biological samples and statistical data distributed over three nations, at least four universities and multiple departments.[8] A method, maybe *the* method, for managing this data is turning each data point into numerical values, which has the tendency to decontextualize lived worlds and assumes that data points speak about processes internal to individual bodies. By contrast, Mexican Exposure data was collected with a commitment to the bioethnographic goal of intra-active looping, so ethnographic data collection was not limited to individuals or to a few aspects of life in two neighborhoods. Instead we have come to characterize the method of Mexican Exposures data collection as *todologia.* Built on the Spanish root word *todo* (all), *todologia* is the study of everything.[9] The term sometimes means knowing a little about a lot and at other times means a study that connects everything.

The problem is that, for now, Mexican Exposure data, gathered through *todologia*, must be organized, managed and coded in ways that will facilitate coordination with public health data. In over 4 years of fieldwork, we have produced hundreds of thousands of pages of field notes and transcripts plus over 30,000 photos that must be managed in order to be coordinated. We have organized a laboratory to harness undergraduate labor for this task, which in turn involves obtaining space where students can engage in the collective coding of the data and in training and management.

One consequence of this team approach to data management is that Roberts's field notes are read and analyzed by the 8–10 students who work in the lab at any given time. Since Roberts had never engaged in a team-based ethnographic project before, her notes about daily life in Mexico City included accounts of her own bodily phenomena. In the spirit of *todologia*, she paid attention to neighborhood water infrastructure, plumbing, bodily conditions and gendered street dynamics and concurrently recorded her own GI illnesses, access to water for showers and bathroom conditions. At this point, making data available to students for coding seems more important than protecting Roberts's privacy. Ethnographers contemplating a project of this scale might anticipate this issue and in fact plan for team-based ethnography as well as team-based analysis as they write their field notes. An upside of the process overall has been that, almost right away, students began to note important patterns in the field notes that neither of us perceived.

Another challenge has been deciding on the most appropriate coding software. Given the volume of our data and the collective and real-time nature of the work of managing and coding it, there is no ideal program for this task. We experimented with online programs that allowed access to multiple users but could not find one able to handle the quantity of our data.[10] To deal with these issues, we turned to ATLAS.ti, an offline software package that can handle thousands of field notes and transcriptions, although it cannot handle large quantities of photos. For that, we need another program.[11] Working with offline software has pushed us toward more connectivity and intensive sociality[12]—that is, toward developing and maintaining an ongoing web consisting of a lab space with set lab hours filled with dry-erase boards, snacks, music, coffee, endless conversation, note taking, scratch paper and pens. All of these elements are intimately intertwined with the interactive practice of coding, which means intensive collective conversation as we decide on new codes and merge or delete old ones.

With respect to developing codes, *todologia* poses another challenge. Most qualitative projects focus on only a few key issues, for example, labor movements or gender and adolescence or cancer diagnosis practices and racial formation, house construction methods, herding economies and so on. While these foci radiate out into multiple arenas, a kind of filtering usually happens that helps researchers identify the relevant subset of issues that should be coded. Within the aims of bioethnography—which do not exclude any observable phenomena or maintain distinctions between the social and the biological—we have already generated over 2000 codes (and counting) and yet have coded less than 7% of the Mexican Exposures ethnographic data. These numbers are already much larger than what ATLAS.ti is used to handling. Thus, ATLAS.ti staff and developers frequently chastise us for creating too many codes. In line with an interest to expand the capacity of their product for large-scale projects, the ATLAS.ti team is working with us to develop new methods to handle this issue. As we continue to organize our bioethnographic research platform, we worry, however, that our ability to manage the ethnographic portion of this data might eventually be short-circuited by the amount and breadth of what the data contains.

The main axis of our coding endeavor is the so-called Master Project. This is an ATLAS.ti file that contains all of the field notes and transcriptions amassed during fieldwork. Students in the lab are assigned satellite projects (usually by date), which contain field notes and transcripts they need to code at the sentence and paragraph level.[13] As students code, new phenomena emerge, which are assigned codes that are immediately entered into a Google.doc shared by all the team members. The Google.doc helps us create a temporary base layer of connectivity between lab members in real time. During our weekly lab meetings, we discuss all newly created codes, accepting some, renaming others and deciding against the inclusion of still others into the Master Project.[14] After this meeting Sanz merges each of the satellite projects into the Master Project and cleans the resulting master code list, a process that usually takes an entire day. When this process is complete, Sanz sends the updated master code list back to students, along with either brand new or updated satellite projects.

Synchronizing and updating the Master Project requires that *all* members of the team send their projects to the administrator at the same time. If just one satellite project is left out, the resulting list of codes will be incomplete, out of date, and unable to reflect all the most recent changes discussed during the lab meeting. This points to perhaps one of the greatest challenges of managing ATLAS.ti: the need to work in sync, coordinating different coding rhythms. Hence coding in ATLAS.ti is about constant synchronization of the collectively harnessed labor of a group of dedicated and engaged students.

Data Request #1

Currently we are working to develop the ability to link Mexican Exposure ethnographic data with ELEMENT chemical-exposure data concerning neurological development, sexual maturation and body mass. We have multiple visions for what kinds of next-order correlations we could pursue as we engage in the projects described above, but we have found that obtaining the data to carry out these correlations requires a careful coordination between our research questions and the research ecology of public health, starting with the actual act of requesting the data itself.

Originally our plan was to obtain all of the ELEMENT biostatistical data about the six Mexican Exposures families. Given our small *n,* any data about these participants seem like it would be helpful for understanding their overall health and lives. We wanted to start making linkages between biological samples—like blood-lead levels and BPA levels—and the lives of these people whose biological substances these numbers are supposed to represent. We knew we would need to learn how to read the biological data like environmental health scientists learning, for instance, what BPA or phthalates do to a urine gravity number or how to interpret a negative blood-lead level (which seemed at first to make no sense). With the help of ELEMENT scientists, we also planned to educate ourselves on how to interpret the data of this small participant subset in relation to the larger cohort.

While our request for all the variables, as in *todologia*, about the small group of participants included in Mexican Exposures seemed simple and straightforward to us, this was not the case for ELEMENT researchers. Data managers would frown warily when confronted with our repeated requests.[15] They would immediately respond with a question that seemed more like a statement: "You want *all* the data, *all* the variables? Do you really think you would be able to work with so much data?" Requesting all the available data on our small *n* did not make sense to them—despite our explanations that, because our work is not hypothesis driven, we anthropologists cannot know in advance which specific variables are relevant and despite our assertions that the mass of biostatistical data about a small *n* would provide hunches to allow more refined research questions and to generate hypotheses about the whole cohort.

Our approach simply did not work, because database managers need to follow statistical protocols when providing information to researchers. When fulfilling a data request, for example, ELEMENT database managers need time to find the right variables within their vast data repositories and to filter, merge and arrange them in specific ways. Based on the request, the database managers decide how to organize the data distribution—whether to set it up in vertical or horizontal arrangements in spreadsheets and which variables should remain fixed in time. There is not just one arrangement for each variable within a database; there are many. The same numbers will be arranged differently to tell different stories about lead, BPA or phthalates. What conveys meaning is not the numbers per se but the relations among them and with the variables.

Thus, requesting *all* variables for a small number of participants would mean providing a massive quantity of numbers untethered to any specific question or hypothesis—which runs counter to how biostatistical databases are designed. In this world, untethered numbers lack specific meaning or scientific value. ELEMENT researchers formulate their requests in such a way that the biological data, the questions asked, and the anticipated answers expected in return (their hypotheses) come into coordination. Data requests will not yield “meaningful” information if researchers fail to coordinate these elements or bypass data-sharing protocols and rhythms.[16]

The correct way to make a data request resonates with the work that Sanz did with oncologists at hospitals in Colombia (Sanz 2017). When Sanz asked physicians about the protocols that helped them to diagnose a cancer, their explanation boiled down to the importance of knowing how to ask the right questions. For instance, if doctors request a bone scanography of patients' bodies without first specifying what they want to obtain from the resulting image, technicians would not know how to modulate the intensity of the “camera” or where to take the picture. Likewise, according to the oncologists Sanz interviewed, it is necessary for doctors to coordinate their diagnostic suspicions and specific imaging requests with the way that technicians and radiologists conduct these exams. Similarly, specific requests for ELEMENT data questions set the conditions for different ways of arranging data and produce different answers (Bowker and Star 2000; Dumit 2004). We have had to learn that when we seek to access ELEMENT data, we need to know in advance *why* we are asking for certain variables and to specify what we expect to get from them. In time, we are fairly sure that through repeated requests for specific variables, we will have received all the data that we wanted initially but had to ask for piece by piece.

Data Request #2: Neighborhoods

We modified our data-request approach by asking for a smaller number of variables (lead levels and BMI) for all the participants in the two neighborhoods where Roberts conducted her ethnographic research. With a larger *n* we hope we might be able to provisionally examine whether ethnographic insights about difference between these two neighborhoods might appear in the biostatistical data and perhaps in relation to the cohort overall.

But then again, generating a list of participants who live in these two neighborhoods has proven to be an exceedingly complicated task, taking over 5 months to accomplish. Part of the problem has been that ELEMENT data had not before been parsed by neighborhood, and deciding the status of a neighborhood and participants' residence required intense coordination between various team members. Another issue was that our data request involved both mothers and children instead of just one or the other, across all three cohorts in the larger ELEMENT project. The majority of typical data requests are limited to one cohort and to either mothers or children, which makes fulfilling the request simpler, since the available data is more consistently collected within a cohort.

Not surprisingly, our first data request for a list of participants by neighborhood did not go well. The data we received turned out to be inconsistent: the total number of participants per cohort did not add up to the total number of participants from both neighborhoods. Inexplicably there were hundreds of duplicates. We suspect this problem was partly due to the mismatch between our ethnographic approach and the design of the database. But it could also be the result of an inaccuracy in the merging of the data set. ELEMENT investigators have assured us, however, that initial data requests, even from experienced requesters, often don't result in usable data the first time, especially when they involve data across cohorts.

And then there is the fact that our request to arrange participants by neighborhood presented a completely a new kind of query, by introducing a new variable, neighborhood, in which to organize other variables. There were no pre-established protocols on how to merge this combination of variables. Database managers kept going back and forth between the raw database and our request. They worked to correlate space (i.e., location, neighborhood) with time (i.e., cohort recruitment dates and participant ages). Lack of coordination did not mean that data managers had failed to understand our requests. Rather, it meant that the required correlation of addresses and participants simply had not existed within the database or had not been attempted before. While the addresses, the participant's biographical information, and the toxicant levels *did* exist as variables in the database, nobody in ELEMENT had formulated the type of question that would correlate them as a precondition to generate new information. We understand our novel queries as a new apparatus that shapes the reality it measures (Barad 2007). The way we formulate our questions and submit the neighborhood data request might not only create a new merging of numbers but also possibly the conditions for new public health policies in Mexico City and around the world, geared toward neighborhoods.

One challenge has been identifying the time points when each participant was recruited to each cohort, so as to decide on the addresses that would determine their place on the list—accounting for the fact that their residential address might have changed between phases of the study. In a longitudinal study like ELEMENT (actually a study of three separate birth cohorts and, later, further follow-up studies with subsets of participants from each of those three cohorts) some participants may have been enrolled in more than one study and changed their address between studies. While limiting participants to one address reduces the complexity of their life experience, this simplification is crucial to the making of a working list that will allow us to conduct neighborhood comparisons. As we tried to parse the data to produce a working list, moreover, we observed that changes in address could be a sign of housing instability—which in turn might shape bodily conditions. This is the kind of insight we plan to investigate further in our bioethnography of neighborhoods.

To fulfill our neighborhood data request, one ELEMENT database manager, Maritsa Solano, provided a manual to explain the data set we requested. Manuals allow people to agree on what is being "seen" in the data sets. Yet "agreeing" takes time and requires a learning process. When accessing biostatistical data, for instance, we must learn to "see" biological measurements through the variables and definitions included in the manual, learn how to read them (vertically, horizontally, chronologically, and otherwise), and learn to "recognize" confounders and identify values that are considered out of the normal range for specific toxicants—which for untrained observers like us would go unnoticed. "Vision" in this text, following Orit Halpern, "operates as a holding term for multiple functions: as a physical sense, a set of practices and discourses, and a metaphor that translates between different mediums and different communication systems" (Halpern 2015, 21).

In trying to master this process, we recall Bruno Latour's essay on learning to recognize different smells in the perfume industry (Latour 2004). Latour describes how trainees become a "nose," that is, someone able to discriminate more and more subtle differences and able to tell them apart from one another even when they are masked by or mixed with others. Before the teaching session, Latour writes, "odors rained on the pupils without making them act, without making them speak, without rendering them attentive, without arousing them in precise ways: any group of odors would have produced the same general undifferentiated effect or affect on the pupil" (Latour 2004, 207). Each of these trainees viscerally learned to be affected by seemingly unidentifiable differences through the mediation of the kit. In our encounters with ELEMENT biostatisticians and database managers, we are being trained to become not "noses" but "eyes." We are learning how to *see* data in hopes of coordinating ethnographic knowledge with public health knowledge, thus making new relationships possible and generating more nuanced questions and spaces for speculation and (dis)agreement.

Conclusion

As we write these lines, we have received word that our request for a list of participants in the two neighborhoods has been fulfilled. Preliminary statistical analysis by ELEMENT epidemiologist Martha Tellez-Rojo indicates that there might be meaningful differences in children's blood-lead levels in the two neighborhoods, as was predicted by our ethnographic observations on how toxicity might serve as protection from the police. This very preliminary and tentative finding—from one rather small data set—of a difference in children's blood-lead levels between two neighborhoods is an initial modest outcome from our half-built bioethnographic platform.

By now it should come as no surprise that myriad complexities are embedded in that one preliminary comparison. These complexities involve, to name just a few things: disparate temporalities embedded in how different bodily systems engage in chemical uptake, specific relations that produce lead exposure in neighborhoods and households and the relevance of neighborhood and household in the first place. The initial finding described above compares blood-lead measures in children instead of bone-lead measures, which were also available. The two measures relate to different temporalities. Bone lead is a measure of long-term exposure and is difficult to obtain. ELEMENT researchers collected this measure from mothers at only one time point. Blood lead indicates acute exposure, and ELEMENT has blood-lead measures for both mothers and children from multiple time points. Conversations, with Dr. Tellez-Rojo, clarified that our research question about neighborhood difference would drive how to select which samples to compare—whether long term or acute exposure. We settled on the latter.

Besides temporality, our efforts to compare bodily lead levels between neighborhoods—indeed, to decide whether it makes sense to think in terms of a "neighborhood lead burden" at all—is structured by the complex relations that produce lead exposure in Mexico City. Lead exposure in Mexico tends not to be associated with the built environment in the same way it is in United States, where lead comes from house paint and plumbing pipes.[17] Since lead was banned from gasoline in 1997, some of the main known sources of lead exposure in Mexico City are leaded pottery (*trastes de barro*) and certain snack foods (e.g., candies with chili) (Tamayo y Ortiz et al. 2016). The use of leaded pottery and the consumption of these foods link to socioeconomic status, and neighborhoods are robustly correlated to SES, all of which lends support to our pursuit of data linking neighborhoods to bodily conditions.

We will face complexity, too, in our ongoing work to link biological samples to lived worlds within neighborhoods. In the future we will need to decide whether we should select and compare all the measures taken around the same calendar date, when air quality might have been the same across neighborhoods. Alternately, if we decide to focus on candy as a source of exposure, we will need to know if candies from different confectioners contain similar amounts of lead. Or we can select blood-lead levels by the age of the child, since age might determine the child's vulnerability to lead. This approach allows us to know only a small thing about what's inside children's bodies at one time without reference to externalities like neighborhood or study conditions at different times. We are still in the process of making these decisions. While we continue to investigate whether it makes sense to think in terms of comparative neighborhood lead burden, we know that we need to think carefully about what we mean when we invoke neighborhoods.

Through these processes we hope to learn more, both about lead exposure and neighborhoods and about how ELEMENT biostatisticians assemble data and make knowledge. At the same time, participating in these processes provides us with an opportunity to observe how we have become interpolated in the complex work of biostatical analysis whereby a particular data request might produce knowledge. In our attempt to make a bioethnographic account, we are also generating new biostatistical knowledge. This is somewhat uncomfortable; as we are unaccustomed to being responsible for making numbers, because no matter how fervently we might insist that numbers are produced through contingent relations, we know that they tend to be treated as autonomous things in themselves (Nelson 2015). Thus, even as we offer a preliminary guide to the deliberate coordination involved in bioethnography, our ultimate goal is to keep numbers tethered to larger accounts that insist on the intra-active complexity of bodily, neighborhood and geopolitical phenomena at work within them.

Acknowledgments Abundant thanks to Maurizio Meloni for providing us with the opportunity to gather our thoughts about bioethnography; Des Fitzgerald for an engaged set of critical comments about the original manuscript; the ELEMENT team, and especially Ana Benito, Jackie Goodrich, Adriana Mercado, Belinda Needham, Karen Petersen, Brisa Sanchez, Howard Hu, Luis Bautista Arredondo, Alejandra Cantoral, Linda Luna, Beti Escobedo, Bekki Tutino, Angeles Martinez Mier, Martha M. Téllez-Rojo, Erica Jansen and Deborah Watkins for conversations, meetings and guidance through this process. Martha M. Téllez-Rojo and Karen Petersen in particular for being such wise co-visionaries in making bioethnography happen. ELEMENT project coordinator Robin Lee and database managers Maritsa Solano and Lu Tang for their endless patience. ATLAS.ti staff, program specialists Susanne Friese and Ricardo Contreras for their expertise and willingness to guide us throughout the coding endeavor, and ATLAS.ti account manager Eve Weiss; Hannah Marcovitch and Erica Jensen for their dynamic experimentation with bioethnography and eating in Mexico City; the families in Colonia Periférico and Buena Vista who gave us the time and space to embark on *todologia* in accompaniment with them; Dean Hubbs for extensive editing and in-depth, iterative conversations that forced us to articulate our arguments more clearly and elegantly; the University of Michigan Department of Anthropology at Michigan, especially Andrew Shryock and Amy Rundquist for finding us lab space; and to all the students in our Mexican Exposures lab for figuring out with us how to do this very complicated thing; Faith Cole, Emily Hogan, Lauren Lund, Shiv Sharma, Kate Vogel, Raquelle Sewell, Kelsey Merritt, Kaavya Puttagunta, Hailey Briscoe, Clara Cullen, Sophie Geyer, Alexandria Choi, Sahar Gowani, and Hannah Marcovitch.

Notes

1. Our vision of a bioethnographic research platform involving observation and biochemical sampling--in a synthetic, symetrical analysis, is different and similar to Keating and Cambrosio's "biomedical platforms," a concept describing the merging of biology and medicine post-WWII, that recast the normal and pathological in productive and powerful ways (Keating and Cambrosio 2003). While bioethnography works to coordinate methods associated with the domains of nature and culture, perhaps understood as more different than biology and medicine were before their platforming, we hope that bioethnography is both powerful and productive in providing more nuanced means to understand relationships between health, disease and inequality that biomedical platforms have so often obscured.
2. A bioethnographic research platform might sound similar to what American biological anthropologists have formulated in recent decades as a "biocultural synthesis," which explores the role of culture in shaping human biology and behavior. But there are important differences. Biocultural anthropologists have contributed to the understanding of a wide range of phenomena including HIV transmission, high-altitude adaptation and lactase persistence (Beall 2006; Brabec et al. 2007; Hadley et al. 2010; Lindstrom et al. 2011; Wiley 2008). By maintaining culture as distinct from biology, however, the approach yields a synthesis that remains asymmetrical. It leaves unexamined the historical and economic conditions that continually shape biological processes and scientific study itself. In effect, this reification of culture as separate from biology is similar to social constructionism, which posits an object world separate from the ideational social world.
3. We imagine other qualitative social scientists might be interested in developing other kinds of "bioqualitative" methods to look at phenomena besides health, disease and inequality. Here we describe a model for a bioethnography of health, disease and inequality because (1) ethnography of health and disease is what we do and (2) because ethnography is arguably the most different qualitative method from what our public health collaborators already use. Their methodological tool kit already contains surveys, questionnaires and

structured observations—all of which are easily quantified. Ethnography could be made more numerical, in an ethological tradition, but up until this point, at least, we have taken a different approach.

4. Epigenetics refers to molecular mechanisms which effect gene expression located in the chromatin that envelops DNA.
5. A telomere is a region at the end of the chromosome, which displays varying levels or weathering thought to be signs of bodily insults. This weathering is measurable.
6. Researchers now claim that over 30% of the medical problems that doctors are faced with are rooted directly or indirectly to sleep alterations (Buysse 2013; Camey et al. 2012; Hoevenaar-Blom et al. 2011). From obesity to diabetes and from heart disease to cancer, sleep shapes most aspects of our health.
7. The accelerometer is a wearable technology—similar to a Fitbit— that is attached to participants' wrists for extended periods of time and allows researchers to monitor their movements' frequency, intensity, patterns and periods of rest, as well as exposure to light or darkness (through a built-in photo detector). Accelerometers also record the steps taken, distance traveled, calories burned and, of course, sleep patterns.
8. There are members of the ELEMENT research team at the University of Michigan, the University of Toronto, INSP in Cuernavaca Mexico, the Instituto Nacional de Perinatología and Hospital ABC in Mexico City, University of Indiana and Harvard University.
9. This term was provided to us by one member of an ELEMENT participant family. When she heard that we were interested in more than blood samples and food questionnaires, and that we wanted to know as much as possible about participants' lives, economic pursuits and family dynamics— but were still also interested in what the blood samples had to say, she commented, "So, you're doing "*todologia*."
10. Additionally, online programs can pose problems if more than one person is working at once. For instance, if one user is coding a data segment and 5 minutes later another user modifies that data by erasing the first user's codes.
11. For now we are coding photos through an online program called Smug Mug, but its capacities are quite limited.
12. Because it is offline, ATLAS.ti software depends on students' individual computers—their own hardware and storage capacity. Thus, when building our research team, we make sure students have enough free disk space on their computers. Because we started using the ATLAS.ti for Mac in 2015, all the technical and logistical platforms of our coding endeavor have been developed and adapted for this particular operating system. Due to incompatibilities between Mac and PC, attempting to use ATLAS.ti for PC has been not only logistically challenging but technically impossible. ATLAS.ti software had only allowed for a one-way transfer of data—from PC to Mac, but not

the other way around. For this reason, we recruited students who owned Mac computers. While drafting this chapter, however, we received good news from ATLAS.ti. After several months' wait and multiple postponements, a new version of the software was finally released, and it included the much-needed Mac-PC two-way data transfer capability.

13. This coding process is facilitated by the fact that it's relatively easy to find students who can code notes and transcripts in Spanish. Our efforts to harness student labor would be more difficult if our field language was less commonly taught in US high schools and universities.
14. Weekly lab meetings consist of 2 to 3 hours of conversations like this; during the previous week a student, Hailey Briscoe created a new "baby" code to apply to the action of a neighborhood resident covering a smelly sewer drain with a plastic bucket. Hailey located the new baby code "changing environment" under a pre-established "mother code" *BUILT ENVIONMENT*. As a group we talked about whether a clearer and more useful "baby" code, that would apply to a variety of situations in other notes, might be *BUILT ENVRIONMENT manipulating*, or *BUILT ENVRIONMENT transforming*, or more capaciously, *BUILT ENVIRONMENT manipulating/transforming*. We are well aware of the gendered and normatively kinned coding framework language we have developed in conjunction with the students (MOTHER and baby codes). It reflects both the make-up of the ELEMENT study in terms of mother/child pairs and the make-up of our lab, which is mostly female.
15. We also had to learn to identify the most appropriate database managers to whom we should pose our questions. Some are located in the USA and some in Mexico, and each has different responsibilities and database jurisdictions.
16. We also learned that data-request protocols are safeguards that seek to protect intellectual property, maintain standards of research ethics, and guarantee accuracy of information. They normalize the use of data and help data managers (and PIs) decide which variables will be shared with whom, based on researchers' questions and hypotheses.
17. Due to the use of different building materials in Mexico (cement instead of wood), paint does not contain lead. There is no research that we know of determining whether water pipes in Mexico contain lead.

References

Afeiche, Myriam, Karen E. Peterson, Brisa N. Sanchez, David Cantonwine, Hector Lamadria-Figueroa, Lourdes Schnass, Adrienne Ettinger, Maurico Hernandez-Avila, Howard Hu, and Martha M. Tellez-Rojo. 2011. Prenatal Lead Exposure and Weight of 0- to 5-Year old Children in Mexico City. *Environmental Health Perspectives* 19 (10): 1436–1441.

Barad, Karen. 2003. Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter. *Signs* 18 (3): 801–831.

Barad, Karen Michelle. 2007. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham: Duke University Press.

Beall, Cynthia M. 2006. Andean, Tibet, and Ethiopian Patterns of Adaptation to High-Altitude Hypoxia. *Journal of Integrative and Comparative Biology* 46 (1): 18–24.

Bowker, Geoffrey C., and Susan Leigh Star. 2000. *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA: MIT Press.

Brabec, Marek, Ricardo Godoy, Victoria Reyes-García, and William R. Leonard. 2007. BMI, Income, and Social Capital in a Native Amazonian Society: Interaction between Relative and Community Variables. *American Journal of Human Biology* 19 (4): 459–474.

Buysse, D. 2013. Sleep Health: Can We Define it? Does it Matter? *Sleep* 37 (1): 9–17.

Callard, Felicity, and Des Fitzgerald. 2015. *Rethinking Interdisciplinarity Across the Social Science and Neurosciences*. New York: Palgrave Pivot.

Callon, Michel. 1989. Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. In *Power, Action and Belief*, ed. J. Law, 196–223. London: Routledge.

Camey, C., D. Buysse, S. Ancoli-Israel, A. Ednger, J. Krystal, K. Lichstein, and C. Morin. 2012. The Consensus Sleep Diary: Standardizing Prospective Sleep Self-Monitoring. *Sleep* 35 (2): 287–302.

Dumit, Joseph. 2004. *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton, NJ: Princeton University Press.

Ekirch, Roger. 2006. *At Day's Close: Night in Times Past*. New York: Norton and Company Press.

Eisenberg, Joseph, and Jim Trostle. 2013. *EcoDess: Environmental Change and Diarrheal Disease: A Natural Experiment*. Accessed 15 December 2016. https://sph.umich.edu/scr/ecodess/home.php?itemID=0&lang=English

Ettinger, A.S., H. Lamadrid-Figueroa, M.M. Tellez-Rojo, A. Mercado-Garcia, K.E. Peterson, J. Schwartz, H. Hu, and M. Hernandez-Avila. 2009. Effect of Calcium Supplementation on Blood Lead Levels in Pregnancy: A Randomized Placebo-controlled Trial. *Environ Health Perspect* 117 (1): 26–31.

Hacking, Ian. 1999. *The Social Construction of What?* Cambridge, MA: Harvard University Press.

Hadley, C., A. Brewis, and I. Pike. 2010. Does Less Autonomy Erode Women's Health? Yes. No. Maybe. *American Journal of Human Biology* 22 (1): 103–110.

Halpern, Orit. 2015. *Beautiful Data: A History of Vision and Reason Since 1945*. Durham: Duke University Press.

Hoevenaar-Blom, M., A. Spijkerman, D. Kromhout, J. Van der Verg, and M. Verschuren. 2011. Sleep Duration and Sleep Quality in Relation to 12-Year Cardiovascular Disease Incidence: The MORGEN Study. *Sleep* 34 (11): 1487–1492.

Jackson, Steven, David Ribes, Ayse Buyuktur, and Geoffroy Bowker. 2011. Collaborative Rhythm: Temporal Dissonance and Alignment in Collaborative Scientific Work. *CSCW*: 19–23.

Jensen, Casper B. 2007. Infrastructural Fractals: Revisiting the Micro-Macro Distinction in Social Theory. *Environment and Planning D: Society and Space* 25: 832–850.

Keating, Peter, and Alberto Cambrosio. 2003. *Biomedical Platforms: Realigning the Normal and the Pathological in Late-twentieth-century Medicine*. Cambridge, MA: MIT Press.

Knorr-Cetina, Karen. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.

Koslofsky, Craig. 2011. *Evening's Empire: A History of the Night in Early Modern Europe*. Cambridge: Cambridge University Press.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

———. 1999. *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.

———. 2004. How to Talk about the Body: The Normative Dimension of Science Studies. *Body and Society* 10 (2/3): 205–229.

Lind, David, and Elizabeth Barham. 2004. The Social Life of the Tortilla. *Agriculture and Human Values* 21: 47–60.

Lindstrom, D., T. Belachew, C. Hadley, Dennis Hogan, and Fasil Tessema. 2011. Nonmarital Sex and Condom Knowledge among Ethiopian Young People: Improved Estimates Using a Nonverbal Response Card. *Studies in Family Planning* 1 (4): 251–262.

Lock, Margaret. 2013. The Epigenome and Nature/Nurture Reunification: A Challenge for Anthropology Medical. *Anthropology* 32: 291–308.

Miller, John H., and Scott E. Page. 2007. *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*. Princeton, NJ: Princeton University Press.

Mol, Annemarie. 2002. *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.

Roberts, Elizabeth F.S. 2015a. Bio-Ethnography: A Collaborative Methodological Experiment in Mexico City. In *Somatosphere*. http://somatosphere.net/2015/02/bio-ethnography.html. Date accessed December 4, 2016.

———. 2015b. Food is Love: And so, What Then? *BioSocieties* 10: 247–252.

———. 2017 "Exposure." Theorizing the Contemporary, Cultural Anthropology website, June 28, 2017. https://culanth.org/fieldsights/1152-exposure, Date Accessed August 28, 2017.

Sanz, Camilo. 2017. Out of Sync Cancer Care: Health Insurance Companies, Biomedical Practices and Clinical Time in Colombia. *Medical Anthropology* 36: 187–201.

Stengers, Isabelle. 2005. The Cosmopolitical Proposal. In *Making Things Public: Atmospheres of Democracy*, ed. B. Latour and P. Weibel, 994–1003. Cambridge,

MA. [Karlsruhe, Germany]: MIT Press; ZKM/Center for Art and Media in Karlsruhe.
———. 2010. *Cosmopolitics*. Minneapolis: University of Minnesota Press.
Strathern, Marilyn. 1991. *Partial Connections*. Savage, MD: Rowman & Littlefield Publishers.
———. 2004. *Commons and Borderlands: Working Papers on Interdisciplinarity, Accountability and the Flow of Knowledge*. Oxford: Sean Kingston Publishing.
Tamayo y Ortiz, M., M.M. Téllez-Rojo, H. Hu, M. Hernández-Ávila, R. Wright, C. Amarasiriwardena, N. Lupoli, A. Mercado-García, I. Pantic, and H. Lamadrid-Figueroa. 2016. Lead in Candy Consumed and Blood Lead Levels of Children Living in Mexico City. *Environmental Research* 147: 497–502.
Tellez-Rojo, M.M., A. Cantoral, D.E. Cantonwine, L. Schnaas, K. Peterson, H. Hu, and J.D. Meeker. 2013. Prenatal Urinary Phthalate Metabolites Levels and Neurodevelopment in Children at Two and Three Years of Age. *Science of the Total Environment* 461–462: 386–390.
Wiley, Andrea S. 2008. "Drink Milk for Fitness": The Cultural Politics of Human Biological Variation and Milk Consumption in the United States. *American Anthropologist* 106 (3): 506–517.
Williams, Simon. 2005. *Sleep and Society: Sociological Ventures into the (Un)known*. London: Routledge.
———. 2011. *The Politics of Sleep: Governing (Un)consciousness in the Late Modern Age*. New York: Palgrave Macmillan.
Wolf-Meyer, Matthew. 2012. *The Slumbering Masses: Sleep Medicine and Modern American Life*. Minneapolis: University of Minnesota Press.
Wright, Jan, and Valerie Harwood. 2009. *Biopolitics and the 'Obesity Epidemic': Governing Bodies*. London: Routledge.

Elizabeth F.S. Roberts is a feminist ethnographer of science, medicine and technology, who teaches anthropology at the University of Michigan. Her work has included research on assisted reproduction in the Ecuador and the United States, reproductive governance in Latin America, transnational medical migrations and currently a collaborative environmental health science project in Mexico and the United States.

Camilo Sanz, PhD, is an Assistant Professor of Anthropology at the University of Indianapolis, Department of Anthropology. His research interests include oncology and clinical rhythms, bioethics, sleep and data science in Colombia, the U.S and Mexico.