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Turbulent Science: Temporality, Proximity, and Scientific Practice in Mexico

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Turbulent Science:
Temporality, Proximity, and Scientific Practice in Mexico

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Anthropology

by

Cristina T. Bejarano

Dissertation Committee:
Professor Mei Zhan, Chair
Professor Bill Maurer
Professor Michael Montoya

2014

DEDICATION

For my son,

may my struggles and achievements

make your journey through life more fulfilling and enjoyable.

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ABSTRACT OF THE DISSERTATION

Turbulent Science: Temporality, Proximity, and Scientific Practice in Mexico

By

Cristina T. Bejarano

Doctor of Philosophy in Anthropology

University of California, Irvine, 2014

Professor Mei Zhan, Chair

Social and cultural studies of science have often left linear time unquestioned while making the important observation that progress is not the inevitable trajectory of science. In the anthropology of time, relativist accounts have tended to focus on nonlinear kinds of time. This ethnography contributes to these two bodies of literature by demonstrating how the flow of time is highly variable, producing complex understandings of the past, present, and future and their relationship to each other. These multiple temporalities are crucial to understanding how science is envisioned, the kinds of research questions that are asked at particular moments, and how research trends eventually take shape. It argues that scientists are not merely in time but are actively constructing various kinds of time through the relations they form between themselves, objects, ideas, and temporal reference points that often have a spatial dimension.

This ethnography uses the particular case of genomic science in Mexico to show how constructions and experiences of time affect scientific knowledge production and practices. Biomedical researchers in Mexico often face an array of material, technological, institutional, and linguistic challenges. Laboratory materials can take two to six months to arrive yet researchers have also learned to anticipate unexpected delays. Most laboratories lack the newest

and more efficient laboratory equipment. Institutions frequently implement policies that directly affect researchers without giving proper notice. Mexican biomedical researchers are required to publish in English in the top journals in their fields, but they often report unfair rejections of their manuscripts due to their country of origin. These challenges give the sensation that time does not progress into the future at a constant speed, but rather varies tremendously. This is compounded by the fact that many biomedical researchers from Mexico have studied and worked at very privileged institutions in the U.S. and Europe. In other words, they have experienced science in contexts where time can seem to progress into the future at a constant and predictable speed. This ethnography shows how these experiences and constructions of time influence which research questions and fields of study Mexican biomedical researchers ultimately decide to pursue.

INTRODUCTION

Real Time

The university laboratory had all the appearance of a publicly funded institution. The architectural design was resolutely utilitarian. Consideration for aesthetics was avoided, perhaps deliberately so. After several decades of use, there was a veil of opaqueness that draped the floors, fixtures, windows, and walls. Time had claimed the luster of all that was once new. Chairs and stools varied in size, shape, and color. Common household glass containers— some with remnants of labels that revealed clues as to their original contents— peppered the shelves serving as adequate substitutes for beakers and flasks. Frugality and improvisation were clearly the order of the day.

A biochemistry graduate student was sitting in a poorly lit corner of the laboratory. The weak amber glow from a single light bulb that hung from the ceiling by its cable failed to extend beyond a few inches. The majority of the light entered through a small window that was slightly open to allow for ventilation. With over a dozen graduate students using the laboratory that morning, she and two other students chose to work in this rectangular room, which was clearly intended for only one person. Indeed, I had seen similarly designed laboratories in Mexico where a comparable room was designated as the head researcher's office.

As soon as I sat down on the metal stool next to her, the graduate student silently and seamlessly switched tasks. With a few swift clicks on her laptop, she opened a PowerPoint presentation and went straight into a summary of her dissertation research. The head researcher felt this would be a mutually beneficial exercise. I would learn about each student's individual project and the students would have the chance to practice presenting their project. The graduate student had conducted an experiment on mice in order to identify genes that potentially play a role in cervical cancer. As she went through her methodology section, she made a point to emphasize that she had used a machine called real-time polymerase chain reaction[1] (PCR). She explained, "In the standard form of PCR, the results are available after the reaction is complete. With real-time PCR, the amplified DNA is detected as the reaction occurs in real time. That way we can start looking at the results immediately. We don't have to wait."

This laboratory, however, did not have a real-time PCR machine. The graduate student had been fortunate to have access to this rather expensive instrument, which can range from $20,000 to $150,000, as a result of a collaboration she had forged with researchers at the National Institute for Genomic Medicine (INMEGEN). Although INMEGEN is also a publicly funded research institution, it had been given a great deal of financial support from the federal government, which allowed for the purchase of more expensive equipment. Therefore, unlike the other students in her laboratory, this graduate student had access to a technology that allowed her to practice science in "real time." Mentioning it was a way for her to distinguish herself from her peers and to highlight her position on the cutting edge of biomedical research in Mexico. For this graduate student, "real time" is something that can be achieved through networking and access to technology.

For this graduate student, time only became "real" when she had access to a technology that others did not. What is also important is that she had access to a technology that others *did* have access to, only somewhere else. In other words, she was well aware that researchers in different places experience time differently. She also knew that even researchers in the same place, her own lab, experienced time differently because not everyone had access to the PCR machine. For her, "real" time meant not having to wait for the data yet she knew all too well that others *did* have to wait. She happened to be among those who were able to do science in "real" time yet she knew others were not practicing science in real time. Moreover, her privileged position in time contributed to her privileged position among her peers and in her field.

She was one among many biomedical researchers[2] I came to know during my fieldwork in Mexico City who emphasized their place in time and the role this played in their research and careers. As I followed Mexican biomedical researchers to laboratories, conferences, talks, and classrooms, constructions and experiences of time began to emerge as a central and constant theme. However, this became most striking when I started to interview very accomplished and prominent biomedical researchers in Mexico. These researchers had studied and worked at very privileged and prestigious universities in the U.S. and Europe and currently held important positions at universities, hospitals, and research institutes in Mexico. This past experience played a crucial role in the way they viewed science in Mexico.

For instance, after learning that Dr. Gerardo Muñoz[3] had spent two years as a biomedical researcher at a very privileged research institution in the U.S., I asked how he thought science in Mexico compared to science in the U.S. He said, "There is simply no comparison. Here in Mexico, most laboratories lack First-World equipment and technology. We are more limited in what we can do here." This differed markedly from another interlocutor, Dr. Andrés Minjarez, who had worked in the laboratory of a large, public university in the U.S. He said the experience had been "*muy bonito*" (very nice) because there was no noticeable difference in the level of training he had received in Mexico in comparison to the American researchers.

The highly accomplished and prominent biomedical researchers would highlight the material, technological, institutional, linguistic, and financial challenges they face when practicing science in Mexico. Laboratory materials can take two to six months to arrive, yet researchers have also learned to anticipate unexpected delays. Most laboratories lack the newest and more efficient laboratory equipment. Institutions frequently implement policies that directly affect researchers without giving proper notice. Mexican biomedical researchers are required to publish in English in the top journals in their fields, but they often report unfair rejections of their manuscripts due to their country of origin. They also purchase the majority of their materials and equipment in dollars, which makes scientific research vulnerable to peso devaluations. The multiple temporalities experienced by Mexican biomedical researchers at home and abroad produced particular views of the past, present, and future and of how time passes.

Far from being a metronome, for these prominent biomedical researchers, the tempo of time itself was irregular and varied tremendously. While its linearity was not questioned, time was often viewed as multiple and highly variable in its speed. These variations in the speed of time were often seen as an aberration to a "normal" flow of time. In this way, this ethnography explores moments when time does not move forward with the regularity of a metronome and why the idea of a "normal" time persists among Mexican biomedical researchers despite having experienced the former. It examines how these experiences and constructions of time affect scientific knowledge production and practices. Therefore, the central argument of this ethnography is that the myriad encounters between people, objects, languages, and ideas produce very particular notions and experiences of time and space that are central to understanding scientific knowledge production and practices.

Time and Temporalities

In her groundbreaking ethnography, *Beamtimes and Lifetimes*, Traweek described the profound and deeply felt tensions about time among high-energy physicists, which she argued were the result of the many conflicting kinds of time they experienced throughout their careers (Traweek 1988). There is a finite yet variable amount of time physicists can have access to the accelerator, or what she called beamtime, as well as to computers and other laboratory facilities, which are all needed to produce knowledge in the field of experimental particle physics. This state of affairs makes physicists view and experience time differently at different stages in their careers. In this way, access to technology necessary for scientific knowledge production means having an adequate amount of time to use a particular technology.

Moreover, the experience of time *and* space both play a crucial role in scientific knowledge production and practices. Shapin and Schaffer noted how the nascent laboratory, as a restricted public space, essentially created a science which was dependent on access to technology. They explained, "If one wanted to produce authenticated experimental knowledge – matters of fact—one had to come to this space and to work in it with others" (Shapin and Schaffer 1985:39). More importantly, one had to spend *time* with laboratory instruments, not just share space with others. For instance, Boyle had to spend time to get to know his air-pump in order to find out why it would often not work the way it was supposed to.

In many ways, the fulcrum of this ethnography can be characterized by what Munn has called "the problem of time" (Munn 1992). Time is both difficult to ignore in social experience and practice yet also difficult to examine on its own terms. One reason for this "problem" is the inextricable relationship between time and space, which Munn examined in her book, *The Fame of Gawa*. There she developed a notion of spacetime where time and space are viewed as the end products of social action (Munn 1986). This ethnography builds on this perspective of time and space and examines the implications this perspective has on scientific knowledge production and practices. It argues that constructions and experiences of time *and* space are crucial to understanding how science is envisioned, the kinds of research questions that are asked at particular moments, how research trends take shape, and how networks are formed. It argues that we are not merely “in” time but are actively constructing various kinds of time through the particular relations we form between ourselves, objects, ideas, and temporal reference points that often have a spatial dimension.

From a cultural relativist approach, temporal pluralism emerged, which argued for a multiplicity of cultural times. Each culture had its unique and equally valid way of understanding and experiencing time. However, the notion that one form of time exists outside of culture has persisted in anthropology. As Greenhouse stated, “Anthropological studies of social time have proceeded from the double assumption that linear time—“our” time—really is *our* time and really is *real*” (Greenhouse 1992:2). This has often led to whole cultures, including “Other” knowledges, which we have called “magic,” “superstition,” “traditions,” or “religion,” being described as existing in another time, namely the past. Indeed, Zhan has recently challenged this state of affairs by demonstrating how “what we have come to call ‘traditional Chinese medicine’ is made *through* – rather than prior to—various translocal encounters and from discrepant locations” (Zhan 2009:1).

This reflective critique that began with Fabian’s *Time and the Other* is in many ways still being worked out in anthropology. Fabian argued that there existed “a persistent and systematic tendency to place the referent(s) of anthropology in a Time other than the present of the producer of anthropological discourse,” which he called a denial of coevalness (Fabian 2002:31). Otto has recently argued that this is not as devastating to anthropology as it sounds. While conceding that temporal stereotypes can obstruct ethnographic understanding, he maintains that “the sharing of time in the present also reveals differences of temporal orientation co-existing in the present and reflecting different pasts” and therefore he argued that “in this sense people do live in different times while sharing the present” (Otto 2013:66).

What is crucial in Fabian's work is that the denial of coevalness did not necessarily occur during ethnographic fieldwork. Fabian underscored that there was a "schizogenic use of time" in anthropology. He explained, "The anthropologist in the field often employs conceptions of Time quite different from those that inform reports on his findings" (Fabian 2002:21). Consequently, "sharing the present" did not automatically and necessarily produce coevalness. In other words, the denial of coevalness often occurred later, in the future, during the writing of ethnography. In this way, the writing of ethnography not only produced representations of cultures (Clifford and Marcus 2010), it also produced a particular representation of time.

It is an important relativizing move to say that all people live in the present; we are all coeval. But, even though we are past the idea of isolated and pristine cultures as the object of anthropological investigation, this ethnography argues that this relativizing gesture has the potential to produce a pristine present, a taken-for-granted present that is often conflated with real time. For instance, in his article, Otto often used "the present" and "real time" interchangeably: "Since human action always—necessarily—happens in the present, anthropologists doing ethnographic fieldwork enter a real time interaction with coeval human beings" (Otto 2013:66). Even though we are aware that other people have different understandings and uses of time, the present continues to be seen as one kind of time that is *real*. Instead of thinking of the present as real time, there are benefits to seeing "a virtuality laden in the present, its possibilities for being otherwise, in other words, the unactualized latencies in any situation which could be, may have been, instrumental in the generation of the new or the unforeseen" (Grosz 2005:76-77). Viewing the present as filled with unactualized latencies and virtualities make the experience and the meaning of the present highly variable.

Temporal pluralism is based on a particular view of reality. As Strathern has argued, the idea of pluralism is "made possible by a modeling of nature that regards the world as naturally composed of entities—a multiplicity of individuals or classes or relationships" (Strathern 2005:xiv). It is a space and time that exists prior to being filled with these entities. In other words, the main problem is that reality is seen as *a priori* and a container of persons and things. In this ethnography, I argue that this view of the reality along with the view of persons and things as discrete entities allows for the conflation of reality and time, and, more specifically, of real time and the present. The feeling that we are "in" time and that we are "in" reality along with the belief that we cannot be in two places at the same time contributes to this conflation.

This ethnography argues that we should remain open to the possibility that the present is not fully shared. As Chakrabarty argued, we "need to learn to think of the present –the 'now' that we inhabit as we speak—as irreducibly not-one" (Chakrabarty 2000:249). Following Otto, this ethnography argues that "the sharing of the present does not mean that one shares the other actors' conceptualizations of past and future" (Otto 2013:66). However, it adds that this does not mean we share the other actors' conceptualization and experience of the present. Grosz described this peculiar aspect of time in the following way: the "double orientation of temporal movement—one force directed at the past, the other to the future—is a splitting of time, the generation of time's divided present, a present that is never fully present" (Grosz 2005:4). At any given moment, there are presents that we can share in some way while others will unavoidably elude us.

However, the denial of coevalness may, in some instances, not be as devastating as it sounds. For instance, when Evans-Pritchard argued that the Nuer did not have abstract time, but instead had "ecological time" and "structural time" it was not with the intention of placing the

Nuer in an inferior position in relation to the West. In his chapter, "On Ethnographic Allegory," Clifford argued that Evans-Pritchard, in a sense, found it refreshing that the Nuer did not see time in the same way he did. Clifford quotes Evans-Pritchard: "Events follow a logical order, but they are not controlled by an abstract system, there being no autonomous points of reference to which activities have to conform with precision. Nuer are fortunate." (Clifford and Marcus 2009:111). Clifford explained Evans-Pritchard's view of time among the Nuer in the following way:

> For a readership caught up in the post-Darwinian bourgeois experience of time—a linear, relentless progress leading nowhere certain and permitting no pause or cyclical return, the cultural islands out of time (or 'without history') described by many ethnographers have a persistent prelapsarian appeal" (Clifford and Marcus 1986:111).

In other words, the act of placing of the Other in another time through the writing of ethnography was often indicative of a desire of the anthropologist for an escape from time, for a time without time. The construction and experience of space and time can produce a myriad of affective responses. Indeed, the experience of time is saturated with affects such as fears, anxieties, and desires. I will also argue in this ethnography that affects are not only the effects of the experience of time, but also the cause for how we view and construct time in particular ways. These affects are significant enough that they can produce a longing for "a world outside of human space and time" (Traweek 1988:162); or what I describe as "a time of no time."

Affects and passions have long been central to knowledge production and practices. Daston and Park have shown how the history of science is not the triumph of rationality over passions and affects (Daston and Park 2001). They explained that science was not an autonomous field of inquiry. The project for finding natural causes for unexplained events and objects was “explicitly strategic, a way of dissolving the fear of divine wrath and the wonder of divine intervention in the course of nature and human affairs” (Daston and Park 2001:335-6). There was a real fear among natural philosophers in the seventeenth century, that the masses would be manipulated and mobilized against the state and crown (Daston and Park 2001; Hirschman 1997; Shapin and Schaffer 1985). According to Daston and Park naturalization and pleasure emerged as a means to diffuse the dangerous combination of fear and wonder. In this way, those passions and affects that were considered more benign were used to combat more dangerous ones.

It is crucial to note that affects and passions are not strictly “in” individuals. Richard and Rudnyckyj “conceive of affect not so much as an object circulating among subjects, but rather as a medium in which subjects circulate” (Richard and Rudnyckyj 2009:59). This ethnography argues that this medium is better characterized as a matrix of “unreal” time where time can flow backward or forward; where the past, present, and future can exist simultaneously; where the past can haunt the present *and* the future; where the future can partially exist in the present; where the present can be absent. These jarring experiences, when time does not move the way it is “supposed” to, produce affects that affect the way we construct notions of time and space in order to cope with this ostensible disorder. It argues that it is more productive to see ourselves as not existing in real time, but instead in a matrix of “unreal” time, which we draw from through experience to construct various notions of “real” time. Among these constructions is the potential for a reinforced belief in a universal, singular, and linear notion of time, which often seems “normal” in part because of linear narratives of modernity, capitalism and nationalism.

Indeed, linear time coupled with science and technology has tended to produce either positive narratives of progress or negative narratives of an apocalyptic future, or what Boellstorff has called "straight time" (Boellstorff 2007). Rather than focus on the rule, particularly in science and technology, that time moves forward at a constant and predictable speed, this ethnography focuses on the exceptions. It is an analytic similar to the one employed by Gibson-Graham in *The End of Capitalism (As We Knew It),* who proposed examining non-capitalistic activities in order to better understand the economy and the ways the economy is what we make it (Gibson-Graham 2006). This ethnography, in a sense, proposes the end of time (as we knew it). In examining the ways time does not flow in the way it is supposed to, we get a better sense of how time is actually time-in-the-making.

The ethnography does not take the term "real" for granted. Hacking has correctly noted that use of the word "real" can oftentimes be unproductive because it is circularly defined and has "undergone substantial mutations of sense and value" (Hacking 1996:23). I use it to highlight that constructions of time can be experienced or thought of as "real." For instance, in his studies of virtual worlds, Boellstorff chose to use "actual" to describe the offline world because virtual worlds can be experienced as very "real" by users (Boellstorff 2008). In other words, what is experienced as "real" can be located anywhere along the spectrum between the actual and the virtual. Moreover, I use the term "unreal" instead of alternatives like "virtual" to emphasize not only the definitions of "imaginary" and "illusory," but also "amazing;" something that causes great surprise and wonder. This ethnography proposes "unreal time," not as a way to describe or explain the world as it really is, but as a way to treat time as an object of wonder; something that can be everywhere and nowhere at the same time.

The title of this ethnography, "Turbulent Science," was selected in order to draw from everyday understandings of turbulence as well as scientific understandings of turbulence in fluid dynamics. This ethnography emphasizes that it is often moments of "turbulence" when time becomes “real,” just like being 30,000 feet in the air becomes “real” when you experience turbulence on a plane. As Grosz has argued, time only becomes thinkable “when we are jarred out of our immersion in its continuity” (Grosz 2004:5). It is those “jarring” moments of turbulence experienced by my interlocutors and, at times, myself that this ethnography examines and restages. It focuses on the moments when the flow of time is experienced and conceptualized as turbulent, which is often seen as an aberration to a “normal” flow of time. I am particularly fascinated by turbulence in fluid dynamics because, like time, it affects countless other things, yet has not been successfully described by any single, grand theory. As Lathrop explained, “...for all its ubiquity, scientists, engineers, and mathematicians have long struggled to understand the underlying nature of turbulence” (Lathrop 2006:36). Moreover, according to Benzi and Frisch, the understanding of turbulent flows in fluid dynamics remains a fundamental issue in modern physics[4] (Benzi and Frisch 2010). Turbulence is cause for bewilderment and wonder in fluid dynamics as well as the dynamics of time.

Although some anthropologists have cordoned off theorizations of time from such fields as physics and astronomy (Fabian 2002; Greenhouse 1992; Gell 2001), it is important to note that even our most scientific and technological attempt at achieving real time shows how time is constructed. For instance, there is an atomic clock located at the National Institute of Standards and Technology in Boulder, Colorado. This aluminum ion clock measures the oscillation between super cooled atoms in order to keep time within one second every 3.7 billion years. But even this extremely accurate form of telling time can very easily slip into the realm of “unreal time.” In fact, a 2010 experiment began with two ion clocks in perfect synchronization. One clock was raised a mere twelve inches higher than the other clock. The higher clock soon went out of sync with the lower clock. It beat just a tiny bit slower due to the differential impact of the gravitational force of the earth on the movement of atoms in both clocks.

Real time is not a given, but rather something that takes a great deal of effort to achieve and maintain. It is an incredibly fragile entity that can shatter at any moment to reveal the never-ending hall of mirrors that is the realm of "unreal time." As Grosz argued, "Time is perhaps the most enigmatic, the most paradoxical, elusive, and 'unreal' of any form of material existence" (Grosz 2004:4). Indeed, time is often viewed as a paradox in anthropology because it is something that is both universal and culturally constructed (Greenhouse 1992). According to Greenhouse, the universality of time cannot be denied because as biological beings we all age and we will all have to face our own mortality. Yet, when facing one's own mortality, time may seem to pass very quickly or time may seem to pass too slowly, during moments of pain, for example. Although the end of time is universal for humans, the speed of time is highly variable. The multiple speeds of time produce particular views of the past, present, and future.

Time is difficult to examine in isolation because it is embedded and is an essential part of some many other things. As Munn explained, "the topic of time frequently fragments into all the other dimensions and topics anthropologists deal with in the social world" (Munn 1992:93). This ethnography argues that time cannot be bracketed as one part of science, just as science cannot be bracketed from society, and just as science in Mexico cannot be bracketed from science elsewhere. Indeed, scholars have noted that there is a need to avoid limiting one's project in advance through use of geographical boundaries (Cohen 1998; Latour 2005; Zhan 2009). An emphasis on the multiple temporalities of science looks beyond traditional boundaries in the anthropology of science, such as nations and cultures, to ask whether it is theoretically productive to think of science as being located "in" Mexico or in any one place for that matter.

Just as Mexican scientists are not merely "in" time, they are working not only "in" the geographical space of Mexico but are also actively constructing and occupying other kinds of spaces including temporal, physical, discursive, imagined, and linguistic spaces. Following Moore, I use spatiality to refer to "the production of space, its discursive and material practices, as well as its cultural understandings" (Moore 2006:3). This, among other things, influences how Mexican biomedical researchers view their place in the international scientific community. In other words, understanding knowledge production and practices in Mexico is not simply about delineating the contours of a particular context and then describing its effect on science, but instead is about how continually constructed temporal and spatial contexts perpetually shape and are shaped by scientific knowledge and practices.

Local versus Global Science

This dissertation research project began with the realization that the majority of anthropological studies of science had taken place in highly developed countries such as the U.S., the Netherlands, France, and Japan. Moreover, as Zhan has noted, Laura Nader's call to "study up" led to a focus on science in the U.S. and Europe (Zhan 2009). I soon began to wonder how science in developing countries would compare to the science in the U.S. and Europe. It seemed possible that a strict focus on science in the U.S. and Europe had left many things unquestioned and unexamined about science. Indeed, as Latour noted, studying the Other created a conceptual divide between "modern" and "pre-modern" peoples, which has left lasting effects on anthropological knowledge production and practices (Latour 1993). This project aimed to examine whether studying science only in the developed world had produced other kinds of divides, which could be made evident through the study of science in a developing country.

After many years of regular travel to Mexico, I had become well aware of its long tradition of scientific investigation and its vibrant scientific community. Yet it was an announcement made by Mexican scientists at INMEGEN that made Mexico stand out as a possible field site for my dissertation research. On the afternoon of May 15, 2009, a news report on a Spanish language news station called Galavisión announced that *el genoma Mexicano* (The Mexican genome) had been discovered by scientists at INMEGEN. According to the report, the study revealed that the Mexican population is fundamentally a mixture of European and Amerindian genes. Upon analyzing the blood samples of the approximately one thousand Mexicans who participated in this project, the Mexican investigators claimed to have discovered that genetically speaking the "Mestizo Mexicano" and the indigenous people of Mexico are substantially different from Caucasians, Asians, and Africans. The main conclusion of this study is that the *mestizaje* (race mixing) of the last 500 years generated important differences in the Mexican population.

The news report then provided a short lesson in genetics complete with computer generated images of DNA, video clips of scientists in white lab coats, images of spreadsheets on computer monitors, and shots of ordinary people walking through the streets of Mexico City. The narrator explained that humans share 99.9 percent of our genomic sequence. However, the 0.1 percent remaining is not shared, and it is what makes each person different from everyone else. She continued, "Our individual characteristics like hair color, the shape of our face, and degree of risk or resistance to common diseases are located in that small percentage."

According to the news report, the map of the Mexican genome would be the first step towards the development of genomic medicine in Mexico, which was estimated to be implemented on a massive scale in five to ten years. "By then," the narrator addressed the Latino audience directly, “with only one sample of saliva or blood, your doctor will be able to detect genes that predispose you to common diseases like obesity, asthma, and cancer.” The INMEGEN director, Dr. Gerardo Jiménez Sánchez, assured the audience by stating, “In time, way ahead of time, way before the symptoms of the disease appear.” The narrator stated, “This discovery will revolutionize medicine in Mexico for, if it can be detected in time that the patient is susceptible to a disease, the patient can be given medication which will prevent or avoid the disease.”

The official presentation of the discovery of the Mexican genome took place at Los Pinos, which is the official residence of the Mexican President. The last frames of the news segment showed the head scientist pointing at a laptop screen with Mexican President Felipe Calderón standing next to him and listening attentively. The reporter ended the segment with a quote from President Calderón, “This is an important scientific project because it will reduce the cost of health care and it will permit the development of more effective medicines.”

During the report, I was immediately struck by how mestizaje was used to argue that the Mexican population would be ideal for genomic studies because I was aware that the exact opposite had been argued in Iceland (Fortun 2008). Iceland’s so-called homogenous population with little to no race mixing was said to make *it* ideal for genomic studies. I was also aware that mestizaje had been used in the U.S. to construct Mexicans as ideal subjects for diabetes genetic research (Montoya 2007). Based on this, I began to envision a research project that would examine the ways in which scientific knowledge production and practices in Mexico might be different from those of more developed countries. Moreover, the vast majority of social scientific research conducted on race and genetics has taken place in the United States (Abu El-Haj 2007). It appeared that conducting research on race and genetics in a country other than the United States would produce novel challenges and questions.

As my research progressed, the boundaries between nations became more and more blurred. Many Mexican scientists had been trained at universities in the U.S. and Europe. Many foreign scientists from the U.S. and Europe had held positions as professors in Mexico and participated in the training of many Mexican scientists. Many Mexican scientists had worked for extended periods of time as postdoctoral researchers, independent researchers, or professors in the U.S. and Europe. They often attended and presented at international conferences. Americans and Europeans were routinely invited to give talks at biomedical conferences in Mexico. The majority of Mexican biomedical researchers were highly proficient in English, which they described as the lingua franca of science. They read and published chapters in English in the same journals as American and European scientists. Also, American and European companies, such as Coca-Cola and Nestlé, sponsored events in collaboration with Mexican research institutions like INMEGEN. Researchers from American and European universities and institutes like MIT and the Broad Institute collaborated with Mexican researchers on projects and they often co-authored papers together. As a result, this ethnography argues that what scientists from developing countries do is not peripheral to a "global" science but is instead part and parcel of it. It aims to show how scientific research is both influenced by national boundaries while also rendering national boundaries, in many instances, irrelevant.

The "global" in global science tends to align with notions of a universal history where the particulars are obscured in favor of a more general account of the development of science. This perspective emphasizes a historiography originating in ancient Greece continuing with the Renaissance, the Scientific Revolution, and the Age of Enlightenment and culminating in the dispersal of scientific principles to the rest of the world through colonization by European powers. More importantly, global science tends to be seen as something that transcends all that is

Earthly. As Taussig argued that the "power of science itself comes from its ability to obscure its locality" (Taussig 2009). It is viewed as not being bounded to any particular place or time. Instead, it is free to travel along an uninterrupted trajectory toward progress. Indeed, scientists are often thought to be working independently of each other in places throughout the world within a time universally shared and experienced by all.

On the other hand, local science tends to be seen as deeply entrenched in a particular location. It is thought to be shaped by everything in its immediate surroundings: culture, language, religion, politics, etc. Scientists working in "local" contexts are often viewed as being temporally behind and peripheral to those scientists contributing to "global" science. As Latour argued, it is a view that "pre-modern" peoples are unable to separate science from society (Latour 1993). This ethnography attempts to use the specific case of genetics in Mexico to highlight the limitations of viewing science in terms of "local" versus "global" science.

In many ways, the distinction between "local" and "global" science is the result a linear account of modernity. According to Chakrabarty, one of the main problems with historicism is that it made "modernity or capitalism look not simply global but rather as something that became global *over time*, by originating in one place (Europe) and then spreading outside it" (Chakrabarty 2000:7). In this way, the development of genetics in Mexico did not develop in a single place and it is by no means a straightforward story of diffusion. However, it should not be assumed that the development of science in a particular country has been completely random or that a singular science exists. Scientists are connected to other scientists as well as ideas, knowledges, instruments, and objects, but not in uniform and predictable ways.

This ethnography attempts to demonstrate some of the ways these entanglements occur while never assuming them to be predetermined, permanent, stable, or complete. It aims to show

how these assemblages traverse the multiplicity of temporal and spatial realities that exist simultaneously, even though they are not necessarily definitively identifiable because these realities are not bounded, stable, or static. They move, shift, and blend in to each other continuously and in ways that cannot be predicted ahead of time. The goal is not to describe or explain them, but to restage them in different ways in the chapters that follow.

In science studies, there is a rich body of scholarship dedicated to understanding how various contexts affect science. One of the main ways in which these contexts have differed has been in terms of scale, namely the nation, institution, and even laboratory. This ethnography aims to build on this scholarship by examining the effect of temporality and spatiality on scientific knowledge production and practices. By emphasizing the significance of time and space, I propose a view of context that foregrounds its ephemeral, non-uniform, and unpredictable facets. It is a view of context as something that is continually being transformed by actors, objects, and spatiotemporal constructions among other things. This continual reinvention of context calibrates how concepts and ideas are defined and interpreted, including scientific knowledge and context itself (Helmreich 2009).

It is important to say upfront that this ethnography does not assert that Mexican biomedical researchers somehow exist in a time and place different from other groups of scientists, but rather that all scientists exist in multiple times and spaces, the realm of unreal time. The particular case of Mexico is used to make these multiple times and spaces evident. It is also not an exhaustive, encyclopedic account of the multiple spatiotemporal realities that exist among scientists in Mexico. It uses the unavoidably limited and partial spatiotemporal realities I was privy to during my fieldwork among biomedical researchers in Mexico to examine how these realities can play a role in scientific knowledge production and practices. These realities do not form a whole that can be represented in a single ethnography (Strathern 2004).

This ethnography argues that reality is multiple and that there are other times and spaces outside of our own taken-for-granted notions of times and spaces. Some of these times and spaces are shared by others. Some are not. This ethnography attempts to restage the temporal and spatiotemporal realities my interlocutors emphasized in interviews, publications, conference presentations, lectures, laboratory work, images, and social media to show how these multiple realities shape and are shaped by scientific knowledge production and practices.

Race in Genomic Science

Recently, there has been "a substantial increase in race-related biomedical research, which has been both lauded and critiqued" (Fujimura, Duster, and Rajagopalan 2008). In the years leading up to and just after the mapping of the human genome, Ellison and Jones demonstrate that the use of race and ethnicity in genetic research had already been on the rise (Ellison and Jones 2002). In fact, race/ethnicity is among the most commonly used variables in health research, and is of particular interest to researchers studying the genetic basis of variation in human health (Comstock et al. 2004; Dressler et al. 2005; Shanawani, Dame, Schwartz and Cook-Deegan 2006). There are many reasons for the use of race as a scientific category in genetic and medical research, which continue to demand our attention.

Prior to the shift to genomics, genetics research centered on identifying disease-causing genes inherited in the simple Mendelian fashion. Genetic tests were developed to inform individuals whether or not they possess the one or more genes that could potentially cause a disease in the future. Fortun emphasized that genomics is building "new zones of intensities, places in and between the laboratory, the corporation, the experimental assemblages, and the biochemical multiplicities of our bodies, where differences are created, become different from themselves, and recombine with other differences" (Fortun 2008). Santos demonstrated how genomics extends far beyond the biological dimension to become an arena for dispute in which historical, social, and political elements are present (Santos 2004). In this way, the shift from genetics to genomics offers many new challenges, including understanding the ways in which genetic knowledge reconfigures the concept of race and the context it inhabits.

One of the stated goals of genomic science research is to identify genetic variations that "cause" common complex diseases and to develop therapeutic interventions that will target those particular variations. In this context, one of the key reasons why race has once again become popular in genetic research is the shift from a focus on individuals and families to populations. Consequently, access to a "well-defined" population for a particular research program has become a central facet of genomics (Fortun 2008). This has produced a whole series of often contradictory arguments for why particular populations are better suited for genetic research.

In the case of Iceland, the population was promoted as ideal for genetic research of complex diseases because it was presented as genetically isolated and more genetically homogenous than most other industrial societies (Fortun 2008). However, Helmreich underscored the paradox that the direct opposite was claimed of the population of Hawai'i in order to promote it as ideal for genetic studies and clinical trials. Unlike Iceland, the population was not promoted as homogenous but, rather, as "a diverse human gene pool" (Helmreich 2009). Montoya has shown how populations are also considered "well-defined" in the gray area between "homogenous" and "diverse." He showed how, particularly in studies in the U.S., a "Mexican" population was one composed of those with a "pure" admixture (Montoya 2011). Mexican data was characterized by a specific percentage of "European," "Indigenous," and

"African" genetic material. In genomics, there is a great deal of variation on when populations are considered "well-defined."

Researchers have often made use of popular notions of national and racial categorization. In Mexico, INMEGEN has argued that the idea that the population is a unique mixture of European, Amerindian and African genes is being used to promote Mexico as an ideal country for the genetic analysis of complex diseases (Silva-Zolezzi et al. 2008; Seguin et al. 2008). Indeed, those engaged in the genetics of "admixed" groups often find it unproblematic that specific geographically defined groups can be "equated with broad socially designated race/ethnic groups" (Hunt and Megyesi 2008). Hunt and Megyesi showed how this logic is dependent upon several unsubstantiated assumptions, namely "that historically there were pure racial types associated with particular geographic locations; that migrations were sporadic and relatively rare; and that racial/ethnic groups are primarily endogamous" (Hunt and Megyesi 2008). This ethnography demonstrates how attempts to define the Mexican population as "mestizo" created a great deal of controversy in the media and in the scientific community in Mexico. In particular, it shows how the combination of "Mexican" with "mestizo" in the category "Mexican Mestizo" produced a great deal of uneasiness among biomedical researchers because of the ways these two terms articulated differently with such notions as the nation and the individual.

Epstein has emphasized how members of minority groups and minority group organizations have been some of the biggest supporters of race-based research (Epstein 2007). For instance, African American identified interest groups held a press conference to call for FDA approval of BiDil (Kahn 2008). Moreover, there has been an increase in minority physicians-scientists conducting race-based research. Fullwiley showed how these scientists claim that they "care for their own disproportionately sick communities of 'racially admixed groups' by recruiting and enrolling them in genetic research" and by lobbying to require the NIH to study minority populations (Fullwiley 2008). As Abu El-Haj has noted, "Medicine has met identity politics and out of that meeting point novel practices of both race and medicine have been borne" (Abu El Haj 2007).

Fullwiley finds it useful to talk of scientific social capital, rather than biocapital, in order to address the fact that "researchers who are part of, or who are affiliated with, the race-based research projects, are quite successfully publishing, building databases, and inspiring prolonged debates in major biomedical journals on their assertions that racial differences exist at the level of human genome biology" (Fullwiley 2008:5). For instance, some minority physician-scientists argue that the composite parts of racial admixture can yield clues about disease severity and health disparities (Burchard, et al. 2003). Consequently, Fullwiley emphasized the importance of gaining "a deeper understanding of the cultural contexts that make racialized genetics attractive to scientists who themselves claim racialized 'admixed' and 'minority' identities today" (Fullwiley 2008). This ethnography examines the role of minority scientists from prestigious research institutions in promoting race-based research in Mexico.

Some minority physician-scientists tend to draw from their own status as members of these minority groups to argue for their ability to tell the difference between various racial groups (Fullwiley 2008). The public may become convinced that a member from a minority group would be a safer, more trustworthy person to lead his community into research on biological difference (Fullwiley 2008). Indeed, Nelson has shown how the legitimacy of genetic genealogy testing is built on the "authentic expertise" of the scientist-entrepreneur, who is a member of the same minority group being targeted for the tests. In Mexico, these minority scientists use their social capital to establish relationships with biomedical researchers in Mexico. Mexican biomedical researchers also share many values and ideas about race and science with these minority scientists in the U.S. Both of which contribute to the continued use of race in genetics. This ethnography argues that it is also particular constructions and experiences of time and space among biomedical researchers in Mexico that play a significant role to the use of race in genetic research in Mexico.

Montoya analyzed the categories used by biological scientists and ultimately demonstrated the slippage in scientific research between the use of race as a pragmatic description and an attribution of qualities of DNA donors' bodies (Montoya 2007). Despite the good intentions of researchers to attempt to redress health disparities, scholars have shown how these researchers not only biologize race, they often pathologize it (Kahn 2008; Montoya 2007; Paradies et al. 2007). However, Paradies et al. note that it is important to recognize that "racialization is a sociocultural phenomenon and not a characteristic of individual scientific projects, much less individual scientists" (Paradies et al. 2007). Therefore, although identity politics may play a role in the use of race in medical and genetic research it is not necessarily used with those intentions.

With the AIMS technology, the complexity of how both geography and time have produced human variation is oversimplified, which makes the AIMS technology increasingly appealing to the wide range of lay, scientific, and law enforcement clients, who are currently using it for their respective purposes (Shriver and Kittles 2008). Essentially, with this technology, the complexity of the globe is flattened and time is collapsed into a world history that centers on the year 1492 with Columbus's arrival in Latin America. For instance, Burchard et al. assume European ancestry in Latin America originated in the Iberian Peninsula, where the population was extremely diverse prior to 1492 consisting of Iberians, Celts, Greeks, Romans, Sephardic Jews, Arabs, Gypsies, and other groups. These researchers argue that Columbus's ships were a sample of that diversity (Burchard et al. 2005). It is also assumed by Burchard et al. that the indigenous peoples prior to Columbus's arrival constituted a homogenous, single population. This ethnography argues that this overly simplistic story of the Conquest persists in Mexico because it is seen to run alongside linear accounts of modernity, capitalism, and nationalism.

Summary of Chapters

In Chapter One, entitled "La Raza Próxima: Language, Race, and Proximity in Genomic Science," examines the controversy surrounding the discovery the "Mexican genome" announced by INMEGEN. It shows how the term "Mexican mestizo" forced many in the scientific community and the general public in Mexico to reflect on what these terms actually meant, how they were different from each other, and what was being taken for granted. It also shows how the distance created between the Mexican genome and the human genome produced anxieties among Mexicans that they were somehow or in some ways not human. It argues that terms like Mexican and mestizo have multiple meanings and ontologies that make them link up to divergent concepts and ideas that also have multiple meanings and ontologies. Moreover, when terms like "race" and "biology," and "mestizo" and "Mexican," are put in close proximity, affects such as fears and anxieties are produced. This chapter deals with how those affects and meanings were managed by INMEGEN.

In Chapter Two, entitled "Trading Gold for Beads: Passions, Affects, and Temporality in Scientific Practice" argues that the story of the Conquest persists as a means to explain the status of science and technology in Mexico because it articulates with historicist accounts of modernity and capitalism which also go hand-in-hand with a particular construction of national identity. Experiences of time and the multiple financial disasters in Mexico have also produced affects such as melancholy that also run alongside these historicist accounts of modernity and capitalism. It also argues that when the future is inaccessible and the past keeps returning despite efforts to prevent them from reappearing, the present can produce a feeling of being absent from time. This absence affects the way science and technology are envisioned in Mexico.

In Chapter Three, entitled "Turbulent Waters: Temporality, Marginality, and Scientific Practice in Mexico," I argue that scientists are not merely "in" time, but are actively constructing multiple kinds of time, some of which have a spatial dimension. I argue that these multiple temporalities and spatialities not only have the potential to reinforce the idea of a singular, universal, and objective time, but they also can lead to a conflation of time and space and the idea that a "normal" temporality of science exists. This chapter also argues that science can be a race to construct and settle the future.

Chapter Four, entitled "Writing Genomes: Witnessing the Virtual Future of Genomic Medicine," examines how a particular view of the future is constructed in genomic science in Mexico. It argues that, in the genomic age, the technology of virtual witnessing has gone from future witnesses of the past to present witnesses of a virtual future. It is a future that exists *partially* in the present through such things as texts, images, and institutions. Biomedical researchers and students in Mexico are being asked to serve as witnesses of this virtual future and to contribute to its conversion to a completed future where genomic medicine will become a reality.

CHAPTER ONE

La Raza Próxima: Language, Race, and Proximity in Genomic Science

Introduction

As I walked across the gray marble floors of the National Institute for Genomic Medicine (INMEGEN), I looked up to admire the impressive barrel vault made of glass as I had on countless occasions during my fieldwork. This architectural element is an imposing display of how INMEGEN is unlike any other National Institute of Health in Mexico. An unprecedented amount of federal funds were used to construct this state-of-the-art research facility[5]. It is in many ways the Crystal Palace[6] of Mexico. It is a monument to progress and a national symbol of Mexico's modern status. Indeed, biomedical researchers in Mexico would frequently emphasize that the level of sophistication of the laboratory equipment and facilities at INMEGEN are a sign that Mexico is on a path to become a leader in genomic research.

The initial steps toward the creation of INMEGEN were taken in 2000 by a consortium of representatives from the Ministry of Health, the Mexican Health Foundation, the National Council for Science and Technology, and the National Autonomous University of Mexico. This consortium completed a feasibility study which indicated that developing genomic science in Mexico would lead to significant improvements in the diagnosis, treatment, and prevention of disease, and consequently lower healthcare costs. The consortium also claimed that building a national infrastructure of genomic science would contribute to economic development in Mexico. In a climate of optimism in the field of genetics in the years following the announcement of the completion of the map of the human genome, in 2004, INMEGEN became the first member of the Mexican National Institutes of Health to be created with the support of all political parties in the Mexican Congress. It was for this reason that the institute received substantial federal funds for research and for the construction of a new research facility.

The metal tubes that form the frame of the barrel vault are the same shade of lavender that colors the roof of the institute's main structure. The distinctive roof is difficult to overlook when driving down Periférico Sur, which is one of the principle avenues of this affluent part of Mexico City. As I approached the main auditorium, I turned to my left to view the curtain of trees that serves as a backdrop for a small garden. A white flagpole stands in front of the trees. I quickly noticed that the Mexican flag was not raised that day. In fact, it was the first time I had seen the flagpole without the flag. Green and red plants had been carefully planted into the soil in the shape of the INMEGEN logo, which was positioned in the center of a recently mowed lawn. The southern part of Mexico City is one of the few places where one can find enough vegetation to offset the dullness created by the gray concrete that dominates the city.

The INMEGEN logo is composed of a small segment of a spiraling double helix that forms an X, which represents the arms and legs of a human being. The top part of the X lacks the base pairs that form the rungs of the double helix while the bottom part retains several of them. A small circle positioned between the "arms" of the X gives the figure its head. The figure is almost completely encircled by a long string of genetic code written with the letters: A, C, G, and T. These letters are used in genetics to represent the four bases found in DNA: adenine, cytosine, guanine, and thymine.

On this day, I noticed that something was also different about the verdant logo. On earlier visits to INMEGEN, the letters of the genetic code had been made of regularly trimmed plants like the rest of the logo, but now the genetic code of the logo had been replaced with a man-made material that looked like plastic. The task of maintaining a representation onto an ever changing reality had presumably become unsustainable and impractical. The failed attempt to preserve a representation in constantly growing greenery highlights the unstable relationship between words and meaning. Meaning, like the greenery, proliferates despite our constant attempts to contain and stabilize it with words and categories.

Figure 1. INMEGEN logo outside of the institute in Mexico City. Photo by author.

This change in the logo and the missing Mexican flag was emblematic of what had occurred in the year following the declaration of the discovery of the Mexican genome. After widespread debates about the meaning and significance of a *Mexican* genome, there had been a complete retraction of the term by INMEGEN. The changes to the INMEGEN website were particularly noteworthy. By July of 2010, the INMEGEN website was completely redesigned and the term “the Map of the Mexican Genome” was replaced by “Map of the Genome of Mexican Populations.” It was an attempt to stop the proliferation of meaning that had been caused by the very public announcement of the discovery of the Mexican genome. This, together with other efforts by INMEGEN, eventually put an end to the debates and dimmed the spotlight that had been pointed so directly at the institute and its researchers.

The change from “the Map of the Mexican Genome” to “Map of the Genome of Mexican Populations” was subtle but important particularly because the term “Mexican mestizo” was still being used by INMEGEN researchers in their research, publications, and presentations. Although the term “Mexican genome” caused the initial debates especially in the media, during interviews with biomedical researchers it became clear that the term “Mexican mestizo” was also problematic to many in the scientific community. Both parts of the term “Mexican mestizo” were saturated with multiple meanings and nuances that often set the words at odds with each other. This made the combination of terms quite unsettling for many. This chapter focuses on when and where those multiple meanings and nuances appeared in order to discuss the role of language in genomic science.

* * *

In *We Have Never Been Modern*, Latour explained that the Gordian knot has been cut with a well-honed sword that parcels up the world into categories that produce hybrids the moment those categories are created (Latour 1992). If those categories are to maintain their boundaries and remain discrete entities, the proverbial sword can never be sheathed. The hybrids, or “remainder” as Strathern called it, must be constantly clipped away and obscured (Strathern 1991). Yet, like with the INMEGEN logo, eventually the task becomes too great and the artificiality of those categories becomes more and more evident.

For Latour, categories like nature and culture must be retied to remind us that we have never been able to definitively and completely separate nature from culture. Strathern has also demonstrated that the relationship between words like nature and culture are not universal (Strathern 1991). Whereas in English the relationship between nature and culture may clarify the meanings of both words, in other languages the words nature and culture gain their meaning through their relationship with other words, not with each other. Moreover, words are not mere vehicles of meaning to be defined strictly by their difference from other words. Language is not a closed, self-referential system. For example, when particular words are brought in close proximity to each other they produce particular affects such as fear that affect scientific knowledge production and practices.

Building on Saussure's idea that the relationship between sign and world is arbitrary, Derrida argued that knowledge is an artifact of language and as arbitrary as language itself since we can only know the world in terms of its meaning for us (Derrida 1998). However, as Maurer noted, we must now go beyond representation's arbitrariness and instead focus on the myriad ways representations in practice always fail (Maurer 2006). Indeed, Keane has shown how the "three interlocking aspects of Saussure's model of the sign continue to haunt both post-structuralism and the arguments of many of its critics: the distinction between signs and the world, the doctrine of arbitrariness, and the system of differences" (Keane 2003:411-412). There is a performativity and a materiality to language missing from Saussurean semiotics (Keane 2003; Munn 1986; Siegel 2006). Moreover, as Hacking has noted, "Classifications do not exist in the empty space of language but in institutions, practices, and material interaction with things and other people" (Hacking 1999:31). As a result, this chapter will discuss the various ontologies of the term "Mexican mestizo" including its materiality as well as its multiple ontologies in institutions, practices, and language.

The failure of representations is the result of the proliferation of meaning as well as the proliferation of the ontologies of that which is being represented. Proliferation is certain, but not infinite. As Mol argued, objects are more than one but less than many (Mol 2002). An object possesses no single essence nor can an object be absolutely anything. An object possesses qualities that limit its possible ontologies (Munn 1986). Objects and subjects are better characterized as having "a radiality without a center" (Maurer 2006:19). Yet, there is "a habit of treating named entities as fixed entities opposed to one another by a stable internal architecture and external boundaries, which interferes with our ability to understand their mutual encounter and confrontation" (Wolf 1982:7). These encounters and confrontations cause named entities to shift from various states of fixity to states of flexibility. If we are to understand this complex process, we must possess "a modest willingness to live, to know, and to practice in the complexities of tensions" (Law 1999:12). Fortun uses the figure of the chiasmus in his book, *Promising Genomics,* to "mark the spot where two distinct concepts can't be distinguished from each other, but feed off each other, send silent coded messages between themselves, and set possibilities in motion" (Fortun 2008:15). In this chapter, the category of "Mexican mestizo" is this kind of chiasmus, although it also interacts and exchanges information with various other things that contribute to the production of its multiple ontologies and meanings.

La Raza *Próxima*

In August 2010, an interdisciplinary conference was held at UNAM's Institute of Philosophical Investigations with the goal of bringing together both biomedical researchers and social scientists to discuss the implications of recent claims made about the genetics of mestizo populations in Latin America. Dr. Guillermo Hurtado, director of the institute, welcomed the packed room of about 100 people with some reflections on the significance of this conference in relation to the bicentennial anniversary of Mexican Independence from Spain, which was less than a month away. He began by emphasizing how mestizaje is fundamental to Mexico. He underscored that it was Miguel Hidalgo, a crucial figure in the war for independence, who had declared two hundred years ago that all Mexicans were the same. *Todos somos mestizos* (We are all mestizos). It was a statement intended to undermine the *casta* (caste) system that had existed in Mexico for centuries. It was the basis for a national narrative that would construct Mexico as the Mestizo Nation.

The casta system in Mexico attempted to create a stratified society based on the amount of Spanish blood each person possessed. The more Spanish one was or could prove to be, the more privilege one enjoyed. For instance, in some places, only those of "pure" Spanish blood could hold public office (Nutini and Isaac 2009). Although it is often described as a classification of races based on biology, it was actually far more complex. For example, the term "mestizo" was originally used to describe the children of Spanish men and Indian women who were not married in the Catholic Church. In other words, the term "mestizo" referred not only to the biological mixing of "races" but also to highlight the fact that the child was born out of wedlock. Therefore, the term was less about biology and more about religious ideology (Martinez 2008). Moreover, what mestizo meant and what impact it would have on one's life varied a great deal from place to place in Mexico and varied tremendously over the three centuries the casta system was in place.

However, by the 1800s, Hidalgo witnessed firsthand how "Indians" were being exploited and disenfranchised by those in power. For Hidalgo, the term "mestizo" could be used to subvert the casta system and to promote a more egalitarian society. It was Hidalgo who is attributed with starting the war for independence in the town of Dolores. He famously rang the bell of the town's church and rallied the people to fight for their independence from Spain. To commemorate this event, every year at midnight on September 16, the current Mexican President stands on the main balcony of *el Palacio Nacional* (The National Palace) just below the actual bell rung by Hidalgo, and in front of tens of thousands of spectators he performs what is known as “El Grito” (the Rallying Cry). The National Palace refers to the government buildings constructed on top of the ruins of the Aztec capital of Tenochtitlan in Mexico City. Ruins of an Aztec temple that were excavated and reconstructed are just a few feet away from the National Palace. Visitors to *el Museo del Templo Mayor* (Museum of the Main Temple) walk through the ruins just before entering the multistory museum that houses a spectacular collection of pre-Columbian artifacts. Just walking through el Zócalo (main plaza) in Mexico City with its pre-Colombian structures, colonial era church, and government buildings, one can almost feel time passing under one’s feet.

The National Palace houses some of the most well-known murals painted by Mexican muralist, Diego Rivera. In fact, the conference at UNAM used an image from these murals along with a colorful image of a microarray to adorn the program for the conference. In the image, a “nuclear family” is walking through a marketplace soon after the Conquest. A “Spaniard” stands in front of his “Indian” “wife.” She is looking down with her face partially covered by her “husband’s” shoulder. She is holding an infant on her back using a *rebozo*, a shawl used as a sling. The infant’s skin is lighter than his mother’s but darker than his father’s and he has dazzling blue eyes. That blue-eyed baby with light brown skin is but one of thousands of figures painted by Rivera on the walls of the National Palace, but this child has often been used to represent the mestizaje of Mexico.

Figure 2. Image used on the program for the UNAM conference.

As I continued to listen to Dr. Hurtado give his welcome address, I noticed the coat of arms of UNAM beautifully carved into a wooden plaque which hung on the wall directly behind the podium where he was standing. In the center there is a shield with a map of Latin America, which is surrounded by the words “Por Mi Raza Hablará el Espiritú” or “For my race, the spirit will speak.” It was a motto chosen by José Vasconcelos, the author of *La Raza Cósmica*. Published in 1925, the book argued that the intermixing that has been taking place between the different races in Mexico since the Conquest is the direction in which the world is headed. With advances in such things as transportation systems, increased racial mixing is inevitable making racial purity a thing of the past. Moreover, he argued in his book that racial intermixing and cosmopolitanism have produced times of great cultural effervescence and progress throughout world history while racial purity and isolationism have had negative impacts.

When I would tell social scientists in the U.S. about the Mexican genome, the first thing they would say was "La Raza Cósmica" as if there were an obvious causal relationship between the two or that they were the same thing. One social scientist even told me, "Yeah, I just read an article that explained how the mitochondrial DNA of Mexicans was found to have more indigenous genes. I don't see why they need genetics to prove that. Everyone knows that the Spanish conquistadors had to marry the Indigenous women." Moreover when, for instance, I would ask my interlocutors in Mexico what they thought the UNAM motto and La Raza Cósmica meant, they invariably struggled to explain either one. For many, it meant pride in being Mexican. For others, it promotes the ideas of brotherhood and solidarity. Still others would shrug their shoulders and admit they did not know or that they had never thought about it. Although they knew Vasconcelos had written the book and that the motto had something to do with the book, they would admit they had never actually read it.

For example, one day I walked with two graduate students through *Cuidad Universitaria* (University City) known in Mexico as CU, which is the main campus of UNAM located in the southern part of Mexico City. I had conducted an interview in the morning and I had arranged to meet the graduate students to see the display of altars and art made by students for the Day of the Dead in front of the Main Library. One display had a poster in black and white of the UNAM coat of arms. I asked, "What does the motto mean exactly?" They both fell silent for several seconds and looked at the ground as we continued to walk over the stone tiles and grass. Francisco said, "Well, I think it means that we should be proud to be Mexican and to have pride in our university. And that we have a responsibility to improve ourselves through education so we can make Mexico advance as a country." Marta responded, "I think it just means being proud of being Mexican. I don't know. I really haven't given it much thought but I know I have a very special feeling of attachment to this school. I think it also has to do with that."

Therefore, although mestizaje is literally written on the walls everywhere in Mexico when it comes to the Mexican genome, the writing was not necessarily on the wall, so to speak. It had to do with La Raza Cósmica and it didn't. It had to do with the Mestizo Nation and it didn't. Moreover, La Raza Cósmica and the Mestizo Nation are not stable ideas that can be copied and pasted on to other things. They meant different things to different people. They have meant different things and have been different things across space and time. Although the Mexican genome sounded like La Raza Cósmica, they were not the same thing. When one looks closely enough, sameness can be just as complex as difference (Hayden 2007). There is a kind of volatile space the concepts of the Mexican genome and La Raza Cósmica share. They are close enough to each other that they share and exchange information, but they are not identical or interchangeable terms. They are also proximate to other things that are sharing and exchanging with other things.

The title of this chapter, La Raza *Próxima*, highlights Vasconcelos's idea that the mixed race of Mexico would be the *next* race, the race of the future[7], but also underscores how the proximity of words and concepts matter. Proximity is often given enough importance to be a basis for causality as with the social scientists just mentioned, who found La Raza Cósmica to be what caused the idea of Mexican genome to make sense. Moreover, what came first is often thought to be the cause of what came next. In chapter 3, I will show how particular constructions of the future can affect the present, just as much as the past does. The more one tries to find the definitive boundary between words and concepts, the more blurry the boundary becomes and the more phantom-like the words and concepts become. It all becomes a mist of uncertainty and ambiguity, a space where things are more than one, but less than many.

Race is a term that creates and occupies a particularly vexed space. Peter Wade[8], a social anthropologist from the University of Manchester, attempted to show this in his talk at the UNAM conference. He stated that the uses of race in the field of biology appear dangerous because of the history of Nazism and eugenics. Indeed, Taussig has shown how this particular history affects the way people interpret genetic knowledge (Taussig 2009). Duster has shown how eugenics has the potential to occur again, but not necessarily in the same form it did in the past (Duster 2003). There is concern among social scientists that racism will increase if race is seen as biological or natural, rather than cultural. Moreover, as Montoya has shown, genetic research based on racial categories not only biologizes ethnicity but can also come to pathologize it (Montoya 2011). Wade explained that he is interested in understanding how scientists use racial categories when studying human diversity. He made a point to say that use of racial terms by geneticists is not inherently bad, but that race and biology are simply "a condemned pair."

This image of a condemned pair caught my attention. It is not just race by itself that is emotionally charged. When race starts to approach biology, there is a fear, especially among social scientists, that terrible things will happen. Race and biology combined will produce a sort of singularity that possesses such a powerful gravitational force that there is a possibility it might pull racism, Nazism, and eugenics towards it. To the geneticists who use racial categories in their research that fear appears to be a sign that the social scientists are calling the geneticists racist. Indeed, throughout Wade's talk, I noticed a man sitting just behind me, fidgeting and grimacing. Others noticed as well, for the frequent shifting in his seat was audible to almost everyone in the room. When Wade finished his talk, rather than applaud like the rest of those present, this man's hand shot straight up. He introduced himself as a molecular biologist. He asked in a rather combative tone, "What is race? If you were a geneticist studying human diversity with limited resources, how would you do it?" Wade explained that race is a discourse that has to do with inheritance of particular differences that were considered significant during colonialism. He said he would focus on the frequency of alleles, rather than on race even though he knows you cannot sequence everything. He attempted to explain the problem with the AIMS technology when the molecular biologist interrupted him saying, "Those genetic markers do not indicate race." Indeed, Montoya has shown how geneticists who use racial categories often do not believe race to be a biological reality (Montoya 2011). Race, for this molecular biologist, is used pragmatically because of the limited resources Mexican biomedical researchers have available to them, which I will discuss further in chapter 3. Montoya has also shown how geneticists will often use race pragmatically in the U.S. (Montoya 2011).

Wade said, "I think it is very important to emphasize that although science tries to separate itself from society, it is not impermeable." The molecular biologist insisted that he does not use race in the way Wade was discussing it. Wade, however, aimed to highlight that although the scientists do not think it is race, once scientific claims that use racial categories get out into society people might interpret the claims to mean that race as biological. The molecular biologist insisted that the Mexican genome project was based on bad science. In this way, he took exception that Wade was calling the Mexican genome project science. For him, a science that promotes racist ideas, which is what he felt the project did, is not a science at all. Therefore, this molecular biologist felt that when science approaches racist ideas, it ceases to be science. Some of my interlocutors felt passionately that once people in Mexico understand that they all carry indigenous genes in their DNA it might actually help promote better treatment of the indigenous peoples and lead to a more democratic society. For instance, Dr. Guillermo Gonzalez, a Mexican biomedical researcher who was in Mexico to give a talk, but was currently a researcher in the U.S. said during an interview, “Look, I don’t know if you know but in Mexico, the indigenous people are discriminated against and treated badly. But I think that if people would see how much of their own DNA is indigenous, they would stop seeing the indigenous people as different. If they see that we (Mexicans) are all basically the same, we could build a better and more just society.” In other words, race and biology are not a condemned pair. Biology could be used to reduce racism.

Despite the attempt to encourage discussion between social scientists and biological scientists, they seemed to be talking past each other because of the vexed space race occupies. Each person understood race, biology, science, and racism differently and associated them differently. For the social scientist, race and biology together produced a fear of increased racism. For the molecular biologist, racism and science together produced anger that he was being called racist by the social scientist. In this way, it was not just meaning that mattered nor the way the words were said, but how the words produced divergent affects for different people when put in close proximity to each other.

Mexican Mestizo

Throughout the 1990s, two groups, one private and one public, were engaged in a highly publicized race to map the human genome. By June 2000, the two groups decided to declare the race a tie. On June 26, at a media event held in the East Room of the White House and in the presence of President Bill Clinton, Dr. Francis Collins of the public consortium and Dr. J. Craig Venter of Celera presented their results together and announced that the human genome had been sequenced. Dr. Venter ended his statement with the words “I’m happy that today the only race we are talking about is the human race." This particular race in science led to an emphasis on the category of human, but the race to find applications for the new information and new technologies that emerged during the race to map the human genome ironically led to a renewed interest in racial categories. I will return to this notion of science as a race in chapter 3 where I will demonstrate how the speed of science is based on and produces very particular notions of time and space that, among other things, contribute to the continued use of the concept of race in biomedical research.

Although researchers in both the private and public groups had made a point to state that race was no longer a valid scientific category (Fullwiley 2008), many biomedical researchers felt this statement had been premature. They continued to argue that there is significant biological variation between different racial and ethnic groups especially in regard to disease susceptibility and drug response and that knowledge of these differences would be useful for medical diagnosis and treatment which would also address health inequities (Risch et al. 2002; Burchard et al. 2003). At the very least, some researchers argued, race/ethnicity provides a useful proxy for the unspecified combination of environmental, behavioral, and genetic factors until a better understanding of genetic human variation is obtained (Burchard, et al. 2003; Collins 2004; Jorde and Wooding 2004; Mountain and Risch 2004).

Other researchers maintain that race is a social construct without a biological basis, pointing out that there is more genetic difference within groups than between them and that race/ethnicity in medical research has limited utility, and produces arbitrary results (Braun 2004; Goodman 2000; Keita et al. 2004). Moreover, critics of race-based research have argued that the search for genetic contributions to racially stratified health outcomes may distract clinicians and public health officials from more pressing and significant social causes and more effective social interventions to redress these health inequities (Cooper et al. 2003; Epstein 2007; Montoya 2011; Ossorio and Duster 2005).

In fact, Fullwiley argued that, with the mapping of the human genome and the rise of genomics, the race concept has been imbued with new degree of "naturalness." She explained that this happened in part because the 0.1% of genetic difference in humans' three billion base pairs translates to 30 million genomic sites of change, which, analyzed alone or taken together as haplotypes, are now the primary units of comparative genomics, and the focus of much pharmacogenetics (Fullwiley 2007). That 0.1% became the focus of genomic research at INMEGEN, which was analyzed with a technology called ancestry informative markers (AIMS). AIMS is a digital database of human polymorphisms presented as geographical clusters. Fullwiley has shown how many geneticists pursue questions of disease severity and racial difference while attempting to link the two at the level of the genome through AIMS (Fullwiley 2008). This is what INMEGEN biomedical researchers attempted to accomplish when they conducted the analysis of the genomic diversity of samples taken from Mexicans from different geographical regions in Mexico.

The article entitled "Analysis of Genomic Diversity in Mexican Mestizo Populations to Develop Genomic Medicine in Mexico," which was co-authored by sixteen Mexican biomedical researchers from INMEGEN, was published in English in *The Proceedings of the National Academy of Sciences*. When it was presented to the Mexican President with great fanfare that same month as described in the introduction of this ethnography, many in Mexico began expressing concerns and raising questions, especially in the scientific community, the media, and on online social networking sites. Biomedical researchers also engaged in lively discussions about the INMEGEN study at many conferences I attended. Many articles were published in popular magazines and newspapers like *La Jornada* and *El Universal*. There were discussions on Facebook, Twitter, and blogs. The debates that ensued centered on what was meant by the term "Mexican mestizo" and the notion of a *Mexican* genome. Many wanted to know what they meant and what the implications such a study would have on the Mexican population.

For example, just two days after the announcement of the discovery of the Mexican genome, Dr. David Romero, Director of the Center for Genomic Sciences at UNAM was quoted in an article in *La Jornada* calling the term "mestizo" semi-racist and that it should not be used in scientific inquiry. Several people commented on the online article. One agreed and could not believe a term invented in the colonial era in Mexico was being used by scientists. Another wondered what benefit there would be in treating Mexicans as if they were a separate species. Moreover, she saw the scientific use of mestizo as a means of the government to promote nationalistic goals and to distract the population from corruption, violence, and poverty. Another said the term "mestizo" is only perceived as racist by those Mexicans who aim to deny their indigenous roots and he called them Malinchistas[9]. Another wondered why the researchers at INMEGEN had insisted on calling it "the Mexican genome" and not "the genome of the populations that exist in Mexican territory." This commentator also felt the term "mestizo" was racist because of its use during the colonial era in the casta system.

There were many questions: Is the term "mestizo" a scientific fact or is it socially constructed? Is the term "mestizo" racist or does it produce a sense of solidarity (as with the UNAM motto)? Does the existence of a Mexican genome mean that Mexicans are somehow different from the rest of humanity? Why did the Mexican President make such a big deal about this scientific article? Was the Mexican genome just a means of distracting the populace from other things like the ongoing drug war that was claiming lives daily?

During interviews, my interlocutors expressed many doubts about the scientific validity of the INMEGEN study. Most of my interlocutors emphasized that the three hundred blood samples taken from students at a private university in Mexico City[10] could not possibly be used to describe the genetic diversity of all 110 million Mexicans. For instance, Dr. Fabian Savedra, who holds an important position at one of the National Institutes of Health, felt that the genetic differences between the many distinct populations from different regions and states of Mexico were not taken into account. He said, "Mexico is a mosaic of genetic diversity. You cannot just take samples from few hundred people in Mexico City and think that will encompass all of the diversity of the country." There were several reasons the three hundred samples were considered insufficient to categorize all Mexicans.

First, it was not clear how genetically "mixed" the participants were. My interlocutors argued that there was no information[11] provided in the article about the parents and grandparents of the participants so, although it was clear the participants were Mexican because they were born in Mexico, it was not clear if they were "Mexican mestizo." Some of my interlocutors stated that the researchers should have determined if each participant had parents and grandparents that were not from a "homogenous" group like an indigenous population[12]. In other words, the ancestors of these participants should have been "mixed" which is, of course, based on the assumption that there are groups that are not mixed in Mexico, such as "isolated" groups that are Mexican but not mestizo.

Second, the participants were from Central Mexico, namely Mexico City, which, from the perspective of my interlocutors in Mexico, is a genetically distinct population when compared to other populations in Mexico. Dr. Federica Rosario, an accomplished geneticist and researcher explained, "In Mexico, we have a particular history that contributed to different regions of genetic diversity. The North, the South, the Western Coast and Central Mexico are all very different genetically." In fact, the INMEGEN study was called the "*El Genoma Chilango*" (The Chilango Genome) in the Mexican media because of this perceived bias of only using samples from participants from Mexico City. "Chilango[13]" is a colloquialism (often used pejoratively) that refers to people from Mexico City. Third, the participants were students at private universities, which my interlocutors took to be an indicator of a higher socioeconomic status because these universities can be quite expensive. There is also a general assumption that these students are less "mixed" because they are assumed to be wealthy and therefore by implication more "white." Some interlocutors stated that getting samples from students at a public university, like UNAM, would have been better because there are students from all over Mexico and from all socioeconomic levels. Dr. Juan Pablo Mercado, a biomedical researcher at a research hospital in Mexico City said, "I do not know why they did not get samples at UNAM. It would have been a far better reflection of the diversity of the Mexican population because there is a little bit of everything there."

Dr. Martín Padilla, the head researcher of a genetics lab in Mexico, was particularly detailed in explaining the problematic use of the category "Mexican mestizo" in the INMEGEN study. He stated that Mexicans from central Mexico, where the samples were taken, would be very different from Mexicans from other regions of Mexico. One example given was that along the coast of the states of Guerrero and Oaxaca there are populations that are almost completely "African." He argued that the higher rates of sickle cell anemia in this population when compared to Africa was evidence that this population was clearly "African[14]."

Yet, because they were born in Mexico one cannot say that they are not Mexican. However, according to him, they are clearly not "Mexican mestizo." He explained that there are other "isolated" and homogenous populations like the indigenous populations that cannot be considered mestizo even though they are Mexican. Other "isolated" groups like the "Chinese" and "Mennonite" communities in Mexico are technically Mexican because members were born in Mexico. But they could not be considered "Mexican mestizos." Therefore, according to this interlocutor, to be labeled "Mexican mestizo" one had to be more "mixed." By definition, a "Mexican mestizo" possesses a particular mix of "Caucasian," "Indigenous," and "African" genes. Montoya noted that by 1991, the admixture estimates had been refined to 31% Native American derived, 61% Spanish and 8% African (Montoya 2011:144). This notion of admixture has often been accepted and used by Latino intellectuals (Anzaldúa 1987; Velez- Ibáñez 1996). I will discuss the role identity plays in how scientific networks are created in chapter 5.

Dr. Luisa Cervantes, who is a prominent geneticist and has held important positions in professional associations in Mexico, explained how she tries to get around this problem when she conducts studies based on population genetics. When she uses the category of "Mexican mestizo" she chooses participants whose four grandparents are Mexican. As a result, there must be three generations of Mexicans to be considered "Mexican mestizo" in her studies. However, she made clear that even that criterion was problematic. She gave the following example:

> There are also those that are not really "Mexican mestizo" even when they are born here. Like my friend's daughter has maternal grandparents that are Spaniards and her paternal grandfather is also a Spaniard while her paternal grandmother is from Cuba. Even though her daughter was born in Mexico she is clearly not "Mexican mestizo."

Furthermore, she explained that her friend's daughter is going to marry a man whose parents are Swiss and Spanish so even her kids, who will be third- generation Mexican, would really not be "Mexican mestizo."

The term “Mexican mestizo” was used in the INMEGEN study with the intention of distinguishing mestizos in Mexico from mestizos in other Latin American countries, which would demonstrate to other Latin American countries the possibility and benefit of knowing the genetic diversity of their own populations, a possibility this new state-of-the-art facility could transform into a reality. In fact, the INMEGEN article states that “the Mexican Genome Diversity Project will contribute to the development of genomic medicine in Mexico and the rest of Latin America” (Silva-Zolezzi et al 2009:8611). [15]It was important to show how Mexican DNA was different. As Montoya has shown, in these kinds of genomic studies, a “pure” Mexican is one with a “pure” admixture (Montoya 2011). In other words, Mexicans are presented as having a specific amount of Indigenous, European, and African genes while people from other Latin American countries would have different amounts of each.

However, the term “Mexican mestizo” is rather peculiar to many in Mexico because it is essentially a “hybrid of a hybrid.” The term “mestizo” has historically been used to refer to the “hybrid” offspring of a European and an Indian usually male and female respectively.[16] To combine “Mexican” to “mestizo” creates another level of “hybridity.” Both terms articulate differently with notions of the nation, national identity, citizenship, the individual, and the collective. For many in Mexico, it was difficult to explain exactly why it was inappropriate to apply the category of “Mexican mestizo” across the entire population because of the complex ways the terms interconnected with other terms.

A problem with the term “Mexican mestizo” is that it is in some crucial ways redundant. Both terms refer to a kind of political and legal status of the citizen. Use of the term “mestizo” for all Mexicans underscored that race would not be the basis for access to social services in Mexico. All citizens of Mexico would be equal under the law. This declaration articulated both terms “Mexican” and “mestizo” to citizenship. Both terms, however, relate very differently to the concept of the individual. Individuals in Mexico do not commonly use the term “mestizo” to describe themselves unless they are faced with a question of whether they are European, Indian, African, or mestizo. In fact, it was not clear on the INMEGEN study how the participants “self-identified” as mestizo. Individuals in Mexico tend to refer to themselves first and foremost as Mexican while still believing that as a nation, as a group, *they* are mestizo. In my scores of interviews and conversations with biomedical researchers and graduate students, they would invariably only accept being mestizo after being confronted with the fact that they believed Mexico to be a nation of mestizos and that it logically followed that each person must be mestizo as well.

Use of the term by geneticists seems to attempt to merge two separate foundations for citizenship. A person can be Mexican if his or her parents are Mexican and that person was born in Mexico. As a result, in order to properly use the label “Mexican mestizo,” the subject’s parents and grandparents had to be born in Mexico *and* be mestizo themselves. If “mestizo” means that the parents and grandparents have the right combination of Caucasian, Indian, and African genes, then it would follow that their DNA would need to be tested to determine if in fact they are mestizo. But, as that is not considered practical, the geneticists choose to see no difference between whether they are Mexican because they were born in Mexico or because their relatives were born in Mexico. They pragmatically assume that if you and your ancestors have lived in Mexico for three generations then you are probably “mixed” enough to be labeled “Mexican mestizo.” In this way, “Mexican mestizo” articulates with a concept of the nation as a bounded territory where a dominant culture exists. “Mexican mestizo” seems to be something that is achieved as if through acculturation, rather than genetic “intermixing.”

This practice, however, has limited applications because the geneticists insist that there are “isolated” groups where the participants would be technically third-generation Mexican, but not “Mexican mestizo.” Another problem with the category of “Mexican mestizo” is that it is an ostensibly self-evident category that on closer inspection is far from self-evident. The meaning and implications of the use of the term in the INMEGEN study proliferated so rapidly in so many directions that even the critics found it difficult to explain why the term was used inappropriately by INMEGEN biomedical researchers. Those interlocutors who were critical of the INMEGEN study stated that the sampling method and generalizations were wrong, but struggled to explain exactly why they were wrong.

Many critics, especially in the media, were concerned that the geneticists were saying that Mexicans were somehow different from the rest of humanity. Many in Mexico wondered whether Mexicans with their “Mexican” genome were somehow fundamentally distinct from the human genome. The distance created between the human genome and the Mexican genome ushered in deep anxieties about being scientifically othered in this way. Were Mexicans not normal? As Taussig noted, “The Human Genome Project aimed to produce a representation, in the form of a map, of a single, archetypically normal human genome” (Taussig 2009:10).

Many within the scientific community, especially those interviewed in national newspapers, labeled the INMEGEN study “racist.” For others, who were less critical of the science, it raised a lot of troubling questions: If Mexicans are genetically different from the rest of humanity, how are they different? Are they somehow not human? Are Mexicans a certain way because of their distinct genetic code? The term “Mexican” appeared to have been disconnected from the category of human. INMEGEN made an attempt to assuage these fears and reconnect what the announcement of the discovery of the Mexican genome had disconnected by sponsoring an exhibit at the children's museum in Mexico City. The next section of this chapter discusses the significance of that exhibit.

Becoming Human, Again

The large white canopy in the patio area of *El Papalote* (The Kite) children's museum in Mexico City gives the impression that it is made of a thick canvas material, which has been stretched tightly, but upon closer inspection one can see that it is made of some more permanent material. From a distance, I found the illusion of a tarp quite clever for a place reserved for temporary exhibits while also being very practical for a city where shelter from the rain is often needed, particularly in the summer months.

In the center of the patio, a large display board stood at approximately six feet with a width of about seven feet. It had been divided into three equal vertical rectangles. The center panel posed the question: "*¿Puedes hacer churrito con la lengua*?" (Can you roll your tongue?). In the center of that panel, a circular color image shows a close-up of a little girl's mouth with her tongue rolled. As with all simple Mendelian traits, there are only two ways to answer. The left panel was filled with dozens of sticky notes in an array of fluorescent colors with the names of all the individuals who had answered "yes," while the other side was reserved for all those who had answered "no."

After placing my green sticky note on the "no" panel, I continued my stroll through the exhibit which had been organized by INMEGEN and sponsored by Nestlé. At one station, a museum employee, who are all affectionately called *cuates* (commonly used to refer to a twin in Spanish, but also used locally to refer to a close friend), gave me a dozen flat circular wooden pieces painted with cartoon images of men and women of three generations. She explained that these were the members of two families and that my job was to sort the members into their respective families based on the presence or absence of physical traits like widow's peak and dimples. When I finished, she explained that this exercise demonstrates how important it is to understand how heredity works so we can understand how particular diseases run in our families.

As I turned to continue on, I stopped for a moment to observe a little boy who, with the help of a cuate, was building a large model of the double helix comprised of dense foam and plastic. At another station, there were microscopes where one could see the cell of an animal and the cuates provided drawings of a vegetable and animal cell with all the main structures labeled, which the children could color. At the other end of the exhibit, two boys were playing a large board game where they were expected to move along a life-size board trying to get to the last space first. Some spaces had questions like, "What are the four letters used to write genetic information?" The child would have to provide the correct answer to the cuate before advancing to the next space. At yet another station, children were asked to spin a vertical wheel which had twelve spaces. They had to follow the written instructions on whatever space the arrow landed on. Half of the spaces had to do with looking for simple Mendelian traits like hitchhiker's thumb, widow's peak, dimples, and attached or detached earlobes on themselves or others. The other half asked the child to do some kind of physical activity like sit-ups.

In neat piles at another table, there were three comic book style books produced by INMEGEN as part of their outreach program to children. They all shared the same title, "Genomic Medicine." However, each one addressed a specific sub-theme within genomic medicine: "The Human Genome," "Medical Applications," and "Pharmacogenomics." These comic books are very similar to the cartoon television series for children in the U.S. called "The Magic School Bus." There was also another educational booklet for children called "The Map of the Genome of Mexican Populations: Popular Science Book about the Genome Diversity Project of the Mexican Population." I was already familiar with these educational materials because I had been given copies of them at another INMEGEN event earlier in my dissertation research project. As a matter of fact, they are frequently distributed to the all those who attend conferences organized by INMEGEN.

Figure 3. Displays of two exhibits, The Human Genome and BicentenArte Pop, at the children's museum in Mexico City. Photo by author.

Altogether there were six activities children could participate in during an exhibit called "*El Genoma Humano*" (The Human Genome), which ran from September 10 - 26, 2010. However, as I walked around I noticed that this was not the only exhibit in the temporary exhibits section of the children's museum. Right next to the INMEGEN exhibit, there was an exhibit paid for by the federal government called "BicentenArte Pop" which I had seen exhibited in multiple locations throughout the city during the year, particularly at malls and outdoor plazas. It consisted of dozens of rectangular poster boards. Each one had the portrait of an individual who had been instrumental in Mexico's fight for independence or the Mexican Revolution. Under each portrait was a short description of the individual's contribution to the corresponding movement.

I found it interesting that INMEGEN had chosen to run an exhibit called "The Human Genome" at precisely the moment all of Mexico was proclaiming to be "*orgullosamente Mexicano"* (proud to be Mexican), which was one of the national slogans during 2010. The Mexican President Felipe Calderón had declared 2010 "*el año de la patria*" (the year of the fatherland or homeland) because Mexico would be celebrating the anniversaries of two of the most significant events in Mexican history. September 16, 2010 was the bicentennial of the start of the struggle for Mexican Independence and November 20, 2010 marked the 100th anniversary of the beginning of the Mexican Revolution. It was clear that the location of these two exhibits at that exact moment was not an accident.

This exhibit took place over one year after the announcement of the discovery of the Mexican Genome by biomedical researchers at INMEGEN because there was still a lot of controversy in the popular discourse and within the scientific community in Mexico. For instance, about two months after the announcement of the discovery of the Mexican genome in 2009, I was in Mexico City conducting preliminary research for my dissertation project. The Mexican genome was being discussed widely in the media. One afternoon, I watched an educational program which had the then INMEGEN director, Dr. Gerardo Jiménez Sánchez, as a guest on the show. Dr. Jiménez Sánchez explained again how the DNA of Mexicans is unique. The host then asked a provocative and intentionally comical question: "What about Salma Hayek? She was born in Mexico but her father is from Lebanon. She surely wouldn't have the same DNA as other Mexicans." Dr. Jiménez Sánchez simply said he was speaking in general about the whole population, but that each individual would have their own particular differences.

This host was not the only person questioning the notion of the Mexican genome. Early in 2009, I had come across a blog called "INMEGEN: un elefante blanco?" or "INMEGEN: A White Elephant?" which I began to follow regularly. This extensive and informative blog was started by a self-described Mexican scientist who was concerned that government funds were being misallocated and misused by INMEGEN. The blogger was very critical of the Mexican genome project in particular and challenged the methods used to reach the conclusions reported in the study. He also challenged the credentials of the biomedical researchers currently working at INMEGEN. He would post information about the qualifications (or, more precisely, lack of qualifications) of the researchers at INMEGEN, which often created heated debates in the comments section of the blog. However, after almost ten months of posting newspaper articles and comments about the day-to-day activities of the current director and the institute, the blogger chose to end the blog in October 2009. This coincided with the end of Dr. Gerardo Jiménez Sánchez's term at INMEGEN. A new director named Dr. Xavier Soberón was appointed to the position and started his term that same month.

Therefore, by the summer of 2010, something very different was happening at INMEGEN. The term "Mexican genome" was no longer being used by researchers and administrators at INMEGEN. Places on the INMEGEN website that once read "The Map of the Mexican Genome" were replaced by "The Map of the Genome of Mexican Populations." Many openly criticized the work of Dr. Gerardo Jiménez Sánchez stating that it was based on bad science and that not all biomedical researchers agree with his methods or his conclusions. Many biomedical researchers I spoke with stated that the Mexican genome was a mistake and some even blamed the media for the sensationalism that took place after the announcement. Therefore, by the time I arrived at El Papalote children's museum to see "The *Human* Genome" exhibit, it did not seem like an accident that it had occurred at exactly the moment when all of Mexico was celebrating their national identity.

In fact, just a few days before I attended the exhibit at the children's museum, I interviewed an administrator at INMEGEN. Upon hearing about my project, she asked if I was a part of a research project organized by social scientists from England. I imagined she was referring to Peter Wade's research team. I immediately said "no." She explained:

> Because the other day this woman came in here asking me about the Mexican genome and genomic sovereignty, but all of that was just media sensationalism. I mean, if you were to ask the IFE (*Instituto Federal Electoral* or the Federal Electoral Institute) what it means to be Mexican even they would have a hard time telling you.

She seemed to be frustrated and annoyed that people were still interested in the Mexican genome project and the notion of genomic sovereignty[17]. It was clear that the new administration at INMEGEN was being forced to deal with the controversies caused by the previous administration. They wanted to erase the public memory of the concept of the Mexican genome. One of the ways they aimed to accomplish this was by having an exhibit called "The Human Genome" at precisely the moment when what was on everyone's mind was the significance of the bicentennial anniversary of the beginning of the struggle for independence from Spain[18].

The fact that this exhibit coincided with the most significant national holiday in Mexico's history in recent times demonstrates how the new administration struggled to manage the proliferation of meaning that resulted in the months after the announcement of the discovery of the Mexican genome. They struggled to rearticulate the term "Mexican" with "human." Dr.

Gerardo Jiménez Sánchez faced such opposition to the use of the term “Mexican genome” that, according to an interlocutor, he was asked to resign[19]. Dr. Savedra explained, “They never said publically that that was the reason he was asked to resign but we all know that that was the reason. It is very uncommon for the director of an institute to resign the way he did.” It was felt by many that the reputation of INMEGEN could only be fixed if he was no longer associated with the institute. The short list of those considered to replace him were well-respected researchers with impressive credentials. This decision to hire a highly qualified scientist was very effective at calming the controversy caused by the Mexican genome. As stated earlier, it was enough to cause the scientist/blogger to end his monitoring of INMEGEN. The new administrators then could distance themselves from the claims made by the earlier administration. Reconnecting “Mexican” with “human” essentially reconnected what had been disconnected by the notion of a Mexican genome.

However that connection was not merely based in semiotics. As Boellstorff noted, form can be just as important as content (Boellstorff 2009). It was not merely stated publicly by the administrators that the idea of a Mexican genome was no longer being promoted by INMEGEN. It was performed through an exhibit in a museum right next to an exhibit dedicated to Mexican national heroes. Children and adults who attended the exhibit performed activities that underscored those aspects of genetics that apply to all humans, not just Mexicans, like simple Mendelian traits.

Siegel has also shown how tonality can be just as powerful as meaning (Siegel 2006). For instance, the new administration attempted to distance itself from the previous administration was by pronouncing the acronym of the institute differently. During the administration of Dr. Jiménez Sánchez, it was pronounced with the accent on the second syllable, in-ME-gen.

Biomedical researchers at INMEGEN, prior to the new administration, all pronounced it this way. During the fieldwork I conducted after the end of the administration of Dr. Jiménez Sánchez, it was more common to hear it pronounced in-me-GEN. The previous pronunciation followed the rules of accentuation in Spanish where words that end in a vowel, n or s carry their accent on the penultimate syllable. The new pronunciation broke that rule of accentuation in order to distinguish itself from the previous administration.

The timing of the exhibit also matters. Had the exhibit taken place at another time, it would not have had the same effect. It was selected as the ideal time to tell the public that INMEGEN was not pursuing questions related to a Mexican genome. The fact that the museum was also holding an exhibit on the bicentennial anniversary of the struggle for Mexican independence in the same area also helped demonstrate spatially that INMEGEN was concerned with the human genome, not the Mexican genome. The gap between the Mexican genome and the human genome was closed both temporally and spatially which effectively contributed to the quelling of the debates about the Mexican genome.

Conclusion

In this chapter, I showed how the act of putting mestizo next to Mexican forced many in the scientific community and the general public in Mexico to reflect on what these terms actually meant, how they were different from each other, and what was being taken for granted. The distance created between the Mexican genome and the human genome produced anxieties among Mexicans that they were somehow or in some ways not human. Given the long history of the idea of mestizaje in Mexico, La Raza Cósmica, and the Mestizo Nation, many felt the Mexican genome was simply a reflection of the pervasiveness of these ideas. However, I argue that each of these terms has multiple meanings and ontologies that make them link up to divergent concepts and ideas that also have multiple meanings and ontologies. Furthermore, this makes establishing a causal link between concepts like La Raza Cósmica and the Mexican genome is very problematic as a result.

When terms like “race” and “biology,” and “mestizo” and “Mexican,” are put in close proximity, affects such as fears and anxieties are produced. Race occupies a particularly vexed space where powerful affects such as anger are produced. The distance created between the human genome and the Mexican genome ushered in anxieties that Mexicans were somehow different from the rest of humanity. The way INMEGEN attempted to close this gap was both temporally and spatially in the form of an exhibit at a children’s museum. The bringing of the human genome and Mexican national identity in close proximity in the exhibit was an attempt to stop the proliferation of meaning that had been produced by the announcement of the discovery of the Mexican genome. It was in bringing them close together in a harmonious space and time that the INMEGEN organizers hoped would calm these fears and anxieties.

CHAPTER TWO

Trading Gold for Beads: Passions, Affects, and Temporality in Scientific Practice

Introduction

The future of science and technology in Mexico was the topic to be discussed by a panel of four prominent Mexican scientists: Arturo Menchaca Rocha (Ph.D. in Nuclear Physics from Oxford University and the Director of the Physics Institute at UNAM), Blanca Elena Jiménez Cisneros (Doctor of Sciences from the Institut National des Sciences Appliquées in Toulouse, France and holder of four patents), Julio Sotelo Morales (M.D. from UNAM specializing in Clinical Neurology and recipient of the National Prize for Science in Mexico in 2001), and Luis Felipe Rodriguez Jorge (Ph.D. in Astronomy from Harvard and researcher at UNAM).

They sat around an oval table in front of a large white projection screen. The title of the roundtable discussion “Prospectiva Científica y Tecnológica” (The Future of Science and Technology) was in large white capital letters on a background inspired by the diagrams of molecules used in chemistry. On either side of the title were images of flasks, beakers, and graduated cylinders containing brightly colored liquids. The repeated pentagonal diagrams of molecules contrasted with the diamond shaped pattern on the area rug under the table.

Dr. Menchaca, who was serving as the moderator, began the discussion about the future of science and technology in Mexico by giving an overview of how Mexico had arrived at the current moment. He explained:

> From the beginnings of Mexico we know that the Mesoamerican cultures were very sophisticated prior to the Conquest. They had a concept of zero and a calendar of 365 days. They had mining, agriculture, herbology, livestock. The Conquest, in reality, was the result of technological domination. It was a short transition, *muy penoso*, (very

> lamentable) that was defined by a culture that was technologically superior. A phrase that has stayed in the memory of everyone, one used widely in the popular discourse, "*cambiar oro por cuentitas*" (to trade gold for beads), is what has defined this domination.

He continued his discussion of the past by explaining how throughout the colonial period the Inquisition obstructed scientific development, although there were some advances in the areas of mining and hydrology. To give a sense of how Mexico had progressed by the early 1800s, he quoted Alexander von Humboldt as saying: "Mexico has the most advanced science I have seen in all of my travels in the Americas." He explained how, soon after Humboldt left, Mexico won its independence from Spain and began to distance itself from Europe. This began an era of wars that made almost the entire nineteenth century devoted to goals that did not help promote science and technology in Mexico.

He continued, stating that by the end of the nineteenth century, science began to flourish with the creation of scientific societies and institutions, but then the Mexican Revolution began in 1910, which made Mexico return to a problematic time that did not promote science and technology. The war ends, there is the creation of UNAM and the creation of institutions that are crucial to science in Mexico today. He explained that the wars in Europe favored Mexico because of the influx of brilliant minds to Mexico, who helped consolidate science in Mexico. Then, in the post-war era, there was an economic boom. Many products were made and repaired in Mexico. The *Consejo Nacional de Ciencia y Tecnología* (CONACYT) was created in the 1970s and there was the creation of the National System of Investigators (SNI) in the 1980s. He argued that all of this created a situation where science trumped technology, which characterizes the current moment in Mexico where, from his perspective, a deficiency in technology exists.

After asking the other panelists about the status of their respective fields, Dr. Menchaca asked Dr. Jiménez: "How are we doing in technology? Are we still trading gold for beads?" With a shared laugh, Dr. Jiménez responded:

> Well, I think much of the current situation has to do precisely with history. As you mentioned, we passed through a period where we had, as a country, something as a result of being conquered that we started to buy things and much of that has to do with technology. We are at a critical moment in which we are getting far less patents, to use one of the indicators of how technology is doing in Mexico, than all of the countries in the OECD but also all of the countries in Latin America. The majority of patents that are protected in Mexico do not belong to Mexicans. They belong to foreigners. The majority of patents presented by investigators in Mexico are also foreigners. We need to educate people on how to invent and protect.

Later, Dr. Morales asked Dr. Fernandez, "Can you take advantage of science and technology without having to participate in it, without participating in that industry?"

He responded with the following:

> You can, but you pay a high price for it. We definitely have to take advantage of the existing technology but the technologies are not free. All of it is patented. It is intellectual property. When we use a technology we are paying the country or institution that made it. We have to produce something. Some exists but we have to have more. There is an imbalance in technology. Mexico is deep in the red while the U.S. makes a lot of its money by selling these technologies. We should use existing technologies but we should enter in the game of creating technologies, the game of patenting and we should benefit

> from them. We have to play both roles of users and creators. If we don't, we are going to return to a disastrous economic situation, as Arturo mentioned, of trading gold for beads.

* * *

The phrase "trading gold for beads" refers to the story that Christopher Columbus gave the native peoples worthless glass beads in exchange for gold during his time in the Americas. Dr. Menchaca says that it is this phrase that has come to define the domination of one culture over another in Mexico. It is a simple phrase that is used to encapsulate all of the ways in which European explorers and conquistadors were able to take advantage of the native peoples of the Americas. The Columbus story is often presented as one part of the larger story of the Conquest of Mexico. For instance, when asked the question, "Are we still trading gold for beads?," Dr. Jiménez makes an immediate connection to the Conquest of Mexico.

Throughout my fieldwork project, my interlocutors would frequently turn to the story of the Conquest as a means to explain the current state of affairs of science and technology in Mexico. Many times I had a hard time seeing the connection. For instance, Dr. Mónica Morales, a head researcher of a genetics lab in Mexico, explained during an interview how difficult it is to fire someone who is not performing well in her lab. She said, "This is something that is a problem in Mexico since the Conquest, I think. It is the tendency to side with the underdog. If I fire someone, they will get a lawyer and the laws are set up to side with the worker. They think 'poor things they are being mistreated by their boss.'" For Dr. Menchaca, the deficiency in technology in the past has contributed to a deficiency of technology in the present. In many ways, it seemed to reflect a need to use the past as a means to make sense of the present. As Dr. Jiménez said, "Much of the current situation has to do precisely with history." However, it was not only the content of the story that called my attention for it is a rather widely accepted story of the Conquest: A handful of Spaniards conquered tens of thousands of Indians due to the fact that the Spanish had more advanced weapons like swords, guns, and armor while the Indians had "stone-age" technology like bows and arrows. In fact, Jared Diamond won the Pulitzer Prize for non-fiction in 1998 for his best-selling book, *Guns, Germs and Steel* which tells this kind of account of European domination in the New World.

However, it is interesting that this kind of account of the Conquest persists in Mexico, despite the fact that the very well-known and celebrated Mexican historian, Miguel León-Portilla, published a very different account of the Conquest of Mexico in 1959 called *The Broken Spears: the Aztec Account of the Conquest of Mexico*. His book gives a much more nuanced rendering of the Conquest, which among other things emphasized the diversity of indigenous groups in Mexico and the ways in which Cortes capitalized on the divisions between these groups to build a predominantly indigenous army to fight and win against the Aztec empire. Although alternative accounts of the Conquest exist, the story of a handful of Spaniards defeating an entire empire persists, especially as a way to explain the present in Mexico. This chapter argues that it persists because it draws from the storylines of modernity, capitalism, and nationalism found in historicism.

The account of the Conquest employed by scientists and intellectuals in Mexico had less to do with history and more to do with the historicism that Chakrabarty examined in *Provincializing Europe*. According to Chakrabarty, one of the main problems with historicism is that it made "modernity or capitalism look not simply global but rather as something that became global *over time*, by originating in one place (Europe) and then spreading outside it" (Chakrabarty 2000:7). Historicism left "developing" countries in a perpetual state of what Chakrabarty described as "not yet" where a particular future already existed. In Dr. Menchaca's account, Mexico was deficient in technology when Europeans arrived and it continues to be deficient in technology. In his view, Mexico has *not yet* reached the level of technology that other more advanced countries enjoy. Moreover, Dr. Menchaca's reference to "Mexico" as if the modern nation-state of Mexico existed at the time of the Conquest highlights what Anderson noted about nationalism that the nation-state projects itself in the past to create a sense of timelessness (Anderson 1983). The story of the Conquest brings together notions of time embedded in modernity, capitalism, and nationalism.

During an interview, Dr. Rojas said, "We use technology every day but although the ordinary citizen in Mexico thinks science is wonderful, it is often thought of as something that is done in other parts of the planet, in other places on earth." In this way, science in Mexico is frequently seen as "not yet" and "not here." It is often seen as not occupying the same space-time of science in Europe and the United States, which I will discuss in more detail in chapter 3. My interlocutors would often say that science in Mexico is in its "infancy" or is "very young" as if it has not had enough time or has experienced too many interruptions due to internal conflicts and foreign invasions to go through the necessary stages of development in order to reach "adulthood." For instance, Dr. Mercado said, "Science in Mexico needs to mature. We need to show a greater commitment to science and technology so we can catch up to First -World countries. Brazil made a decision to improve science and technology and they have done that in a short amount of time. We need to do the same." Moreover, as Dr. Fernandez explained, "Mexico is deep in the red while the U.S. makes a lot of its money by selling these technologies." Mexico is not only behind in technology, but also behind in capitalizing from the development of technologies.

In *The Cage of Melancholy*, Bartra demonstrated that over the last century many Mexican intellectuals reflected on what it meant to be Mexican and in the process they collectively constructed a particular kind of national character. In their writings, intellectuals in Mexico have constructed Mexicans as the product of an "immense tragedy," "the inhabitants of a violated limbo" where "backwardness and underdevelopment have come to be seen as manifestations of a perennial static infancy that lost its primitive innocence" (Bartra 2005:36). Phrases like "trading gold for beads," "we were conquered," and "science in Mexico is in its infancy" are a part of this construction of national character. Indeed, Bartra argued that its origins can be found in "a powerful national will bound to the unification and institutionalization of the modern capitalist state" (Bartra 2005:16). In other words, science in Mexico runs alongside linear accounts of modernity, capitalism and nationalism, drawing from them to explain the present.

There were two things about the way the story of the Conquest was told that struck me. First, these references to the Conquest were almost always filled with negative feelings of lamentation, pain, embarrassment, melancholy. As Dr. Menchaca said, the Conquest was "muy penoso" (very lamentable). Another poignant example of this can be found on a cement stela at *La Plaza de Tres Culturas* (The Plaza of Three Cultures) in Mexico City which marks the place where the last Aztec emperor, Cuauhtemoc, surrendered to Cortes on August 13, 1521. It describes that moment as the *painful* birth of the Mestizo Nation. Second, I was struck by the implications of the pronoun "we" as used in the question: "Are *we* still trading gold for glass beads?" The "we" showed how those who used this phraseology identified with the "losing side" of the Conquest. In fact, I encountered the phrase "*Nos conquistaron*" (We were conquered) frequently throughout my fieldwork, which shows more clearly the identification with the "losing side" of the Conquest.

In this way, there is a moralistic stance embedded in this account of the Conquest. As Gibson-Graham argued, there is a sense of "purity" to powerlessness that is based on a singular conception of power (Gibson-Graham 2006:6). They warn that this can lead to an attachment to a past political analysis or identity that is "stronger than the interest in present possibilities for mobilization, alliance, or transformation" (Gibson-Graham 2006:5). Bartra calls this way of thinking a cage of melancholy. In this chapter, I argue that this identification with the powerless can originate from a particular experience of time where the present is experienced as an absence and where possibilities seem fleeting and elusive.

In *The Condition of Postmodernity*, Harvey stated that Enlightenment thinkers believed that, "the development of rational forms of social organization and rational modes of thought promised liberation from the irrationalities of myth, religion, and superstition, release from the arbitrary use of power as well as from the dark side of our own human natures" (Harvey 1990:12). In their book, *Wonders and the Order of Nature*, Daston and Park demonstrated that the project of finding natural causes for what Harvey called "irrationalities" was "explicitly strategic, a way of dissolving the fear of divine wrath and the wonder of divine intervention in the course of nature and human affairs, rather than an autonomous medical or natural philosophical inquiry" (Daston and Park 2001:335-6). In other words, it was not the lack of rationality that made these "irrationalities" dangerous, but rather the combination of fear and wonder they inspired which could be used to manipulate the masses against church and crown. As Shapin and Schaffer have noted, seventeenth century thinkers were interested in what would constitute reliable knowledge insofar as assent could be achieved with the goal of avoiding civil war (Shapin and Shaffer 1985). However, these thinkers did not combat passions and affects with rationality, but with different passions and affects.

As Hirschman noted in his book *The Passions and the Interests*, what human nature is was an open question in the seventeenth and eighteenth century. The idea that it is human nature to be self-interested was the outcome of decades of debate. Self-interest won out because it was considered more predictable than the other passions and therefore a better basis for governance. As a result, "Capitalism was precisely expected and supposed to repress certain human drives and proclivities and to fashion a less multifaceted, less unpredictable, and more 'one-dimensional' human personality" (Hirschman 1997:132). This idea arose from "extreme anguish over the clear and present dangers of a certain historical period, from concern over the destructive forces unleashed by the human passions with the only exception, so it seemed at the time, of 'innocuous' avarice" (Hirschman 1997:132). Therefore, it was "not only the valuation of these emotions, but also their proximity and distance from one another" (Daston and Park 2001:15). There was not only bad avarice but good avarice. In the history of science, wonder went from being good in the fifteenth and sixteenth century to becoming vulgar in the seventeenth century. Passions and affects are not unique to Mexico but have always been part and parcel of knowledge production and practices. Naturalization and self-interest arose out of fears that the past would return, that civil wars would break out again. In other words, the passion and affects that drive science arise out of particular experiences of time.

The Absent Present

The fountain at the entrance of the World Trade Center in Cuernavaca, Mexico was overshadowed by a blue inflated advertisement in the shape of a hot air balloon. A white trapezoidal label interrupted the shiny blue material to serve as a better background for the words Pharma&Pack, a local pharmaceutical company. The single vertical stream in the center of the fountain struggled to reach the height of the balloon until it finally collapsed into the reserve below. As I continued on to the registration booth, the sound of the splashing water soon faded into the background, drowned out by the voices of those standing in small groups by the conference room doors.

I had arrived early on the first day of a two-day conference entitled "Bioconnect: Opportunities for Investment in the Life Sciences." Although it was October, it was a warm morning, which is to be expected of the place just outside of Mexico City known as "*la tierra de la eterna primavera"* or the land of eternal Spring. I walked through the conference room doors and quickly found a table towards the back of the room. Over the course of 45 minutes, the room had reached its maximum capacity. I was struck by the presence of over a dozen camera crews from the local news stations. There were several reporters interviewing people. In my experience, it was highly unusual that the media would be interested in covering a biomedical conference.

Soon the soft buzz in the conference room was abruptly silenced by the words, "*Buenos días*" (Good morning). The conference organizer welcomed everyone and expressed his appreciation for the presence of the governor of the state of Morelos, Dr. Marco Antonio Adame Castillo. A loud applause ensued as Dr. Adame walked briskly toward the stage followed by a large entourage including over a dozen highly alert *güaruras*[20] (bodyguards), which is a profession that has thrived in recent years due to the extreme levels of violence in Mexico[21]. Sixteen other individuals with important positions in the government were also introduced. Short speeches were given by the municipal president of Xochitepec, the Federal Health Secretary, Secretary of Economic Development, and a member of the Federal Commission for the Protection against Sanitary Risks.

In sum, this first panel of speakers emphasized the significance of the conference for the state of Morelos and for Mexico in general. In a very optimistic tone, they expressed how this conference brought together academics, investment capital, and researchers in order to exchange ideas on how to improve the health of all Mexicans. They remarked on how this would lead to the creation of an infrastructure designed to produce increased numbers of new and improved research projects. This, they argued, would boost the economy by creating more jobs and by developing an increased number of local products. After the last speaker had presented his vision for the future of biomedical research in Mexico, an announcement was made that there would be a thirty minute break before the next panel. We were encouraged to visit the Expo being held in the room next door.

I collected my things and followed the crowd to the Expo. There were dozens of booths for biomedical and pharmaceutical companies, as well as local universities. There appeared to be a lively and pleasant interaction between the people manning the booths and the conference-goers. I visited many booths including the INMEGEN booth where I was given a large commemorative poster that read "*Mapa del Genoma de los Mexicanos*" (The Map of the Mexican Genome). Poster in hand along with four INMEGEN educational comic books, I soon returned to the conference room for the next panel. When the panel began, it seemed very strange that there were significantly less people present and all of the news crews were gone. I assumed most conference-goers had lost track of time while at the Expo, but over the course of the day, the room ebbed and flowed at less than half full. I was struck by the fact that even less people attended the second day of the conference.

My note-taking after this second panel forced me to arrive slightly late to the cafeteria where lunch was available for purchase. I bought a sandwich and sat alone at the last empty table hoping to take advantage of the break to add more details to my field notes. Within a few minutes, two other conference attendees approached my small table for four and asked if it would be all right to sit down. I immediately answered with the customary, "*Claro*" (Of course) and gestured for them to sit down. After a short round of introductions, I learned that both were biomedical researchers from the state of Morelos, and they learned that I was an anthropologist from the United States conducting my dissertation research on science in Mexico. After answering several of their questions about my project, I began by asking them what they thought of the conference so far. They glanced at each other and then at me. Both expressed an intense disappointment, and I was immediately struck by their frankness. They made no attempt to sugar coat their feelings.

Daniel explained, "This bioconference is not like bioconferences in the U.S. where there are thousands of booths and a lot of exchange between researchers and investors." Felipe chimed in, "This was a political event. The investments have already been made. Nothing is going to come of this. The organizers said they were going to learn from the mistakes they made last year but they didn't." I asked them why they thought the organizers had not corrected the mistakes from the previous year. Daniel responded, "This is a problem Mexico has had since the Conquest. This country is not like the U.S. where colonists went to pursue peaceful lives. This country was founded by *rateros y sinvergüenzas* (thieves and scoundrels). The conquistadors were only interested in raping and pillaging our country." Felipe interrupted, "*Somos hijos de la chingada.*" Daniel continued, "The people in power today are the descendants of the conquistadors and they share the same interests in Mexico. They all just take what they want." They both continued to explain how Mexico is run by a handful of powerful families with distinctive last names, some of whom can trace their lineages back to time of the original

Conquistadors. The handful of people in power are the descendants of the handful of Spaniards who conquered the Aztec empire. My seemingly innocuous attempt at small talk turned into over an hour of vented frustration about the many problems in Mexico.

I was particularly taken aback by Felipe's use of the phrase "hijos de la chingada" for many reasons. It was an unsettling moment because I had never found myself in a situation where a man I had just met had used a vulgar phrase in front of me. "Hijos de la chingada" is a very vulgar expression and is one of the most offensive phrases used in Mexico today similar to "sons of bitches" or "motherfucker" in English. It is considered extremely disrespectful for men to use vulgarities in front of women, and it is highly unusual to hear vulgarities in this kind of context in Mexico. In fact, academics usually refer to each other with the formal term "*usted*," rather than the informal "*tú*," out of respect for each other, and "usted" is also used when speaking to someone you have only just met. In other words, Felipe's use of a vulgarity seemed to break down a certain level of formality that is generally expected in these kinds of encounters.

Based on this previous knowledge, my mind flooded with concerns about what had just taken place. I scrutinized Felipe's face in order to determine whether he would show any signs that this was an unusual interaction. I even expected an apology that often follows when men forget they are in the presence of women and accidently use a vulgarity. Yet the apology never came, and Felipe did not show any indication that something inappropriate had occurred. Felipe had not felt his use of the phrase was inappropriate because the meaning he intended was not vulgar, although it is exactly the same phrase more commonly used as a vulgarity. For Felipe, "somos hijos de la chingada" meant "we are the children of the raped woman." It alluded to the Conquest of Mexico where "the raped woman" represents all of the nameless indigenous women who were raped and impregnated by the conquistadors. According to this story, this historic act of violence had essentially produced the Mestizo Nation of Mexico.

I soon realized that it was not Felipe who had been "vulgar," but I. According to Heidegger, I had committed a common error in Western philosophy to conceive of time in terms of what he called "vulgar" or ordinary time (Heidegger 1996). "The vulgar understanding of time sees the fundamental phenomenon of time in the *now,* and indeed in the sheer now, cut off in its complete structure, that is called the 'present'" (Heidegger 1996:427). The quotidian activity of sharing a meal had led me to take for granted that Felipe, Daniel, and I were sharing a single time and space called the present.

Recently, Otto has argued that the sharing of time in the present "reveals differences of temporal orientation co-existing in the present and reflecting different pasts" and "that in this sense people do live in different times while sharing the present" (Otto 2013:65). In light of Fabian's critique of anthropological writing where he argued we denied co-evalness to the Other, it is an important relativizing move to say that all people live in the present; we are all coeval. However, I argue in this chapter that this relativizing gesture has produced a view of the present as a sort of default notion of time. In the face of so many different conceptions, experiences, and constructions of time, the present tends to be taken-for-granted as the one kind of time we all must share. As Greenhouse has noted, it is difficult to see time as strictly culturally constructed because of the universality of mortality (Greenhouse 1992). In other words, there seems to be a sense that there is a universality to time given that we all age and we all have to face our own mortality. But as I spoke with Felipe and Daniel, the present seemed to dissipate into places and times beyond the here and now, producing a temporal vacuum filled with the invisible ether of virtualities. As Grosz argued, it is "a present that is never fully present" (Grosz 2005:4). Moreover, *we* are never fully present in the present.

For Felipe and Daniel, the future that the government officials were referring to at the beginning of the conference already existed. As they said, "The investments have already been made," even though the conference was supposed to produce "opportunities for investment." That future was no longer possible because it was already a reality. The alternative futures in which Felipe and Daniel would have been able to connect with investors also became impossible. Moreover, the failure of this conference was experienced as a return to the failure of the previous year's conference. As Felipe claimed, "The organizers said they were going to learn from the mistakes they made last year but they didn't." In this way, Felipe and Daniel's present was defined by being forced to relive the past even when they tried to prevent its return. They were also forced to accept an unfavorable future from which they would be excluded even though they had come to the conference with hope that more favorable futures were possible. In other words, their presence in the present was experienced as an absence. It was an absence from the past, the present, and the future. Their concerns about the failure of the last conference were ignored. They were excluded from participating in the construction of the future. They felt there was nothing they could do in the present to change this state of affairs. It was feeling of being outside of time, a present that is experienced as an absence.

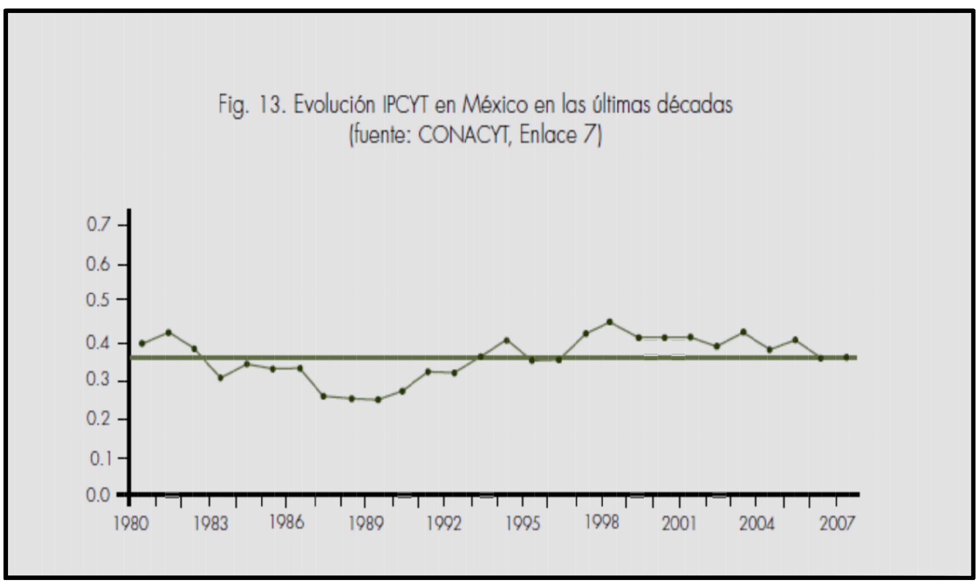
Felipe and Daniel had attended this conference in search of connections and funding for their research. Many of my interlocutors would say that although there is an advanced level of science in Mexico, but the institutions do not work together or share resources. For instance, Dr. Pedro Córdoba, an award winning chemist in Mexico said, "In Mexico, there is good science, good researchers but we often forget to work together." He explained that there are many scientists doing good work, but " *nos falta articular los varios actores y instituciones*" (we need to connect the various actors and institutions)[22]. There was a need to build networks to promote the circulation of knowledge, researchers, and resources. Conducting high quality science is not enough.

In his book, *The Pasteurization of France,* Latour argued that scientific facts do not spread simply because they are true or self-evident. He demonstrated how it is crucial to capture the associations or networks that are created, which allow for the successful spread of scientific knowledge (Latour 1988). However, Latour's notion of the network-building scientist is dependent on the idea that the future is open to the possibility that a future exists where one's discovery or invention will be adopted by others. In other words, the scientist must have a particular view of the future in order to successfully build networks.

In Mexico, there are fears that the past will return to the present and ruin the future, making network-building far more challenging. Throughout Dr. Menchaca's overview of the five hundred years of science and technology in "Mexico," he highlighted how Mexico returned many times to moments of political and economic instability, which had negative impacts on science and technology. Dr. Fernandez argued that if Mexico does not participate in the creation of knowledge and technology, it will "*return* to the disastrous economic situation of trading gold for beads." As Gammeltoft argued, "the past may insist on presence in our now and in our premonitions regarding what comes next, even if we do not want it to" (Gammeltoft 2013:160). The next section will discuss how the repeated economic disasters in Mexico have left their mark on the future of science in Mexico.

Peso Devaluations and Science

When I would ask biomedical researchers what has been the factor that has most affected the development of science in Mexico, almost every person would respond with only two words, "*La economía*" (the economy), as if no other explanation was required. I always had to probe with more specific questions to arrive at exactly what was meant by *la economía* and how they felt it had affected science. The lack of adequate funding was always the most important factor mentioned by my interlocutors. One interlocutor, an accomplished geneticist, Dr. Miguel Rojas, went so far as to search his computer for a graph that showed the amount of government funds allocated to science and technology in Mexico from 1980 to 2007. He enlarged the image and turned his monitor towards me. Surprised, I switched from Spanish to English to say, "It's a flatline." He laughed, and responded in Spanish, "Yes. If this were an EKG reading, science in Mexico would be declared dead." I laughed with him and continued in Spanish to ask: "So, the change in the government has not made a difference?" I was referring to the dramatic



shift in power that occurred in 2000. After over seventy years of being in power, the *Partido Revolucionario Institucional* (Institutional Revolutionary Party or PRI) lost the presidential elections to the candidate, Vicente Fox, from the *Partido Acción Nacional* (National Action Party or PAN). PAN has now been in power for the last two presidential terms of six years each called a *sexenio* in Mexico. Presidents in Mexico cannot serve more than one term in office as stipulated in the 1917 Constitution of Mexico. Congresspersons can also not be reelected but unlike the president they may run for office again at a later date. This shift in power from PRI to PAN has been noted as a monumental democratic transition in Mexico, and I wondered whether it had had any effect on science. Dr. Rojas went back to his computer to show me another graph. He explained, "We often use this graph (below) to bad-mouth the PAN, but if anything the PAN has promoted a certain degree of stability." But he went back to the first graph, pointed to the early 1980s, and explained:

> This was the time of the PRI governments of presidents like López Portillo who were *rateros* (thieves), and one way or another made things worse. But, in reality, if a single state policy exists in this country, independent of everything else, it is to invest very little in science and technology.

Another interlocutor, Dr. Diana Fuentes, echoed this consistent lack of funding for scientific research, "There is no money so the government cuts spending. That is our problem. Well, it is actually our structure. We do not see it as a problem anymore. We just know this is our reality." One of the "problems" or the structure to which Dr. Fuentes referred is that researchers in Mexico are largely dependent on public funding. The most active and prestigious research institutions in Mexico are public institutions. Even though researchers often ask the government to invest more in science and technology, government officials have not increased funding in decades. I asked Dr. Rojas, “Why do you think the government does not spend on science and technology?” He replied, “I don’t know. There simply is no conviction among Mexicans to invest in science and technology.”

During my time in Mexico, one of my friends was working as an assistant to a Congressman from the ruling PAN party. One day, I asked if she thought it would be possible for me to get an interview with him. I had heard dozens of researchers express negative feelings about Mexican government officials’ commitment to science, I thought it would be a good opportunity to discuss the state of science with a government official. A few days later, she said I could meet him the following week at 10 AM. When I arrived, there was a great deal of commotion at the entrance to the Congress. Dozens of people were trying to get through security and through the gates. My friend just grabbed my hand and pulled me to the front of the crowd to what she said was the employee line but it was too chaotic to figure out what was happening. There were scores of men wearing cowboy boots and distinctive white sombreros. It was clear they were not from Mexico City. They were there to protest to the Congress about the failure of the federal government to help the several states severely affected by droughts[23].

Entering the building, I noticed that many of the walls throughout the Congress are decorated with intricate imagery representing national themes and heroes. Carved in one of the wood-paneled walls was a quote by José María Morelos, one of the founding fathers of Mexico, in 1819: “As good law is superior to every man, our Congress should dictate those that require constancy and patriotism, that moderate opulence and indigence.”

As expected, the Congressman was very charismatic, offering me a bag of coffee brought from his home state. Later in the interview, I began to talk about science. He admitted he knew very little about scientific research in Mexico. He said, “Look. In Mexico, we are faced with a huge challenge. Half of our population is dying of hunger, how are we supposed think about science when people are dying? Our priority is to help our economy grow and improve the lives of all Mexicans. Once that is taken care of, then we can worry about science." Many of my interlocutors admitted that they would not want to use money for research that could have gone to solve urgent social problems. For some, scientific research seems to be a luxury Mexico cannot afford. As discussed in chapter one, many accused INMEGEN of being "a white elephant," an inefficient and irresponsible allocation of public funds.

However, one of the problems in Mexico has been that many times it is the government officials who have taken money and have created urgent social problems. The presidency of José López Portillo was underscored by many of my interlocutors as a time period of extreme financial hardship in the scientific community in Mexico. López Portillo, president of Mexico from 1976 to 1982, has one of the worst reputations in the popular memory. Many of my interlocutors referenced his presidency as one of the worst in Mexican history and one of the worst for scientific research in Mexico. During his presidency, the peso dropped from 26 to its lowest value up to that time 100 pesos to the dollar (Meyer et al. 1999).

López Portillo blamed the private banks for the flight of $22 billion dollars of Mexican capital. He was quoted as saying, "A group of Mexicans, led, counseled, and aided by private banks, has taken more money out of the country than all the empires that have exploited us since the beginning" (Hellman 1983:225). Yet when he left office it was clear that he was a member of that group. He had purchased large pieces of prime real estate and built four mansions for himself and his family. Moreover, while Mexico sunk into an even worse economic crisis López Portillo took an extended vacation to Europe (Meyer et al. 1999).

It is instances like these in recent Mexican history that have affected all those who have suffered through these repeated economic crises caused by corrupt officials. The people of Mexico have been forced to endure incredible abuses of power that have led to devastating devaluations in the peso. Dr. Luz Elena Sarmiento, who has a Ph.D. in chemistry, said she had been working as an independent researcher in France for several years, when she finally decided to return to Mexico in 1983. This was the moment of one of the worst peso devaluations in Mexico's history. Since the majority of the items needed by scientists in Mexico must be purchased in dollars, she soon realized that the substance that she was using in her experiments cost more than her annual salary as a researcher in Mexico. This made it impossible to continue her research project in Mexico. She, fortunately, had the ability to return to France for another year. Dr. Sarmiento recalled, "Inflation was so high, it was impossible to do science at that time. Scientific research in Mexico dropped dramatically. It is a very important gap in research in Mexico that I am aware of, from 1982 to 1987. All of the devaluations in the peso impede research."

There is a connection between the economic crisis of the early 1980s and the creation of the *Sistema Nacional de Investigadores* or SNI (The National System of Investigators) in 1984. The SNI is essentially a grant intended to supplement the income of researchers in Mexico. Researchers are paid by their home institution but this system was intended to supplement the institutional income of all registered researchers. The federal government was afraid of a *fuga de cerebros* (brain drain) during the economic crisis and decided to find a way to support the researchers. There are various tiers in the SNI that correspond to different funding amounts. The more publications one has the faster one gets to the highest tier.

Dr. Rojas emphasized, “El SNI fue el gran detonador” (The creation of the SNI was a great detonator). It created an explosion of publications in Mexico. However, there began to be a trend towards having more authors per article. Dr. Rojas reflected, “This could either mean more people are collaborating or that the system was becoming corrupt.” Corrupt in the sense that quantity became more important than quality because researchers in the system were being evaluated solely on the quantity of articles published, not on the quality or impact of the work. Moreover, many researchers at the beginning chose to produce two or three articles out of data that could have been put in one article in order to get a higher number of publications. Many of these articles were only a few pages long. Researchers were very eager to reach the highest tier in the system as quickly as possible. At first, this caused the quality of science to decrease but as more researchers reached the top tier, the quality of the articles began to return and increase. Therefore, Dr. Rojas explained, “Although the SNI seemed to have had an adverse effect on the quality of science in the first years, the problem now seems to have corrected itself.” But for a time, the devaluations of the peso had caused the devaluation in the quality of scientific articles in Mexico. Corruption in the government had also led to a corruption in science.

Although the SNI helped to buffer the effects of the dramatic devaluation of the peso in the 1980s, that economic crisis has not been easily forgotten by the Mexican people. The people who went from living relatively comfortable and stable lives saw their worlds turned upside down almost overnight. There was a consistent devaluation in the peso throughout the years of the PRI. At one point, Mexicans needed around 11,000 twenty-cent coins to make one dollar. Many decided to collect them and put the worthless coin to better use as something other than money, like washers for screws. In fact, in 1994, the government decided to drop three zeros off their currency and call them “nuevos pesos” (new pesos). Melancholy exists about the current state of affairs in Mexico not simply because it is embedded in Mexican national character as Bartra argued. It has also been these recurrences of economic crises that have produced a certain degree of melancholy among the Mexican people.

In January of 2012, one of my interlocutors, a graduate student working in one of the laboratories of a public university, sent me an email that had been circulating in Mexico that traces the peso devaluations during the presidencies of every Mexican president since 1970 so that I would understand the gravity of the situation in Mexico. She wrote, "Maybe this will give you an idea of the role the economy plays in science." From 1970 to 1976 the peso went from 12.50 to 22.69, from 1976 to 1982 the peso went from 22.69 to 150.29, from 1982-1988 it went from 150.29 to 2483.00, from 1988-1994 it went from 2483.00 to 3375.00. From 1994-2000 it went from 3.37 to 9.45 (new pesos), from 2000-2006 it went from 9.45 to 10.90 and from 2006-2012 it went from 10.90 to 11.80. The email aimed to show how PAN presidents had in fact maintained peso devaluations stable at 15% whereas during the 30 years prior to the PAN victory in 2000 some of the devaluations had ranged from 36% to 1553%. This was the stability that Dr. Rojas said the PAN had created.

Many biomedical researchers and academics in Mexico are the first generation in their family to reach a certain degree of financial stability. All public education in Mexico is practically free, including higher education. Mexico actually spends more on education than any country in the world. Therefore, people from the most humble backgrounds can potentially get an advanced degree including a Ph.D. Many of my interlocutors noted that their parents were not highly educated. For instance, Dr. Guzmán told me, "My dad only finished elementary school and worked in construction his whole life. I never would have gone to college if it had not been for UNAM." As a result, these economic challenges in scientific research have connections to the larger trends of economic disasters experienced outside of the scientific community. Researchers have reached a middle class status but are afraid that status is only temporary and that at any moment things could change for them.

Many of my interlocutors identified the economic crises as one of the most important aspects of Mexican society that have affected the development of science. As Dr. Sarmiento explained, “We buy all of our laboratory equipment in dollars. The dollar fluctuates around 12 pesos but when it is at 15, the money just does not go as far.” Even small changes in the value of the peso can lead to huge effects in the research projects. It makes researchers nervous about when to purchase their equipment. They are never sure when the peso is going to go up or go down. Timing is everything. Dr. Sarmiento explained, “One time I was very lucky. I rushed to buy all of the equipment I needed and about a month later there was a dramatic devaluation in the peso. If I had delayed just one month to buy my equipment, I would have lost fifty percent of all of it. We live hoping that there will not be another devaluation.” This uncertainty can cause a great deal of stress for researchers. For example, one does not even know how much to ask for in a grant because what if by the time one gets the funds there is a huge devaluation in the peso? At that point, more funds will be required to complete the research project. There are many things that are outside of the control of researchers but they do try to control as much as they can in order to have successful careers.

As a researcher, one needs to plan as much as possible. Researchers know there is a large amount of things they do not control so they try to plan and control as much of their lives as possible but no matter how good one gets at this there are always abrupt changes to policies and unexpected events. For instance, in the U.S., the National Institutes of Health (NIH) have fixed dates when researchers can apply for grants. In Mexico, researchers never know when the call for grants is going to be made. There are no fixed dates. Therefore, they simply have to be constantly alert and simply wait for the calls for grants to come out. But if the call for grants comes out late, sometimes there can be a gap of up to a year and a half between funding. Researchers have to do what they can with the funds they have available but if there is a devaluation during that time, this only makes matters worse.

Dr. Sarmiento explained to me:

> It happened to me that for the last three years, the call for a CONACYT[24] grant would come out every summer. So I decided to teach a class in the spring so that I could be free in the summer to write the grant proposal. Well, the call came out in March instead. They sent it out ahead of time rather than postpone it as they usually do and I was in the middle of teaching a class when I had to rush to send in my proposal. So we cannot plan. We live in complete uncertainty.

In this way, it is not only that calls for grants have no fixed dates but that the calls can theoretically come out at any moment depending on the administrators at the CONACYT. As Dr. Sarmiento explained, the calls can even come out early, they are not only delayed. She had tried to do everything to plan her life around the call for grants only to find that her planning was useless. It is this kind of uncertainty that makes science appear to move at different speeds. Not knowing what the future will bring creates the turbulence of uncertainty. I discuss this more in chapter 3.

Dr. Sarmiento gave another poignant example:

> One year the call for the university grants would not come out and would not come out. Then the call was sent out and we were told we had ten days to design a project. So what do we do? They do not give us the time to construct a solid and important project because

> we have to send something out. We have to send something that sounds good but is not too risky. We can't think about it. Ten days is not enough to think about it. We were all very upset because we found it very disrespectful.

For researchers in Mexico it is not only about the uncertainty, it is also that they are not given the level of respect they feel they deserve from the institutions for the work that they accomplish. Of course, this also affects the kind of research projects researchers design. As Dr. Sarmiento said, they are not given the time to develop solid and important projects. It seems the solution would be quite simple. Creating fixed dates for grants would not only reduce the stress experienced by researchers because they will be able to plan better, but it will also improve the quality of scientific research. Yet as it stands, researchers live in uncertainty attempting to keep up despite all of the obstacles they encounter along the way.

Scientists in Mexico tend to find pleasure in making their own equipment and inventing solutions when they do not have access to or cannot afford the technology they need. These improvisations and impromptu inventions is an approach they proudly call "*a lo Mexicano*" (Mexican style). They do invent out of a pleasure of not having to pay for a more expensive technology and not with the intention of selling the idea for a profit. They often share these inventions and ideas with their fellow researchers through informal means as discussed in chapter 3. Dr. Rojas argued, "Our ability to improvise and invent on the spot makes science in Mexico better because, rather than just using technology, we understand the science behind the technology.

When the sexenio is coming to an end there is the tradition that the current president of the Mexican Academy of Science submits a document of recommendations for the presidential candidates in the next election so they can plan their policies for science and technology. In

November 2011, Dr. Arturo Menchaca Rocha fulfilled his duty by publishing a report entitled, "The Only Road towards Development in Mexico Must Traverse Knowledge: Recommendations for a Better Future." Among the four recommendations he outlined were: 1) improve the quality of education 2) increase the number of researchers of the highest level 3) the government should make science and technology a higher priority 4) increased spending in science and technology.

These kinds of requests are often made in terms of the economy. In other words, it is assumed that science and technology go hand-in-hand with the economy. For instance, there science is thought to be proportional to the population size of a country as well as the size of the economy. Dr. Rojas underscored that "Mexico ranks 13th in the world in absolute numbers of articles published. Yet countries with much smaller populations have many more publications." This is based on information from the Institute for Scientific Information, which gathers data on internationally recognized journals. He also highlighted how "Mexico ranks 25 or 26 internationally in science, when we are the 14th economic power." He found it a bit strange that Mexico is so far behind in terms of publication. He continued, "In general, we are number 30. We are 25 or 26 in productivity and 30 in quality. Neither number corresponds to our economic power." These kinds of statistics are often used as arguments for increasing spending on science and technology.

While these changes would invariably make science and technology better in Mexico, there are very concrete changes that could improve scientific research and which have the potential to improve science over time. From the perspective of government officials, they can seem to feel that they have more urgent matters to worry about than to worry about science and technology. When I asked Dr. Sarmiento, "What would improve science in Mexico?" She responded, "If CONACYT would just fix their grant dates, I think science in Mexico would improve." I was truly struck by her response. Most of my interlocutors would say, "The government needs to invest more money in science and technology." But she was simply asking for a bit more certainty in scientific research. It would seem that researchers should work toward finding ways to increase the degree of certainty in their lives rather than trying to restructure the entire system.

Conclusion

In this chapter, I argue that the story of the Conquest persists as a means to explain the status of science and technology in Mexico because it articulates with historicist accounts of modernity and capitalism which also go hand-in-hand with a particular construction of national identity. However, it is also the experiences of time and the multiple financial disasters in Mexico that have reinforced a feeling of powerlessness and melancholy. When the future is inaccessible and the past keeps returning despite efforts to prevent them from reappearing, the present is experienced as an absence. It is the feeling of being absent from time. It is a view of the future that is quite different from the network-building scientist.

Moreover, when things are perceived as unchanged like a deficiency in technology at the time of the Conquest and a deficiency in technology in the present there is a sense of being outside of the flow of time. Some of this comes from the cage of melancholy that Bartra described but it also comes from the experience of time throughout the careers of biomedical researchers and the experience of financial disasters like massive devaluations in the peso that directly affect biomedical research in Mexico.

CHAPTER THREE

Turbulent Waters: Temporality, Marginality, and Scientific Practice in Mexico

Introduction

Like most prominent Mexican scientists, Dr. Mónica Morales worked many years in laboratories in the U.S. before finally settling into a position as a biomedical researcher in Mexico. In many ways, her life is not unlike her American counterparts. She heads her own laboratory and designs her own research projects. She trains graduate students and has published scores of chapters in English in all of the most prestigious journals in her field. She even attends and presents at some of the same conferences. Yet she is well aware of the fact that she cannot compete with the science of the U.S.

The experience of working ten years as an independent researcher in the U.S. made all too apparent one crucial difference between laboratory science in the U.S. and Mexico. Dr. Morales explained, “In the U.S., if researchers need a particular reagent like insulin they can get it in a matter of hours or days whereas in Mexico it can take from two to six months depending at which research institution one works.” There are also unexpected delays. Dr. Morales recently had to wait eleven months for a critical component of her proposed experiment, which was scheduled to arrive nine months earlier. This state of affairs forces researchers in Mexico to plan projects that anticipate and incorporate expected and unexpected delays, but of course this is not always possible.

Dr. Morales made a point to emphasize that researchers in Mexico are capable of doing cutting-edge work, but the delays they invariably experience make them think: “Why should we, if by the time we get the reagent, the results will already be published?” Therefore, biomedical researchers in Mexico try to design projects that can interest others in their field but are not the most interesting topics of the moment. Dr. Morales frequently chooses to ask the kinds of research questions that she believes do not currently interest researchers in the U.S. in order to create a niche that allows her to continue doing what she loves while still being interesting enough to get her publications in the same journals as her American counterparts.

However, this is only one part of the story of being a biomedical researcher in Mexico. Dr. Morales described in great detail the various institutional and bureaucratic challenges that consume so much of her time. With a sigh, she said: “I feel like I am constantly swimming. It is a sensation that I cannot swim against the current. I just have to get in and let the current take me because, if I stop, I will lose everything.” For Dr. Morales, the experience of being a biomedical researcher in Mexico is like swimming in turbulent waters.

* * *

At the end of her ground-breaking ethnography, *Beamtimes and Lifetimes*, Sharon Traweek concluded that high energy physicists possess “an extreme culture of objectivity: a culture of no culture, which longs passionately for a world without loose ends, without temperament, gender, nationalism, or other sources of disorder—for a world outside of human space and time” (Traweek 1988:162). While most anthropologists in science studies commonly cite the phrase “a culture of no culture” to describe science, my ethnographic work among biomedical researchers in Mexico has compelled me to consider the significance of the latter part of the quote, “a world outside of human space and time.”

By treating science as a culture, Traweek demonstrated that science, like the various cultures in the ethnographic record, differs in its conception of space and time. The multiplicity of divergent notions of space and time across cultures has often been used to challenge the idea of a singular, objective, and universal time and space (Harvey 1990; Grosz 2005). In anthropology, this idea has often been viewed as a cultural construct that can be unmasked by reflecting on its multiplicity. In this chapter, I aim to show how the multiple localities and temporalities of scientific research have the potential to further entrench the idea of a singular, objective, and universal time and space.

More specifically, this chapter argues that the multiple localities and temporalities of science can produce and obscure the locality of a "normal" temporality, which can give the illusion that science operates outside of space and time. In Mexico, this illusion has been adopted by the various institutions that determine many of the policies that govern the lives of researchers. Administrators at these institutions assume their researchers are participating in a world outside of space and time shared by all other researchers in every country. In contrast, the multiple temporalities experienced by Mexican researchers as they travel from labs abroad to those back at home offer key insights into how the temporalities of science are just as significant as the localities of science.

Laura Nader argued that "Western science is generally considered an autonomous activity – separate from social, political, or economic contexts, and even separate from technology" (Nader 1996:3). On the other hand, science outside of the West is often considered inextricably enmeshed in social, political, and economic contexts. This view of science creates a problem for scientists in developing countries like Mexico who have inherited Western thought and consider themselves part of Western culture yet are relegated to exist on the margins of Western science. While Mexico may not be geographically located in the West, it is Western in many important ways. As a result, it is important to challenge the notion of a monolithic West (Taussig 2009) while also calling into question assumptions embedded in Western thought that emerged historically from a decidedly European context (Chakrabarty 2000).

In this chapter, the "local" and the "global" are not used as starting points of analysis or preconditions but are, instead, viewed as the end products of complex processes (Helmreich 2009; Zhan 2009). In this way, I argue that science in Mexico develops through interaction with, rather than separate from, science in the U.S. and Europe. Indeed, science, like culture, is not static or bound by geopolitical borders although there are many ways in which scientific research can be shaped by a specific national context (Haraway 1989; Martin 1994; Traweek 1996; Franklin 2007). This chapter aims to show how Mexico's status as a developing country, its location outside of the West, and its close proximity to the U.S. all play an important role in the way Mexican biomedical researchers envision science, time, and their place in the international scientific community, which in turn affects the way they practice science.

Stefan Helmreich has noted that the metaphor of water has a long history in anthropology. He argued that it can be problematic when water is used strictly as a "theory machine," which he described as "an object in the world that stimulates a theoretical formulation" (Helmreich 2011:132). My use of water here, however, articulates with the empirical as well as social theory in order to highlight how time and marginality are experienced and understood by Mexican scientists while carefully avoiding the ways in which water metaphors can tend to naturalize power relations. Specifically, the emic metaphor of "turbulent waters" is used in this chapter because it offers a concrete way to visualize such abstract things as time and space. It also offers a way to think of science as fluid and constantly in motion as well as to offer a powerful analogy for how Mexican scientists struggle to compete in the international scientific community while surrounded in a dense and turbulent temporality.

Science in Mexico is connected to many types of places (physical, discursive, imagined) and multiple kinds of time (historical time, the experience of time, conceptions of time). These multiple spaces and times also run alongside, overlap, and interconnect with many other things. I highlight some of these connections throughout this chapter, not to give a totalizing account of a specific segment of a singular reality nor to argue that everything is connected (Strathern 1991). Following Bill Maurer, it is an attempt to "allow knowledges to lie alongside each other in their entanglements and durative becomings, as they continually divide, recombine, and exchange, in the meantime" (Maurer 2008:23). Therefore, this chapter draws on data from a wide range of sources, including interviews with biomedical researchers, participant observation, thought experiments, language, publications written by Mexican scientists, images, documentaries, and social theory, in order to construct an argument about space and time that has the potential to enrich our understanding of scientific knowledge production and practices in an increasingly globalized world of science.

Space-Time

During extended periods of time working in laboratories in the U.S. and Europe as post-docs or independent researchers, my interlocutors had felt time essentially speed up. Back home, expected and unexpected delays in getting key components to their experiments created the sensation of time slowing down or even standing still. Planning future projects in attempts to anticipate the invariable delays also forces them to envision where they will be in their research and their lives many months into the future. Moreover, it is not only the speed in which requested substances and materials arrive, but also the fact that the majority of lab work is not mechanized in Mexico, which causes these labs to operate less efficiently.

One biomedical researcher, Dr. Cervantes, told me that just two years ago she worked in a lab at a prestigious university in the U.S. that had nine machines that accomplish the majority of the time-consuming work in a genetics laboratory. Then, she paused, stared at me intently, and said: “In my lab, I have two. What more do I need to say?” After a silence that seemed to go on for several seconds, she slowly dropped the two fingers she had held up to me, and continued, “And, I am truly privileged to have two such machines in my lab. Most labs in Mexico do not even have one.” Of course this means that a great deal of the lab work in Mexico must be done manually, which requires far more time.

All of these factors give the sensation that time does not progress into the future at a constant speed, but rather varies tremendously. It speeds up, slows down, and even stops, many times without warning. Biomedical researchers in Mexico can feel like they are in the past, present, and future simultaneously. The slower temporality of their labs makes them feel like they are in the past. Their knowledge, training, and experience, which are at the same level as American and European researchers, make them feel like they are in the present. The need to plan their projects far in advance forces them to envision the many possible circumstances that will shape their future. For Dr. Morales, these divergent and often simultaneous speeds of science reminded her of the movement of water.

While the experience of time was central, it was also clear that space was an important component to understanding the experience of Mexican biomedical researchers for it was through their travels to the U.S. that these temporal differences were detected. Yet, the relationship between space and time is quite difficult to visualize. Theoretical physicists must constantly deal with this challenge, and they often develop what Albert Einstein called “thought experiments” in order to overcome this challenge. A 2010 biographical documentary[25] about the life of Einstein describes one of his famous thought experiments on space and time.

As the story goes, Einstein was on a bus in Bern, Switzerland where he worked as a patent clerk. As the bus began to leave, he looked back to see Bern’s famous clock tower and wondered what would happen if his bus were to travel past the speed of light away from the clock tower. He realized that as he would get farther away from the clock, the light from the clock would no longer reach him. Consequently, the hands on the clock would appear to be frozen in time while back at the clock tower he knew time was passing by normally. He suddenly realized that space and time were intimately related. In fact, this thought experiment compelled him to propose the idea that space and time were one and the same, or what he called "space-time," which had revolutionary effects in physics and many other disciplines.

Inspired by his thought experiment, I developed my own version of it. I imagined a map of North America. In the middle of the United States, there stood a giant clock tower. Next to the clock tower, I could see a laboratory where all of my interlocutors, clad in white lab coats, were busy conducting their experiments shoulder-to-shoulder with American researchers. I then allowed my eyes to travel downward to Mexico City where I could now see my interlocutors alone in their own laboratories. Despite the distance, they were all looking back at the clock tower keenly aware that while time was passing "normally" for the researchers back in the U.S., for them time had slowed down.

From the perspective of biomedical researchers in Mexico, it is the U.S. that determines what the "normal" temporality of science is. Continuing with the thought experiment, the everyday routine of doing science near the clock tower eventually renders its time normal. So normal, in fact, that for those who have always worked near that clock tower, it eventually fades into the background and becomes taken for granted. This reinforces the illusion that time is experienced in the same way no matter where one is in the universe. Under this framework, it can seem as though science does, indeed, occur outside of space and time. But for biomedical researchers in Mexico, it is all too apparent that time is not experienced in the same way everywhere. However, administrators at the institutions in which they work expect Mexican researchers to thrive in this imaginary world. As Dr. Morales emphasized, she cannot stop swimming because, if she does, she will lose everything. This makes the difficulty of the challenges that face biomedical researchers in Mexico quite vivid.

In fact, Dr. Morales emphasized just how challenging it is to be a researcher in Mexico. Upon grasping the extent of the pressures they face, I asked: “What would you say is the motivation of researchers in Mexico to continue doing research despite these overwhelming challenges?” She pointed to the whiteboard in her office where, during the course of the interview, she had drawn the three tiered system of the *Sistema Nacional de Investigadores* (National System of Investigators) and the four tiered system[26] of the *Universidad Nacional Autónoma de México* or UNAM (National Autonomous University of Mexico), where she is a researcher. Since 1984, all serious researchers in Mexico have become members of the National System of Researchers[27] while also working for a particular research institution. It was created to provide researchers with supplementary funds for their projects, which has substantially produced an increase in the number of publications by researchers in Mexico year after year since 1984. Each system requires regular submission of proof of publications in high-impact journals along with many other requirements that change continuously, oftentimes without notice. Dr. Morales said it would be the equivalent of preparing a tenure packet in the U.S.

Dr. Morales happened to be in the process of preparing her packet when I interviewed her. In order to show me just how much work is involved in this process, she found the packet she had been preparing and allowed it to fall on her desk in front of me. The two folders each over two inches thick caused a thud when they hit the desk, which demonstrated to me quite effectively the amount of proof researchers in Mexico are required to submit for these reviews.

These reviews vary from annually to every three or ten years depending on which system and which level one currently occupies in the tiered systems. If they fail to meet the requirements, researchers can be brought down to a lower tier and are subsequently given a pay cut[28].

While continuing to point at the tiered systems she had drawn on the whiteboard, Dr. Morales answered my question:

> Much of our motivation comes from that. I simply can't live on a basic salary. Anyway, where am I going to work? If I have a doctorate, outside of the UNAM or the centers of investigation, who is going to care that I exist? For most jobs, I am overqualified. But, what is the motivation? Well, for most of us it is because we like it. That is the reality. But now, why do we kill ourselves? And we really do kill ourselves because we know we can't go against the current. We can't lose *la carrera*. We have to try to continue on and plan for the next hurdle they [the institutions] are going to put in front of us.

I was intrigued by her use of the word "carrera." Carrera has multiple meanings. While it could be translated in English to mean "career" or "profession," it could also be translated to mean "race" as in a contest of speed. Interestingly, it seemed that both meanings were relevant to her predicament. By opting out of the National System of Investigators or leaving her position at UNAM, she would be free of their requirements and policies, but she would essentially have to accept a position where her doctorate and her many other accomplishments would go unrecognized. She would lose la carrera. She would lose her career because her doctorate, research, publications and everything she had worked towards for decades would become superfluous for any position she would be forced to accept. However, the challenges of keeping up with the institutional requirements in Mexico while also trying to swim with the current of the international scientific community made it apparent that Dr. Morales intended carrera as a metaphor for doing science. In other words, science is a race. It is a race she knows she cannot win, but she tries very hard to not lose because if she loses la carrera, she loses her career.

Science seen as a race implies movement. The rate of speed at which science moves has important implications. For instance, one only senses movement when one is not moving at a constant speed. When one is moving at a constant speed, one can forget that one is even moving. Consequently, in the most privileged research institutions in the U.S., science is like a beam of light traveling through space at a constant speed with nothing to interrupt its trajectory. When Mexican biomedical researchers worked in these kinds of labs in the U.S., science seemed to flow at a predictable and constant speed. Back in Mexico, delays in getting materials and sudden institutional policy changes produce hurdles that cause science to suddenly shift in speed or even halt abruptly, which creates the turbulence of uncertainty.

This constant rate of speed is what truly accounts for the normalizing effect of the temporality of science in the U.S. from the perspective of my interlocutors. The apparent constant speed of science in the U.S. creates the illusion that science occurs outside of space and time. Space and time are taken for granted because uncertainty and unpredictability are not part of that reality. It is through the experience of Mexican biomedical researchers that the multiple temporalities of science are made evident.

If science is a contest of speed, for biomedical researchers who practice science at a slower temporality than what is believed to be the "normal" temporality of science, there can be a very real fear of being left behind. This often has important implications for the direction in which scientific research proceeds in Mexico. As Dr. Morales emphasized, she cannot swim against the current. Many biomedical researchers in Mexico often choose to ride the current of the international scientific community because they do not want to be left behind.

Fear of Falling Behind

The thousands of aluminum hexagonal panels that adorn the curved surface of the Soumaya Museum in Mexico City caught the brilliant morning light of May 2, 2011 in unexpected ways. This made contemplation of its distinctive architectural design, for the moment, too harsh for my eyes. At the entrance to this art museum owned by Mexican businessman Carlos Slim Helú, who for the second year in a row had been named the richest person in the world, I was given a small pin with the logo for the *Instituto Carlos Slim de la Salud* (Carlos Slim Health Institute). It is a very simple logo of a midnight blue globe, crisscrossed with fine white lines representing the lines of latitude and longitude. The landmasses of North and South America are composed of tiny white human figures similar to the symbols used to represent male and female on the doors of public restrooms. The globe is turned at an angle making the flat white figures that represent the U.S., Canada, and Greenland curve along with the globe. This effect makes these figures appear smaller than those that populate the area below the U.S. with the obvious intention of making it more a map of Latin America than of the Western Hemisphere.

The symposium entitled "Use of Genomic Medicine in the Fight against Chronic Diseases" was organized by the *Instituto Nacional de Medicina Genómica* (National Institute for Genomic Medicine) and the Carlos Slim Health Institute. These two institutions along with the Broad Institute of MIT began a collaboration in January 2010 called the *Iniciativa Slim en Medicina Genómica* (Slim Genomic Medicine Initiative) with the stated goal of promoting the development of genomic research in Mexico and translating the knowledge produced through this research into preventive, diagnostic, and therapeutic technologies for the benefit of the

Mexican population and the world. Sixty-five million dollars were provided by the Carlos Slim Health Institute to fund this three year initiative.

The stage of the Soumaya Museum auditorium had an illuminated hot pink backdrop that contained a large high-resolution image of a double helix along with the logos of all three institutions and the Slim Initiative. Dr. Eric Lander, the founder and director of the Broad Institute with a Ph.D. in mathematics from Oxford, introduced Dr. Carlos Bustamante, a population geneticist from Stanford with a Ph.D. in biology from Harvard and a post-doc in mathematical genetics from Oxford. As the audience welcomed him with applause, Dr. Bustamante walked across the wood paneled stage, approached the clear podium, and commenced his talk entitled "Population Genetics in a Personal Genome Era." As a self-described Venezuelan, he chose to address the packed auditorium of approximately three hundred fifty predominantly Mexican biomedical researchers and graduate students in Spanish[29].

He began by emphasizing that 90 percent of studies on the genetic causes of diseases have been conducted solely on European populations. Consequently, he argued, more is known about the genetic causes of disease among Europeans. He emphasized that soon geneticists will be able to scan the genomes of individual Europeans in order to identify genes that increase the individual's risk for particular diseases, which will allow for early diagnosis, preventive treatments, and use of pharmacogenomics. It was underscored throughout his talk that *only* Europeans will benefit from these technologies.

Moreover, he explained that the International Hap Map Project[30] did not include the genetic material of the indigenous populations of the Americas. To offer proof that genetic research into these populations is absolutely crucial to understanding the genetics of Latin American populations, he presented a recent discovery made by a collaborative project between a biological anthropologist at the *Escuela Nacional de Antropología e Historia* (National School of Anthropology and History) and a researcher at the *Instituto Nacional de Nutrición* (National Institute for Nutrition). These researchers published an article in 2010, which states that they discovered a gene variant that is associated with low high-density lipoprotein cholesterol levels. This gene reportedly affects the levels of this "good" cholesterol in the body and is only found in Latin American populations. Dr. Bustamante emphasized that this important discovery would never have been made if the study had been conducted only on European, Asian, or African populations.

Scholars of science have been interested in understanding why science proceeds in the direction that it does dating back to when the notions of progress and Truth began to be challenged. Thomas Kuhn's concept of paradigms emphasized the significance of theory (Kuhn 1996). Others have argued that experimental and instrumental traditions also affect the direction in which science proceeds (Galison 1987; Rheinberger 1997; Hacking 1999). Steven Shapin and Simon Schaffer demonstrated that, from the beginnings of experimental science, the only valid questions were those that could be answered experimentally (Shapin and Schaffer 1985). Therefore, what the instruments can do or are believed to do by a community of scientists determine to a large extent the kinds of questions asked and the kinds of answers that are produced.

As a result, it is important to note that Dr. Bustamante's premise that Latin American populations are genetically distinct from other populations goes hand-in-hand with the technologies used to analyze the genetic material. For example, one commonly used technology is Ancestry Informative Markers[31] (AIMs), which is a digital database of the genetic markers that are believed to be unique to each distinct racial group. Yet, if one's starting point is that Latin

American populations are genetically different from Europeans, Asians, and Africans, the only reportable findings will be those that demonstrate the particular ways in which these groups are genetically different, for instance the presence of gene variants in one racial group that are absent in the other groups. This is an example of how laboratories have the potential to become self-vindicating systems when theories and laboratory technologies are perfectly attuned to one another (Hacking 1992).

Many scholars of science have raised concerns about the use of AIMs technology in genetic research. Duana Fullwiley explained that this methodology is designed to bring about a correspondence between "body traits made meaningful through conceptions of race ... and supposedly politically and socially neutral DNA" (Fullwiley 2008:17). Others have argued that "research that attempts to explain disease prevalence between human groups using such techniques as AIMS will almost always conflate the descriptors of the population with the attributes of the population" (Paradies, et al. 2007:208), a process Michael Montoya calls "bioethnic conscription" (Montoya 2011). In this way, the conclusions drawn have the potential to be the product of the a priori categorization, rather than the data (Strathern 1991; Latour 2005; see also Cohen 1998).

Significantly, use of technologies like AIMs can give this race-based approach to genetics an air of objectivity because it is not the scientist claiming that races are genetically different, but rather the technology itself. The genetic basis of race is an embedded and unquestioned assumption in the AIM s technology or what Bruno Latour has called a blackbox (Latour 1988). Moreover, scholars of science have shown how scientific instruments have been historically thought to be objective because, as non-humans, they are not subject to the limits of human perception or human biases (Shapin and Schaffer 1985; Latour 1987). However, objects, including scientific instruments, are never separate from people. People embed objects with various assumptions about reality, and people transform objects in various ways once these objects become things in the world (Mol 2002; Dumit 2004; Jain 2006).

While there are many factors that contribute to why science proceeds in the direction that it does, my research in Mexico shows that the experience of the multiple temporalities of science and the idea that time is singular, linear, and progressive can also be contributing factors. For instance, Mexico has often come to accept theories together with technologies specifically because they are used in the U.S. or Europe. Many in the scientific community in Mexico have criticized this as the "me too" approach to science. If the U.S. or Europe has it, these critics say that some Mexican scientists want to be able to say, "me too." This is one example of how science in Mexico develops through interaction with, not separate from, the U.S. and Europe. There is the sensation that science in the U.S. and Europe is on the tip of the arrow of time speeding off into the future at a constant speed while science in Mexico is always lagging behind, sometimes farther away than other times, and they are never able to close the gap. The "me too" approach to science is one attempt to close that gap. It is important to note that the current of research created by American and European researchers oftentimes goes unquestioned and unexamined because the sum total of their work is assumed to constitute a single future of science. This view of the future not only produces a fear of being left behind, but also a desire to be included in that future.

Crisis

At the end of his talk, Dr. Bustamante warned the audience: "If you don't do it, if you don't take the reins, if you don't see it as an important challenge, then no one else is going to do it. This is something you must do. This needs to be done so that it will translate into benefits for the entire world." This perspective on genetic research creates a sense of urgency that there is a need to understand how Latin American populations are genetically different from the rest of the world. Dr. Bustamante's talk emphasized that Mexican biomedical researchers are essentially losing the race to find the causal relationship between genetics and disease in their population. They are being left behind in science, and medicine in Mexico will be forced to combat diseases in obsolete ways while Europeans will have more modern technologies.

Peter Redfield has raised concerns about the rhetorical power of crisis. He argued that decisions made in the face of crisis can often be assumed or expected to be completely closed off to critique (Redfield 2005). In science, basing the decision to follow a particular line of research because of a sense of urgency or crisis has the potential to reify a very particular view of the future which goes unquestioned. Moreover, this sense of crisis exacerbates the fear of being left behind and fuels a desire to be a part of that future.

Throughout my ethnographic project in Mexico City at symposia, colloquia, conferences, and during interviews, biomedical researchers in Mexico tended to repeat the arguments made by Dr. Bustamante, oftentimes specifically mentioning him. They often propose changes to policies related to scientific research as well as changes to the direction of research in Mexico as a result. What becomes crucial in the case of Mexico is Mexico's proximity to the U.S. They are close enough to still see the clock tower, so to speak. They have lived and worked in the U.S., they go to conferences in the U.S regularly, and collaborate with American institutions and researchers. These experiences have made clear that their training as scientists is on par with researchers in the U.S. In fact, several Mexican biomedical researchers expressed to me that they had enjoyed their experiences in laboratories in the U.S. because it gave them the opportunity to confirm that they had, indeed, received the same quality training as the U.S. trained researchers. Yet, the proximity of the U.S. to Mexico gives the impression of being tantalizingly close to reaching that level of science in Mexico. It also causes academics and scientists from all disciplines in Mexico to constantly wonder, what is Mexico doing wrong?

After an interview, I was collecting my things and preparing to leave the office of Dr. Emilio Guzmán, a prominent scientist in Mexico with a Ph.D. in chemistry. As I shook his hand to thank him for his time, he gave me some chapters and said, "I think these will be important for your project." One was a 2010 editorial in *Nature Materials*. It was written in English by a scientist from Mexico with a Ph.D. in physics named Dr. Jesús Rogel-Salazar, who was a lecturer of physics, astronomy, and mathematics at the University of Hertfordshire, U.K. at the time of the chapter's publication. The title of the editorial was "Mexico Must Do More." The author states that "Mexico's scientific and technological output clearly lags behind its potential." He cites a statement made by Dr. Arturo Menchaca Rocha, an accomplished physicist and the President of the Mexican Academy of Sciences that "only 0.7% of publications indexed by the Institute for Scientific Information Web of Knowledge are from Mexico, despite the country's 1.6% share of global population." The author underscored two central concerns for science in Mexico, the severe underfunding of science and technology in relation to the country's GDP and Mexico's enormous dependence on foreign technology.

As I was reading the chapter, however, what caught my attention was the image right in the center. It was a picture of the famous pre-Colombian structure at one of the most visited archaeological sites in Mexico called Chichen Itzá. I was immediately fascinated by its appearance in the chapter and by the caption below it, which read, "The ancient Mayan observatory *El Caracol* in Yucatán is a testament to the long scientific tradition in this region." Of the many complex societies that developed in what is now Mexico, the Maya are often singled out for their advanced understanding of mathematics and science. It was from that observatory that the Maya are believed to have observed and recorded the movements of the planets, the stars, and the moon. It is believed that they were able to predict eclipses and the appearance of comets. Indeed, the Mayan observatory can also be found on the logo for the Mexican Astronomy and Astrophysics Journal.

Figure 5. Logo for the Journal of Mexican Astronomy and Astrophysics.

Tracing back the history of science in Mexico to pre-Colombian cultures is not uncommon among intellectuals and scientists in Mexico. On many occasions, I heard academics trace the origins of their respective disciplines to pre-Colombian cultures. Indeed, contemporary scientists in Mexico often see themselves as descendants of these “ancient scientists.” For example, in October 2010, I attended a biomedical conference organized by INMEGEN in Mexico City. A presenter from the U.S. began to address the audience of about five hundred biomedical researchers and graduate students from Mexico in Spanish. About midway into his PowerPoint presentation, he came to an overly saturated slide filled from top to bottom with strings of numbers and calculations. He began to explain how those numbers were obtained when suddenly, he stopped, looked at the crowd, and said: “Well, I guess I don’t have to explain math to the descendants of the Maya and Aztec.” There was a loud collective laugh from the audience as he skipped to the next slide in his presentation.

By highlighting the accomplishments of pre-Colombian cultures like the Maya, many in Mexico insinuate, often with great lament, that Mexico *was* on a path towards progress. Independently of the West, this group of people had developed the concept of zero and an incredibly accurate astronomical calendar, but it is emphasized by many in Mexico that their progress was interrupted. Many argue that it was the Conquest of Mexico that caused this interruption in progress. To put it differently, had the Conquest not occurred, Mexico might have been able to achieve the greatness achieved by Europe and the U.S. While the Conquest undoubtedly had countless important ramifications, what is significant here is that this perspective is based on the assumption that time is singular, linear, and progressive.

Because Mexican biomedical researchers often envision the U.S. and Europe ahead of them in a single linear path toward the future, they often tend to see the immediate future as a completed project created by the U.S. and Europe. In many ways, there is the assumption that the U.S. and Europe are the architects and builders of the future. Moreover, “Western” and “modern” are frequently assumed to be synonymous (Latour 1993; Fabian 2002). In Mexico, this view of the future consequently affects the kinds of research questions they ask in the present. As Dr. Morales explained, researchers in Mexico can do cutting-edge work but they think “why should we, if by the time we get the reagent the results will already be published?” As a result, it is not only the past that affects the present, but also perceptions of the future that affect the present. This is exacerbated by the rhetorical power of crisis used by Dr. Bustamante that postulates that a particular future in genomic science already exists from which Mexican scientists are being excluded. In fact, the rhetorical power of the future has been central to genomic science from its beginnings (Fortun 2008; Sunder Rajan 2009).

Dr. Morales described science as a current she must struggle to navigate. Rivers, albeit limited, are a useful way to visualize science. They flow at different speeds simultaneously and at different moments in time. The main current of a river is the fastest and the one most often traveled. If a river splits into several channels, the alternative channels are often called the backwaters. Yet rivers are not static and never impervious to human activity. As Hugh Raffles noted in his book, *In Amazonia*, even the course of the largest river in the world, the Amazon River, has been continuously altered by human activity (Raffles 2002). In other words, the course of rivers, just like the course of science, is not predetermined or unchangeable.

From the perspective of biomedical researchers in Mexico, science in Mexico must content itself with always trailing behind the science of the U.S. and Europe or traveling alongside it in the "me too" approach to science. For others, it may seem that science in Mexico is forever doomed to exist in the backwaters of science. However, water is not confined by national borders, just as science is not. It is rather simplistic to claim that all laboratories in the U.S. operate at a faster temporality than all laboratories in Mexico. As mentioned earlier, even labs affiliated with different institutions within Mexico operate at very different temporalities. This is true of labs in every nation, including the U.S. and Europe. In other words, the multiple temporalities of science cannot be neatly plotted onto a geopolitical map. There are backwaters to science everywhere.

When Backwaters Become the Main Stream

A science television program narrated by Morgan Freeman[32] started with an interview with Dr. Vera Rubin, who is an accomplished astronomer now in her eighties. Dr. Rubin began to tell her story, “I had two children, one almost two and one almost four. And, I didn’t like the idea of competing with astronomers for real hot topics.” Then, the unmistakable voice of Morgan Freeman continued as an image of a young Dr. Rubin looking up from a telescope filled the screen: “Vera Rubin knew that if she studied something sexy like black holes, other astronomers would end up beating her to publication so instead she began surfing the galactic *backwaters*.” Instead of swimming with the current of science, Dr. Rubin had decided to conduct research in an area of science where there was no current. She chose to study something she knew no one else in her field was interested in at the moment.

The program continued with Dr. Rubin reflecting on the past, “I’m not really sure why I started studying galaxies except that they seemed very mysterious to me and there was not a lot known about their motions, almost nothing.” According to the program, she began looking at the Andromeda galaxy where she expected to find that the stars would orbit the center of the galaxy just as the planets of our solar system orbit the sun. In our solar system, the closer the planet is to the sun the faster its orbit, but after two years of tracking ninety stars in the Andromeda galaxy she discovered that they were all moving at the same velocity: 250 km/second. She came to find that this was true of other galaxies as well. She explained, “There must be very significant amounts of matter that are invisible. Perhaps 90 to 95 percent of the material in the galaxy is invisible.” That invisible material is now known as dark matter, which has had revolutionary effects in astronomy and other disciplines as well.

The program segment concluded with Dr. Rubin saying, “I did find it amazing and amusing that I had picked this field because I was interested in doing something that no one would care about.” As she continued, a picture was displayed where she is shown shaking the hand of President Bill Clinton. “Suddenly, I was involved with lots and lots of astronomers who had ideas and observations, and it was a hot topic." Indeed, she had almost single-handedly converted the galactic backwaters into the main stream of astronomy.

Dr. Rubin's story demonstrates that there can be backwaters to science everywhere, including in the U.S. Although my interlocutors may feel that the U.S. is ahead of them because they are comparing U.S. labs with their labs back at home, Dr. Rubin's story makes clear that science within the U.S. also operates at a wide range of temporalities. Scientists in the U.S. also choose particular research questions based on their keen awareness of these multiple temporalities. Not all American scientists work under the illusion that science operates outside of space and time. One of the reasons many Mexican biomedical researchers feel this enormous temporal gap between the U.S. and Mexico is because they often work at some of the most privileged laboratories in the U.S. It is at these very privileged labs in the U.S. that time and space are taken for granted. In other words, these very few privileged laboratories in the U.S. are believed by my interlocutors to represent the "normal" temporality for all science in the U.S., but this is clearly not the case.

The story of Dr. Rubin also demonstrates how the backwaters of science always have the potential to become the main stream. Accordingly, what is thought of as the backwaters of science is not necessarily doomed to be the backwaters for all time. Although there are institutional and infrastructural obstacles in Mexico that slow down scientific research in very particular ways that are important for understanding science in Mexico, it is crucial to note that this slower temporality is not unique to Mexico. Science should not be viewed as a something that is confined to particular places but rather that science operates at a wide range of temporalities across a wide range of localities. Interestingly, it seems that a growing community of researchers in Mexico has begun to benefit from this idea. Since they know they cannot swim against the current, and many do not want to simply ride the current of science in the U.S. and Europe, they have decided to create an alternative current.

In Mexico, scientists are beginning to find ways to speed up the flow of science. While many scientists in Mexico continue to make demands on the government to spend more on research and development of science and technology, which more often than not fall on deaf ears, some scientists in Mexico have discovered a way to circumvent the bureaucracy that slows down science in Mexico. Ordinarily, researchers at the most privileged institutions in Mexico like UNAM request materials, which reach them approximately two months later. When researchers in the less privileged institutions need something, they must provide their institution with three price estimates for each requested item. Their institution then decides which one is within the institution's budget and the requested items may be ordered. These materials can take up to six months to reach these researchers, if and when they are ordered.

One of the challenges for many researchers is that their laboratories are part of the public healthcare system. Therefore, administrators are expected to address the needs of the patients prior to considering spending money on laboratory materials and technology for scientists. Dr. Cervantes gave the example that if the hospital is faced with the decision to buy either a tomography machine that will benefit patients or a machine for the researchers, the hospital is expected to buy the tomography machine. Although the researchers agree that patientcare should be the priority, they feel the federal government should provide more funds so that there will be enough for the researchers to improve their laboratories.

Recently, researchers in Mexico City have been trying something new. Through a listserv they have created, they have begun to contact each other directly requesting particular substances or materials from their fellow researchers. Anyone who is willing to share these items responds and, once they are in contact, they arrange for a way to get what is needed to the researcher in need of that item. They share expertise in this manner as well. When someone stumbles upon some aspect of their research project they do not know how to do, they solicit the help of anyone interested in sharing their expertise. All of this leads to collaborations and co-authorships.

This approach has effectively served to shorten the wait time for necessary materials which increases the speed of their projects. More importantly, the new network also helps researchers deal with unexpected delays and abrupt changes to policies because they can make adjustments to their research projects or develop new projects immediately, rather than having to wait months for the necessary materials to arrive. Therefore, not only does this network speed up the temporality of their labs in Mexico but it also helps absorb the shock of the turbulence of uncertainty.

These researchers allow materials, expertise, access to machinery, and anything else they might need to flow more efficiently and effectively. It has also been an attempt to bring together researchers from multiple research institutions throughout Mexico City so they are not alone in their labs staring at the clock. Rather, this new network of researchers consolidates and shares its resources in ways that are more efficient than the way in which the bureaucracy is currently set up. This innovative approach gives Mexican biomedical researchers the opportunity to do the cutting-edge research they are fully capable of doing. It also has the potential to render inconsequential the bureaucratic and infrastructural obstacles that previously interrupted and obstructed the flow of science in Mexico. More ambitiously, this approach may compel administrators to change their policies and do more to encourage and support scientific research in Mexico.

Conclusion

"Scientific activity is not 'about nature,' it is a fierce fight to construct reality," Bruno Latour and Steve Woolgar famously wrote (Latour and Woolgar 1979:243). Based on my research among Mexican biomedical researchers, scientists appear to be less concerned with the construction of reality and more preoccupied with the construction of the future. I would agree with Dr. Morales that science is a carrera. It is a race, a race to settle the future, where "settle" means both to resolve definitely and conclusively, and to take up residence. Indeed, science is a space-time that is constantly being settled, unsettled, and resettled. The way scientists construct that space-time and perceive their position in relation to it has important implications for how science is practiced and the knowledge that is produced.

In this chapter I have argued that scientists are not merely "in" time, but are actively constructing multiple kinds of time, some of which have a spatial dimension. Whereas temporal pluralism has often been used to call into question a singular, universal, and objective notion of time, I have argued that temporal pluralism also has the potential to reinforce a belief in it. These multiple temporalities and spatialities not only have the potential to reinforce the idea of a singular, universal, and objective time, but they also can lead to a conflation of time and space and the idea that a "normal" temporality of science exists. In other words, places where science appears to operate at a constant and predictable speed can come to be viewed as localities where the "normal" temporality of science can be found.

In Mexico, the various constructions of time and space have the potential to produce a fear of being left behind and a desire to be a part of the perceived singular future of science. The temporalities of science that biomedical researchers experience in Mexico come to be viewed as an aberration that requires an explanation and correction. However, the explanations and corrections Mexican scientists propose are often based on the assumption that time is singular, linear, and progressive. All of this affects how science is envisioned, the kinds of research questions that are pursued at particular moments, and the general direction in which scientific research proceeds. Gaining a better understanding of the role of temporality and spatiality in science will improve our understanding of scientific knowledge production and practices.

CHAPTER FOUR

Writing Genomes: Witnessing the Virtual Future of Genomic Medicine

Introduction

"El Genoma en un Chip" (The Genome on a Chip), written in large capital red letters, was the title of the cover story of the May 2008 edition of *Information Week México*: *Business Innovation Powered by Technology*. A picture of Dr. Jiménez Sánchez, the director of INMEGEN, wearing a white lab coat over his pinstriped long-sleeve shirt and a green patterned tie fills the entire page. He is holding a black and white chip made by Affymetrix, which is a little smaller than a flip phone, in both hands while leaning his right elbow on the machine used to read the chips. The subtitle states, "The technological foundations for the study of the human genome have been established. Soon, every individual will be able to carry his genetic information on a chip and, with it, predict diseases and improve his quality of life."

Another large picture of Dr. Jiménez Sánchez holding the chip can be found in the table of contents. The caption reads much like the first, "In a few years, medicine will be totally predictive thanks to Information Technology. We will all carry our genetic information, including our predisposition to certain diseases, on a chip." The caption under the actual article is a little more conservative about how soon this will become a reality. It reads:

> In less than 20 years we will be able to carry our individual genome, or personal bar code, on a chip. The nature of medicine will be radically transformed, by becoming predictive, with the consequent savings in costs and the improvement in the quality of life of Mexicans. Powerful supercomputers and other new and more economical technologies are making it possible.

The article continues, “Behind this ambitious project, technology plays a fundamental role. It is enough to imagine that it involves reading a text of 3,000 million letters.” It explained that “the project had two objectives: identify every letter and locate every gene; in other words, the paragraphs in the text that give the precise order. The order is written in long and short paragraphs.” Jiménez was quoted in the article explaining, “It is just like being able to write Don Quixote or the yellow pages in Spanish, the order can affect the instruction, which can be fatal, like death in utero or an adverse reaction to pharmaceuticals. Every letter counts and the order counts.”

The article quotes Dr. Jiménez Sánchez saying “Mexico is on the frontier of technology and this is not usual. We have made a commitment to genomic technology. This national development is noteworthy.” The next page has another full page picture of a smiling Dr. Jiménez Sánchez reaching into a bin of hundreds of chips with both of his hands. This time the words “The Genome on a Chip” are in blue. The article continues by mentioning that INMEGEN has established connections with MIT, Harvard, and the Broad Institute, which specializes in genomic medicine. These institutes will work together to conduct a study related to diabetes and breast cancer. The article continues, “Created in 2004, INMEGEN has not only established the technological bases for the study of genomic studies but has also become a ‘fast follower,’ says Jiménez, to the best in the world.” The article states that his objective is to become one of the leaders in this field, especially in Latin America, “where no other country is doing genomic medicine.” Dr. Jiménez Sánchez emphasized ‘not by a lot.’

COVER STORY

EL GENOMA EN UN CHIP

POR **MÓNICA MISTRETTA**
FOTOS: **FERNANDO CANSECO**

En menos de 20 años se podrá llevar el genoma individual, o código de barras personal, en un chip. El carácter de la medicina se transformará radicalmente, al convertirse en predictiva, con el consecuente ahorro en costos y la mejora en la calidad de vida de los mexicanos. Poderosas supercomputadoras y otras nuevas y más económicas tecnologías lo están haciendo posible.

OBESIDAD, INSUFICIENCIA CARdiaca, hipertensión, tabaquismo, son todos desórdenes cuyo posible desarrollo podrá ser evitado al conocer el mapa genómico de los mexicanos. A futuro, cada uno podrá llevar su información genética en un chip.

Detrás de este ambicioso proyecto la tecnología juega un papel fundamental. Basta imaginar que se trata de leer un texto de 3,000 millones de letras. La bioinformática o biología computacional permite el manejo de esta gran cantidad de información, la comparación de secuencias en forma masiva, el análisis de bases de datos y el estudio de la expresión de los genomas.

Un mapa genómico nacional como el que el Instituto Nacional de Medicina Genómica (Inmegen) trabaja desde 2005, puede reducir hasta 40% el costo de estudios genéticos que no cuentan con la información sobre la estructura del genoma. Una vez que concluya mapa genómico o de haplotipos, que se encuentra su segunda fase, México contará con cerca de un illón de SNP (*Single Nucleotid Polymorphism*) que falitarán el análisis de los genes mexicanos asociados n el desarrollo de las enfermedades más frecuentes tre la población local.

Entonces sí se podrá hablar de medicina preventiva, que redundará en enormes ahorros en la atención a salud y en una mejor calidad de vida. "México está en frontera de la tecnología, y esto no es habitual. Hemos trado de lleno a la tecnología genómica. Este desarrollo cional es de destacarse", afirma orgulloso Gerardo Jiénez Sánchez, director general del Inmegen.

Gerardo Jiménez Sánchez, director general del Instituto Nacional de Medicina Genómica (Inmegen) y sus chips.

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Figure 6. Dr. Gerardo Jiménez Sánchez holding genome chips in the May 2008 edition of *Information Week México*: *Business Innovation Powered by Technology*

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In *The Leviathan and the Air-pump*, Shapin and Schaffer explained that from the beginnings of experimental science, "attention to the writing of experimental reports was of equal importance to doing the experiments themselves" (Shapin and Shaffer 1985:63). Moreover, Robert Boyle went through great lengths to ensure that the images of his scientific instruments were accurate in his reports. Indeed, toward the end of the 17th century, a different approach to nature emerged; one that emphasized uniform and inviolable laws (Locke and Nguyen 2010). Scientists at this time attempted to control the activity of illustrators who depicted objects found in nature in order that only truthful representations be created (Daston and Galison 2010). Although the meaning of images is not fixed, images can be constructed in such a way as to promote particular interpretations with very particular objectives and with very real effects, particularly if these images appear repeatedly over time (Chavez 2001; Lutz and Collins 1993; Dumit 2004).

For Boyle, images were not only intended to represent nature as it really is, but also serve as proof that the experiments were really done and that they were done in the way described in the text. In other words, images “allayed distrust and facilitated virtual witnessing” (Shapin and Shaffer 1985:62). According to Shapin and Schaffer, “The technology of virtual witnessing involves the production in a reader’s mind of such an image of an experimental scene as obviates the necessity for either direct witness or replication” (Shapin and Schaffer 1985:60). In the age of genomics, the technology of virtual witnessing has shifted away from future witnesses of the past to create present witnesses of the virtual future; a future that partially exists somewhere but not everywhere. It is a technology of virtual witnessing that obviates the necessity to question the possibility or the benefits of that future.

In the article in *Information Week*, the text stated that the future of medicine will entail carrying our genomes on a chip. The images of Dr. Jiménez Sánchez with the genome chips signal that the future being described in the text, one in which “we” will all carry our genomes along with our predispositions to certain diseases on a chip, already exists. The chips are already there in his lab along with the machines necessary to read them. The images of Dr. Jiménez Sánchez with the bin of chips are a way to convince readers that the number of chips needed to usher in that particular future also exists. The chips are there, waiting to be written with “our” individual genomes. It aims to convince the readers that it is just a matter of time before this future reaches them. The future is physically present in a present albeit not in “our” present, just as future readers of Boyle’s reports were not present during a particular past, but Boyle did everything he could to make them believe that that particular past had occurred.

In *Aramis or the Love of Technology*, Latour showed how designers of technology involved in the projection of a state of technology years into the future must create fictions

(Latour 2002). They must attempt to convince others that they know where the network will lead. In this way, he likens designers of technology to novelists. He noted only one key difference: “their project – which is at first indistinguishable from a novel—will gradually veer in one direction or another. Either it will remain a text... or else it will be transformed into an object” (Latour 2002:24). This chapter examines how virtual futures are written in the field genomic science; futures that partially exist in the present in such things as texts, images, talks, and technology such as genome chips, but are still not fully here and may never be fully here or anywhere. Genome chips may one day be written with our genomes or they may be written into the history books as something that could have been but never became a completed reality.

DNA itself is often described as a text, the book of life. Indeed, in the article, the author calls it a “text of 3,000 million letters” that is written in “long and short paragraphs.” Moreover, to emphasize that the order of information matters, Dr. Jiménez Sánchez said it could be the difference between the masterful novel like *Don Quixote* and the yellow pages. The metaphor of the book is based on the idea that DNA is a language written in four letters: A, C, G, and T. However, as Helmreich has noted, “DNA is not a language—it has neither grammar nor semantics” (Helmreich 2009:60). Following Martin’s call to “wake up sleeping metaphors in science,” (Martin 1991:501), this chapter also examines the metaphor of DNA as the book of life in order to discuss the ways it may influence knowledge production and practices in the field of genomic science in Mexico as well as how time is envisioned and constructed.

In the article, Dr. Jiménez Sánchez also makes a point to emphasize the prestigious institutions of Harvard and MIT involved in the study to allay distrust in the statement that Mexico is on “the frontier of technology,” which as he admits is unusual. Indeed, in chapter 2 I showed how a *deficiency* in technology is a major source of concern for scientists in Mexico.

The relationship with Harvard and MIT serves to bolster trust in Dr. Jiménez Sánchez's statements. As Shapin and Schaffer explained, during Boyle's time, "the credibility of witnesses followed taken-for-granted conventions of that setting for assessing individuals' reliability and trustworthiness: Oxford professors were accounted more reliable witnesses than Oxfordshire peasants" (Shapin and Schaffer 1985:58). Harvard, MIT, and the Broad Institute, essentially serve as reliable "witnesses" for the statements made by Dr. Jiménez Sánchez. He also emphasized that Mexico through the creation of INMEGEN is following fast behind "the best in the world" and is way ahead of the rest of Latin America. This is another way to convince readers of the reality of that future; a future that "the best in the world" are actively and rapidly transforming into a reality. The idea that Mexico is just behind the U.S. and Europe and its effects on science in Mexico was discussed in more detail in chapter 3.

As Latour argued, in order to "follow a technological project, we have to follow simultaneously both the narrative program and the degree of 'realization' of each of the actions" (Latour 2002:81). This chapter examines the ways a future, where an individual's genome can be written on a chip and be used in preventive medicine through an examination of our predispositions to certain diseases, is both here and not here. It traces the efforts of key figures to try to convince others that a particular future is almost a reality and how they try to convince biomedical researchers and students in Mexico to participate in making it a real reality and not a virtual one.

Mexico's Place in Genomic Science

During the summer and fall of 2010, I audited a graduate-level course called "Introduction to Proteomics," which was a class of 16 graduate students from various fields including biochemistry, molecular biology, and medicine. Proteomics is the study of proteomes and their function. A proteome is the entire complement of proteins that is synthesized by a cell or organism at a given time.[33] It is a blend of the word "protein" and "genome," which, according to the professor, was coined in 1994. Unlike the genome, the proteome is constantly changing due to the influence of intracellular and extracellular factors. In other words, every "reading" of the proteome can potentially be different as a result of the many factors that affect which proteins are synthesized at any given moment. It is a fascinating and incredibly complex way of looking at the interactional relationship between genomes and the environment.

At the end of our class on August 30, 2010, the professor announced that there was going to be an event at INMEGEN on September 9. Eric Lander from the Broad Institute was scheduled to give a talk. The professor highly recommended that we all attend. He then asked, "Has anyone been to the new INMEGEN building?" Two students raised their hands. He continued with excitement in his voice, "*Las instalaciones son de primera*. (The facilities are first-rate.). It is truly something Mexico can be proud of." Chapter one discussed how INMEGEN has come to be viewed as a sort of monument to progress and modernity in Mexico. As I walked out with the other students, all of us said we would be attending the event and that we would see each other there. The majority did indeed attend the INMEGEN event.

When I walked into the main conference room at INMEGEN on the day of Eric Lander's talk, it was almost completely full. I had to find a seat in the last row at the top section of the room, which only had a few empty seats left. From the top, it seemed that the majority present were between 20 and 40 years old. It seemed possible that many professors from different institutions had recommended that there students attend the event, just as the professor of the class I was auditing had recommended we attend. There were also many attendees in white lab coats suggesting they had interrupted their work at their labs just to attend the talk.

The main conference room at INMEGEN is quite nice. The oak color hardwood floor of the stage, the theater-style seats, a large projection screen, and a second level adorned with curved wooden panels were all brand new. In fact, when he began his talk entitled, "10 years after the Human Genome Project: Challenges and Opportunities for Developing Countries," there were still issues with the sound system. A loud high pitched sound filled the room several times before it was finally remedied. The facility was still under construction and the conferences rooms were only recently beginning to be used for these kinds of events. INMEGEN laboratories continued to be housed on two floors of a six story building just down the road. Once the new facility was complete, INMEGEN would be moving their operations to this new, permanent location.

Eric Lander began by reviewing events surrounding the mapping of the human genome and he briefly listed the other maps that emerged after that: genetic map, physical map, sequence map, 3-D folding map, gene map, and evolutionary map. Then, he switched to technology by asking a question, "What has happened to sequencing technologies in the last decade?" To which he responded, "More powerful machines." He also explained how "genetics has experienced the fastest decrease in cost in any industry and any technology. The costs have plummeted far below what Moore's law would have predicted." He showed a graph which illustrated what Moore's law would have predicted and where genetic technology is currently in terms of cost. He said that this has produced "unimaginable quantities of data."

Moore's law is was named after the co-founder of Intel, Gordon E. Moore, who wrote a 1965 paper describing his observation that, in the history of computing hardware, the number of transistors in a circuit had doubled every two years. It has also come to mean that over time technology becomes less expensive. His law has become a law in part because it is used in the computing industry to guide long-term planning and to set targets for research and development . It is an example of planned obsolescence in the computer industry. It is an example of how a prediction about the future can become a reality when others accept it as the way the future will be.

He went through an extensive list of things that have been found since the mapping of the genome. For instance, there are many fewer protein-coding genes than expected. Before they thought there were 100,000 genes that code for proteins. However, by 2007, that estimate had dropped to 21,000. By the end of his hour long talk he said, “Most of the secrets are yet to be discovered. Mexico is playing a major role especially through the creation of INMEGEN.” He showed a blue map of the world with Mexico colored yellow to show that it is the only country with a National Institute for Genomic Medicine in the world.

The floor was then opened up for questions. A science journalist stood up and mentioned that Mexico was going to be celebrating its 200th anniversary in a few days. He asked, “What do you think is going to be going on in science in the next century?” Lander responded by saying that it was impossible to make such predictions. He said, “Next year OK, next 5-10 years OK. We predict what we must to maximize investing in young people.” He continued, “In the 200th anniversary, Mexico should reflect, is it investing like the kind of country it wants to be?” There was a very loud applause that lasted over ten seconds and I saw many in the crowd smiling.

Another person approached the microphone to ask, “In these ten years, what has resulted from the mapping of the human genome?” Lander responded by saying:

> “As readers of the human genome, *we* are ten-year-olds. Ten-year-olds usually aren’t good at reading sophisticated stuff. After all these years, we are still utterly ignorant about cell pathways. The media and journalists promised too much. Science doesn’t work

that way. We don't know enough. It's like an alien technology arrives on earth and we are supposed to fix it."

Lander's talk aimed to show how genomic medicine was increasingly becoming possible because of the massive reduction of costs and the advancements in sequencing technology. In other words, the technologies exist and the cost to conduct the research is more reasonable. The only thing that remains for a future in which genomic medicine exists is being able to read the genome effectively. The future is there, written in our genomes. It just needs to be read. But, as he said, in terms of their ability to read the genome, they are still at the reading level of a ten-year-old.

In *Promising Genomics*, Fortun argued that "genomics *must* be analyzed in terms of the promise, because promising is an ineradicable feature of genomics" (Fortun 2008:10). Lander attempts to make a distinction between predictions and promises by explaining that there are *necessary* predictions and *unreasonable* promises. He said he *predicts* what he must to maximize investing in young people. It was the media and journalists who had *promised* too much. He sees prediction as a necessary aspect of doing science but that it should be done within reason. As he said, he could make predictions for next year and maybe five to ten years from now but not more than that. It would seem that he has accepted a more conservative approach to the future because of all the negative consequences that hype and speculation has had on the field of genetics.

As we all walked out of the conference room, we were all given a CD and a poster entitled "Chronology from the Human Genome to the Map of the Mexican Genome." It was the only time I was given a CD after a talk in Mexico. Once I was able to, I put the CD in my laptop and found that there was a five-minute podcast produced by INMEGEN entitled "What is

Genomic Medicine?," there was also the poster for Eric Lander's talk, and a digital version of the poster we were given.

The large poster was a timeline created by INMEGEN. The hard copy unfolded to the size of four standard size pieces of paper. It had color images to illustrate each milestone in the history of genetics leading up to the Map of the Mexican Genome. A stylized, silver double helix runs across the middle dividing the timeline in two. The timeline begins with Gregor Mendel publishing the laws of inheritance in 1866 and continues with Friedrich Miescher, who identifies nuclear DNA in 1866, Albrecht Kossel, who discovers nucleic acids in 1881, and Alfred Hershey and Marta Chase, who use a virus to confirm that DNA holds genetic material in 1950. Next, the first protein, insulin, is sequenced in 1951. Then, James Watson and Francis Crick discover that the structure of DNA is a double helix in 1953, followed by the development of the genetic code in 1960. 1982 marks the year that the first pharmaceutical based on recombinant DNA technology is produced.

The timeline continues with Kay Mullis, who invents polymerase chain reaction in 1985. In 1990, the human genome project begins which is financed by the U.S. government and led by Francis Collins. In 1995, the private human genome project by Craig Venter's Celera Genomics. The first human chromosome is sequenced in 1999. In 2000, President Clinton and Prime Minister Blair announce the first complete draft of the human genome. This first draft is published in 2001. In 2002 the International HapMap begins. In 2004 INMEGEN is born in Mexico. In 2005, the Mexican genome project begins with a chapter in Yucatan followed by Zacatecas, Veracruz and Guerrero. In 2006 inauguration of high technology units and the continuation of the Mexican genome project with chapters in Guanajuato and Tamaulipas. In 2007, the continuation of the Mexican genome project with chapters in Oaxaca, Durango, and

Campeche. In 2009, it is the official announcement of the publication of the Map of the Mexican Genome by President Felipe Calderon. The chronology ends very optimistically with the phrase "*Lo mejor está aún por venir*..." (The best is yet to come.).

The talk by Lander emphasizing Mexico's important role in genomic science because of INMEGEN, the CD with a podcast about genomic medicine, and the timeline where Mexico plays a central role in genomics all seemed to serve a central purpose. It was a way of showing the many students and biomedical researchers that genomic science is the future and Mexico is going to play a key role in that future. Hype and speculation and other forms of forward-looking statements are often highlighted as forms of producing markets and value (Sunder-Rajan 2006; Fortun 2009). In Mexico, these visions of a future in which genomic medicine will be a reality serve to encourage students and researchers to pursue that field of inquiry. It was a way to assure these students that there will be jobs in genomic medicine in the future.

Many students do not pursue careers in science because they feel there will not be able to make a living or that there will be no job security. Indeed, a lack of "plazas" or positions was always what biomedical researchers emphasized as one of the challenges facing Mexican biomedical researchers. It is for this reason that many apply for and accept positions abroad. Many of my interlocutors see this as a waste of government money because many students are trained in public universities that are free of charge like UNAM, and then they have to use their training in another country, rather than in Mexico. Dr. Cervantes went so far as to criticize highly educated women who do not pursue employment in their professions. She explained, "It is not right for women to get their Ph.D., which is paid for by the government, only to become stay-at-home moms. They have a responsibility to society to use the education they have been given." In other words, Mexico makes an investment that others benefit from.

The timeline, in particular, served to insert Mexico in the forward moving inertia of time to make students and young researchers excited about being a part of “the best that is yet to come.” It is an optimistic view of the future that offers them a chance to not only be a part of history, but to make history. Including the “highlights” of INMEGEN’s Mexican genome project in the history of genetics demonstrates that INMEGEN is an important institution in making that history and the future. A state-of-the-art research facility called the National Institute for *Genomic Medicine* that Mexicans “can be proud of” serves to assure them that genomic medicine is a future that is virtually here. It is a future that is becoming a reality. It is a future that is under construction, just like the facility itself.

Soon, as the story goes, the construction will be complete and the future will be here and there will be plenty of job opportunities. The students and biomedical researchers are being invited to serve as witnesses of a virtual future called genomic medicine, which exists partially in talks, podcasts, CDs, timelines, genome chips, and INMEGEN. These material things aim to give the virtual future more solidity. Whether those parts will add up to the whole predicted remains to be seen.

The Book of Life

On a cool September morning in 2011, I made my way through a crowd of biomedical researchers and students to the registration desks. I received my badge, program, and a commemorative blue and gray backpack adorned with the INMEGEN and Nestlé logos. It was the first day of an international symposium entitled “Nutrigenomics: Diet, Genomics, and Health” sponsored by INMEGEN and Nestlé. Next to the registration table, there was another table where audio equipment was available for the purpose of instant translation. Most biomedical conferences I had attended did not need translation equipment because the presentations were conducted in Spanish for a Spanish-speaking audience, but this conference was rather unique in that it had gathered presenters from all over the world. Over half of the talks were conducted in English. There were presenters from Norway, Sweden, Australia, Canada, Ireland, France, Germany, Spain, the Netherlands, and the United States. The presenters had also come from a wide range of disciplines: molecular biology, medicine, chemistry, nutrition, biochemistry, public health, and biological anthropology to discuss the complex interaction between genes and diet.

It was almost time for the conference to begin. I had passed the NesCafé coffee stand in the foyer of the main conference room and decided to return to get a cup of complimentary coffee. As I asked for a *café Americano*, I could overhear the conversation of a small group of conference-goers just next to me. A young woman in her early twenties was speaking with three other conference-goers. After I received my coffee, I walked over to join the group. The young woman was holding her coffee with one hand and was struggling to hold both her purse and the INMEGEN backpack in the other.

She introduced herself as a chemist with a keen interest in pursuing a career in the field of genomics. She pushed aside her backpack to reveal a book she was reading as a sort of introduction into the field of genomics. The others in the group reacted immediately with a chorus of positive responses. The man standing next to me pulled his head back, raised his coffee cup toward the book, and exclaimed, "*Oh, sí. Buenísimo libro.*" (Ah, yes. Great book.). The young woman, pleased with the approval of the group, smiled and placed the book securely in her backpack.

I had recognized the book instantly despite the fact that I had read it many years before. The cover art had been brilliantly done. A double helix is displayed with bright red and green spheres on glossy paper. The matte black background makes the DNA molecule appear three-dimensional. The single word title written in a large white font and capital letters seems to jump out at the reader. It was *Genome: The Autobiography of a Species in 23 Chapters* by Matt Ridley.

Bestselling popular science books in the area of genetics like Ridley's would often make their appearance during my fieldwork in Mexico. In casual conversations like the one described above, during interviews, and on the bookshelves of my interlocutors. I would often ask my interlocutors which books they would recommend to get a better understanding of genetics. Ridley's *Genome* and Richard Dawkins's *The Selfish Gene* were the books they most often mentioned.

These books had actually been recommended to me by the head researcher of a genetics lab I had started working at for a short time in 2003. He told me they would be a good introduction into genetics. It was even recommended by *The Wall Street Journal*. The blurb right above the title of the book: "A fascinating tour of the human genome... If you want to catch a glimpse of the biotech century that is dawning... *Genome* is an excellent place to start." But I was surprised it was still being recommended eight years later since so much had changed in the field of genetics. I decided to reread *Genome* for, as Fortun argued, "sometimes, engagements with novels read by our interlocutors can be as generative as 'being there'" (Clifford and Marcus 2009:xiii).

Ridley's book is particularly interesting because he says he chose to structure his book in the same way that the human genome is structured. The book's twenty-three chapters were chosen to parallel the twenty-three chromosomes found in the human genome. For Ridley, the twenty-three chromosomes *are* chapters of the book that is the human genome. Moreover, genes are “stories” contained in those “chapters,” and the “stories” are written in a “language” that is based on an alphabet of only four letters: A, C, G, and T. As a result, he argued that “the idea of the genome as a book is not, strictly speaking, even a metaphor. It is literally true” (Ridley 2000:7).

I had encountered this view of DNA as the book of life fairly early on in my fieldwork. Indeed, INMEGEN produced a comic book style document intended to disseminate the findings of the Genomic Diversity Project of the Mexican Population conducted by INMEGEN on the Mexican population. I was given a copy along with three other comic book style books at an INMEGEN conference almost a year earlier. The book begins by explaining that the human genome is known as “*el Libro de la Vida*” (The Book of Life) and that it can be compared to a text written with 3,200 million letters, using an alphabet of only four letters. The article in *Information Week* discussed at the beginning of this chapter makes a similar comparison.

This idea of the genome being the book of life is, of course, dependent on what is meant by book and by life. Ridley defined a book in the following way:

> A book is a piece of digital information written in linear, one-dimensional and one-directional form and defined by a code that transliterates a small alphabet of signs into a large lexicon of meanings through the order of the groupings (Ridley 2000:7).

To Ridley, the human genome is a book that only needs to be opened, read, and translated from “genetish” to English. This idea of a book presents an illusion of something that is unchanging, something that can be known and mastered.

As Dr. Jiménez Sánchez said, the order is important. It can be the difference between *Don Quixote* and the yellow pages. Every copy of *Don Quixote* has to be written in exactly the same way, word for word as Cervantes wrote it or it ceases to be *Don Quixote*. However, even if the order of the letters, words, and paragraphs is the same, it does not guarantee the reader will understand the text even if it is translated from Spanish to English. Books are far more complex than that.

As Spivak noted in her introduction to Derrida's *Of Grammatology*, "The book is not repeatable in its identity: each reading of a book produces a simulacrum of an original that is itself the mark of the shifting and unstable subject that Proust describes, using and being used by a language that is also shifting and unstable" (Derrida 1998:xi-xii). Every reader reads a text differently, and even the same reader reads the same text differently each time he or she reads it. The author is a sense vanishes the moment his or her book is read. Latour and Woolgar said it more succinctly, "It is the reader who writes the text" (Latour and Woolgar 1996:273). Indeed, for Foucault, the author was "the ideological figure by which one marks the manner in which we fear the proliferation of meaning" (Foucault 1984:119). It is a way to get passed the feeling that there are, as Geertz wrote, "turtles all the way down." In other words, it is not just the book itself that is shifting and unstable but language as well. As discussed in chapter 2, language is not a closed self-referential system. If the genome is a book it more like the proteome. Each reading of the proteome is different depending on a myriad of factors.

Ridley explained that "From four billion years ago to just a few hundred years ago, the genome has been a sort of autobiography for our species, recording the important events that occurred" (Ridley 2000:5). This autobiography is written in a code "Mother Nature" or "Nature" has chosen. In this way, there is a clear connection between the "book of life" and the "book of nature." Traweek demonstrated that "the intellectual roots of the image of nature as a text lie in biblical exegesis, with the assumption that the Bible is the written word of God and, by analogy, that 'the book of nature' is the manifestation of God's purposes" (Traweek 1988:180). In fact, when Ridley attempted to demonstrate the size of the book that is the human genome he said, "There are one billion words in the book, which makes it longer than 5,000 volumes the size of this one, or as long as 800 Bibles" (Ridley 2000:12). By seeing the human genome as a text written by nature, the job of the scientist is simply to read it. Traweek argued that "physicists see data and nature as equivalent," the see themselves as "the decoders, or at most as the ghostwriters, of a story whose original author is nature" (Traweek 1988:180). As a result, perhaps some readers may see *Genome* and the genome as objective texts.

Moreover, not only is the book of life not a book, at least not in the way Ridley defined it, and it is not life. As Helmreich argued that "what Foucault called 'life itself' is today in flux" (Helmreich 2009:253). For instance, microbial oceanographers talk about the ocean possessing a genome. Therefore, life itself no longer resides solely in an individual organism. He explained that, "In the age of molecularization, when life is broken down to be built up again, what emerges is not always again 'life itself.' Life is no longer itself but rather its partibility, its relationality" (Helmreich 2009:282). Rose argued that "life now appears to be open to shaping and reshaping at the molecular level; by precisely calculated interventions that prevent something happening, alter the way something happens, make something new happen in the cellular processes themselves" (Rose 2001:16). Indeed, Franklin argued that today "questions of what the biological *is* has become inextricable from what the biological *does* or can be made to do" (Franklin 2007:33).

In fact, in January 2013, *Nature* reported that a team of scientists were able to successfully retrieve data they had encoded in DNA with 100% accuracy. They stored all 154 of Shakespeare's sonnets, a short audio-clip from Martin Luther King's "I have a dream" speech, a copy of Crick and Watson's paper on the structure of DNA, a photo of the researchers' institute, and a file describing how the data were converted. The project was led by Nick Goldman of the European Bioinformatics Institute in the U.K.. In an age of massive amounts of information, reliable ways of storing data are becoming increasingly necessary. DNA is being turned to as a compact and durable way to store information. Goldman explained that 100 tape drives could be converted to 41 grams of DNA and the information should last for "millennia in cold, dry, and dark conditions."

Goldman and his team had to develop a complex cypher, which was described in the following way in the article:

> "Every byte—a string of eight ones and eight zeroes—is represented by a word of five letter that are each A, C, G, or T. To try to limit errors further, the team broke the DNA code into overlapping strings, each one 117 letters long with indexing information to show where it belongs in the overall code. The system encodes the data partially overlapping strings, in such a way that any errors on one string can be cross-checked against three other strings (Yong 2013).

Goldman called his method of storing data, "apocalypse-proof." In other words, if there is a global disaster, future generations might eventually find the DNA stored with data and be able to read it. He said, "They'd quickly realize that this isn't DNA like anything they've seen. There are no repeats, and everything is the same length. It's obviously not from a bacterium or a human." Given that "massive amounts of data" are being produced in the field of genetics, as Lander noted, a strange future may arrive when our genomes may not be stored on genome chips, but on DNA itself. There may be a time when DNA will, indeed, become the kind of book Ridley says it is. But for the time being, the human genome remains the kind of book where the reader is the writer.

Images and the Distancing of the Observer

Traweek argued that the machines of scientists are like "eyeglasses through which they read and then decipher the fixed text of nature" (Traweek 1988:180). This was the basis of what Daston and Galison called "mechanical objectivity" (Daston and Galison 2010). Scientific instruments imposed both a correction and a discipline upon the inherently fallible senses (Shapin and Schaffer 1985). Although human senses are imperfect, they could be perfected through technology. As non-humans, technology is often considered more objective than humans (Shapin and Schaffer 1985; Dumit 2004; Mol 2002). These technologies often produce powerful images.

As Crary explained, there is a relentless abstraction of the visual, where "visual images no longer have any reference to the position of an observer in a 'real,' optically perceived world. If these images can be said to refer to anything, it is to millions of bits of electronic mathematical data" (Crary 1992:2). In the field of genetics, Montoya has called this process *in silico* where "life-worlds are powerfully reduced to data sets that can be emailed and run through countless software programs," which "violently extracts the meaning of diabetes from those most affected by it" (Montoya 2011:39).

In an educational pamphlet produced by INMEGEN, the process through which the blood samples of participants in the Mexican Genome Diversity Project were analyzed, was described as follows and the image below was used to give a visual representation of it.

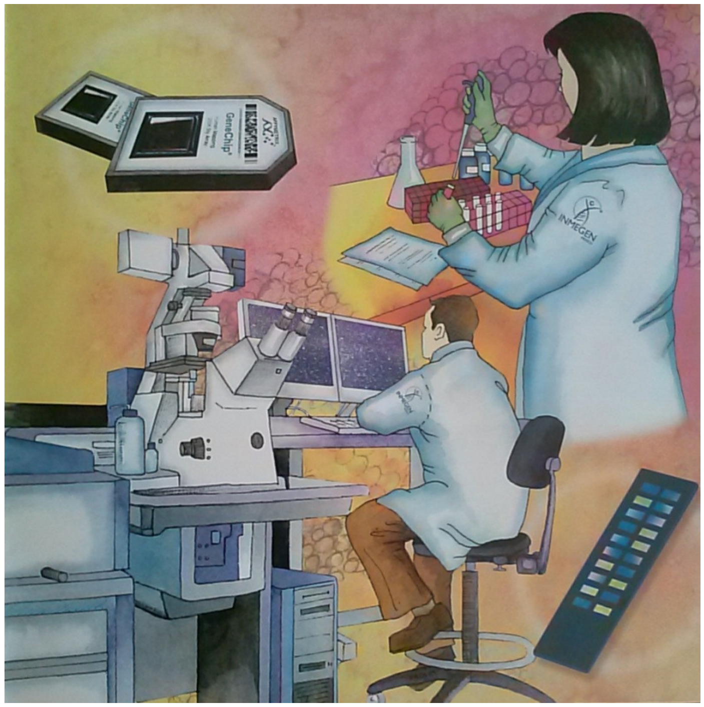

Figure 7. Image from an educational book produced by INMEGEN.

The following is my translation of the page entitled “The Processing of the Samples and the Generation of Results,” which demonstrates exactly that way in which the life-worlds of the donors vanish *in silico* and how the observer becomes more and more distant from the “real” optically perceived world.

> The samples patiently waited in the laboratory refrigerator while a group of scientists prepared to extract the genome from every tube of blood. For this, they used modern methods, sophisticated laboratory equipment and robots that carry out the work with great precision. The work was arduous and many hours later the purified genome of each one of the participants was obtained.
>
> Later, a group of specialists equipped with the most advanced technology, took the strands of the human genome, cut them, colored with a dye and put each sample on a plastic chip that fits in the palm of your hand. A couple steps later, a microscope with a

> laser read each one of the chips identifying thousands of SNPs in each sample and transmitted the signals to a computer.
>
> Moreover, a group of experts in computer systems integrated the information in a supercomputer prepared for this purpose processed 2.3 trillion operations per second!
>
> Therefore, after weeks and months of intense work, a group of geneticists, mathematicians, and statisticians, among others, deciphered the results that would produce the first draft of the map of the genome of the Mexican populations.

Every step in the process of converting blood samples into the draft of the map of the genome of the Mexican populations creates more and more distance from the life-worlds of the donors and from the actual world. Indeed, the life-worlds of the participants were never documented yet the samples are anthropomorphized. They are described as “waiting patiently.” The samples swing from technology to experts and back again in repeated oscillations, each time producing a new layer of data and images that are further and further from the individuals who donated the sample and from the observer. As the image shows, the researcher is staring at two computer screens filled with long strings of code. What the researcher eventually sees and examines is far removed from its origins in the blood of donors. Moreover, here genomic medicine exists in the “modern” and “sophisticated” technology needed to transform those blood samples into data. Genomic medicine exists in knowledge and skills of geneticists, mathematicians, and statisticians, who may be able to develop genomic medicine.

Figure 8. Covers of the three educational books produced by INMEGEN.

The virtual future of genomic medicine also exists in the three comic book style educational pamphlets developed by INMEGEN. There genomic medicine is described as the search of variations in DNA that are related to a particular disease. It says it can give a more precise diagnosis of what ails you. It will develop medications related to genes and the lifestyles of each population. It will be able to know what will make you sick before it happens. You can avoid the things that will cause you the most harm. A particular vision of the future exists in these books, where all who receive them are treated as present witnesses of a virtual future.

Conclusion

This chapter argues that, in the genomic age, the technology of virtual witnessing has gone from future witnesses of the past to present witnesses of a virtual future. It examined how, in the field of genomic science, a virtual future exists *partially* in the present through such things as texts, images, and institutions. In Mexico, Biomedical researchers and students in Mexico are being asked to serve as witnesses of this virtual future. They are also inserted in the inertia of time that promises an optimistic future. A future in which they will be active participants and contribute to its conversion to a completed future where genomic medicine will become a reality.

This chapter also examines the view of the human as the book of life. It argued that what is meant by "book" and by "life" is much more open, fluid, and multivalent than the book of life that Ridley and INMEGEN described in their texts. The writer of a book is, in large part, the reader of the book. If the human genome is a book is has been processed to such an extent that it no longer is what it started out as. It has been increasingly distanced from its material substance and the donors. It has been converted through multiple stages of analysis and has passed through the hands of multiple experts, where it becomes a screen of information to be examined.

The metaphor of the human genome as the book of life is limited in many ways. In fact, in 1990, a science columnist, Steven Strauss, was unsatisfied with the extant metaphors for DNA. He decided to hold a contest where readers would attempt to come up with a better metaphor for DNA. He instructed readers to send in metaphors that would describe DNA in six words or less. There were hundreds of entries but the winning metaphor was the following: "DNA is the web that spins the spider." For Strauss, the metaphor captured the potentiality and actuality, the becoming and being of DNA. The winner, Trevor Spencer Rines, said that the idea of the molecule that unzips itself and puts itself back together reminded him of spiders consuming their own web and then re-spinning it. The winning entry was both unexpected and strikingly familiar for Geertz is famous for quoting Weber: "Man is an animal suspended in the webs of signification he himself has spun" (Geertz 1977). DNA can be seen as the web that spins the spider but we also spin the webs of signification in which DNA and we are entangled. DNA is the web that spins us and that we, in turn, spin.

CONCLUSION

Social and cultural studies of science have often examined the many reasons science proceeds in the way that it does. In order to challenge the taken-for-granted notion of progress, scholars of science and technology have emphasized the role of paradigms, interest, instrumental traditions, institutions, and funding, to name a few. This ethnography has contributed to this scholarship by examining how constructions and experiences of time among Mexican biomedical researchers affect the kinds of research questions that are asked at particular moments, how science is envisioned, and how research trends take shape. It has done so by focusing on the particular case of genomic science in Mexico. It has shown how studying science in a developing country and examining the way Mexican biomedical researchers construct and experience time can serve to complicate the temporalities of science writ large.

This ethnography has argued that science is less about scientists longing for a culture of no culture and more about a longing for a time of no time. It is a longing for a place where time fades into the background, a place where there is no turbulence. Mexican biomedical researchers often imagine this place to be in the U.S. or Europe because of their experiences at very privileged institutions there. However, this ethnography has shown how science is practiced at multiple temporalities that cannot be arranged neatly onto geopolitical maps. It calls for a move away from terms like local and global science. Instead, places like "the U.S." and "Mexico" as well as times like a "normal" constant flow of linear time are actually the end products of constructions and experiences of time. This ethnography calls for a view of science writ large as turbulent where all of the temporalities are too numerous and complex to collapse into one kind of time in science.

Most relativist accounts of time have focused on cyclical time and left linear time unexamined. This ethnography shows how linear time is not singular and cannot be taken for granted. It argues that a forward moving linear time persists because it is embedded in narratives of modernity, capitalism, and nationalism. Mexican biomedical researchers get caught up in the inertia of time, the undertow, embedded in these narratives, when they see Mexico as behind the U.S. and Europe. By focusing on the exceptions to the kind of linear time that moves forward at a constant speed, this ethnography decouples science and technology from a single, universal, and linear time. This calls into question the simplistic view of science and technology as naturally moving toward progress while also calming those afraid that science and technology will lead to disaster.

It is more productive to see fragments of possible futures in the present. Those pieces may eventually come together to form a particular future or they may not. There is no way to know in advance because there are too many variables to take into account. Science is too turbulent and it also interacts with many other things that are equally turbulent. It calls for a move away from of view of the present as pristine, untouched by the past or the future and experienced in the same way by everyone. The multiple and varied speeds of time produce very particular views of the past, present and the future. This ethnography argues that we are not in time, but rather that we exist in the realm of unreal time, where time is constantly in the making.

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[1] A technique used to replicate a fragment of DNA so as to produce many copies of a particular DNA sequence. Oxford Dictionary of Biology 6th edition

[2] As Troy Duster noted in his chapter entitled "The Prism of Heritability and the Sociology of Knowledge," the vast majority of those working under the umbrella of genetics increasingly come from a wide range of disciplines (Nader, 1996). This trend was clearly evident in Mexico where researchers originally from the fields of biochemistry, chemistry, zoology, biology, medicine, etc. have become interested and involved in research projects in the areas of genetics and genomic science. Therefore, although this dissertation project focused on those institutions and researchers in Mexico involved in genetics and genomic science, I refer to my interlocutors as "biomedical researchers" in order to adequately characterize the wide range of specialists currently involved in these areas in Mexico.

[3] All of the names of my interlocutors have been changed to protect their identities. I did not give pseudonyms to public figures or to individuals who presented at public events. Also, although it is customary to use both paternal and maternal last names in Mexico, I gave my interlocutors only one last name so as not to distract the reader and because the use of one last name has become more common among scientists and intellectuals in Mexico in recent years.

[4] http://www.scholarpedia.org/article/Turbulence

[5] The construction of this research facility took many years and was still not complete by the end of my fieldwork. The inauguration of the new institute took place on November 22, 2012. However, the main auditorium and a few of the buildings were used for several years prior to this for conferences and courses.

[6] See Victorian Anthropology by George Stocking Jr. for an interesting discussion of the significance of the Crystal Palace during Victorian era England.

[7] Vasconcelos's book is often misinterpreted as saying that Mexicans are unique race of people.

[8] Peter Wade was the director of a comparative project studying how ideas of race interact with genomics in Mexico, Colombia, and Brazil.

[9] Malinchista is a term used in Mexico to refer to a Mexican who prefers all that is European over Mexican things. It comes from the name given to the native woman who served as an interpreter to Cortes during the Conquest of Mexico. It is also synonymous with traitor.

[10] The PNAS article says "All mestizo participants were mostly, but not exclusively, members of the local state university community."

[11] Although the article does not specify, the supporting information states "All participants declared to have 4 grandparents not self-recognized as recent immigrants and born in the state in which recruitment was performed."

[12] Some geneticists I interviewed expressed that when non-Indigenous Mexicans realize how much of their DNA is indigenous, there will be more solidarity between indigenous peoples and the rest of Mexico. "They will realize that we are not that different from them," one interlocutor told me. In this way, genetics was seen as a way to break down the ways the indigenous peoples of Mexico have been viewed and treated as Other. Genetics is seen as a resource to promote a more equitable society where everyone is the same. Everyone is "mixed." A similar perspective is popular in Brazil (Santos 2004).

[13] "Chilango" can be a derogatory term when it is used by people outside of Mexico City to refer to people from Mexico City.

[14] Duster has shown how testing for sickle-cell anemia has reinforced preexisting racial and social categories, even though the distribution of the gene is far wider than the African American community (Duster 2003).

[15] UNAM was the first place in Latin America to offer a degree in genomic sciences.

[17] Genomic sovereignty was an idea promoted by a group of Mexican scientists intended to demonstrate the need for Mexico to conduct genomic research on its own population.

[18] There was some debate in Mexico about the use of the term "Mexican Independence" in relation to 1810. They began saying instead that 1810 was "the anniversary of the beginning of the struggle for independence from Spain." Mexico did not gain its independence from Spain until 1821.

[19] This was not publicly stated as the reason. My interlocutors said this was the reason he was asked to leave INMEGEN.

[20] According to the late Carlos Monsiváis, who was a well-known cultural critic and writer in Mexico, one is not considered a millionaire in Mexico unless one has at least ten güaruras.

[21] By this time, tens of thousands had been killed in the so-called Guerra Contra el Narcotrafico (Drug War).

[22] A conference held in August 2011 reflected this growing desire in Mexico to increase connections between institutions. At a two-day conference held by UNAM Chemistry Institute and INMEGEN, the respective directors signed an agreement to collaborate in the creation of a unit of investigation focused on understanding the genomics of the Mexican population and its applications to human health. It would be a way to share information, technology, and resources.

[23] Weeks later, I happened to be on the subway on my way to Cuidad Universitaria CU when a man entered the cart and began telling everyone on board about a documentary he was handing out for free with the condition that we copy it and pass it along to others. I gave him a small donation and watched the documentary at home. It was precisely about the hardships being experienced by ranchers in several states in Mexico due to the droughts. The documentary emphasized how the plight of these ranchers has been largely ignored by the federal government.

[24] CONACYT or *Consejo Nacional de Ciencia y Tecnología* is the equivalent of the National Institutes of Health (NIH) in Mexico

[25] History Channel (2010) Biography: Einstein

[26] This tiered system at UNAM is called PRIDE (Program Performance Bonuses for Full-time Academic Staff). It has four tiers A-D. D being the highest.

[27] There are approximately 17,000 researchers currently registered in the National System of Researchers.

[28] Some of my interlocutors insisted that it is difficult to lose one's place in the higher tiers of these systems.

[29] Many of my interlocutors described English as the lingua franca of the biomedical sciences. Those pursuing advanced degrees in these fields are expected to be fluent in English. However, at conferences in Mexico where presenters gave talks in English, audio equipment for instant translation was always available.

[30] The International HapMap Project was a project that collected genetic material from various human groups in order to identify and catalog genetic similarities and differences in humans.

[31] AIMS was used in a study conducted at INMEGEN. It resulted in the publication of an article that concluded that the Mexican population is fundamentally a mixture of European, Amerindian and African genes. This chapter was presented to the Mexican President at a media event in May 2009.

[32] "Through the Wormhole with Morgan Freeman" is a science documentary series which started airing on the Science Channel in June 2010.

[33] Oxford dictionary