

ENTANGLED HISTORIES: AN ANALYSIS OF THE ANGLOPHONE
HISTORIES OF SCIENCE IN LATIN AMERICA FROM DEPENDENCE TO
DECOLONIALITY, 1950-PRESENT

A Thesis
by
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Abstract

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Science in Latin America has a rich, complex history characterized by a hybridization of multiple Indigenous, Creole, imperial Iberian and Western/Northern knowledge practices. As a result of these entangled histories, Latin American science does not fit easily into the standard periodization of Western histories of science, nor into traditional Latin American historical periodization. This inability to effectively categorize and constrain the heterogeneous histories of Latin American science has meant that these fascinating narratives have been widely ignored by historians in the West. After reading widely from what has been published over the years, some patterns began to emerge in the ways in which Western-located academics have considered the subject. This thesis examines how Anglophone historians have written about science in Latin America over the previous 70 years, from the early narratives of dependence, through social histories and constructivism, to more recent

postcolonial histories and decolonial standpoints. The hope is that through such historical self-reflection, Anglophone historians will more readily incorporate heterogeneous and pluriversal perspectives on science in Latin America in their research and in their curriculums, and also begin to publish works that are accessible to diverse peoples outside of niche academic circles.

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I owe an incredible debt to Professor René Harder Horst, a wonderful Latin American historian who generously allowed me to pursue my dual passions for the History of Science and Latin American History. Dr. Horst first gamely agreed to work with me on an independent study on the history of science in Latin America, then pushed me to speak at academic conferences for which he traveled great distances to support me, next he co-authored an academic paper with me which was published in the February, 2019 issue of *The History Teacher*, and finally he served as the ever-patient chairperson of my thesis committee. Furthermore, his solidly-researched forthcoming book on Indigenous Latin American history informed some of my thesis work. Dr. Horst's kindness and support made the long drives from Asheville to Boone completely worthwhile, and without him my graduate work would have lacked the richness and intellectual excitement that it has held for me these last years. Thank you and thank you again Dr. Horst.

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Finally, I am ever grateful to my family. My brilliant daughter Astrid, who loves to do her "homework" on the table next to me, and my sweet son Björn, who sits in my lap while I read or type. I am incredibly thankful to my partner Grayson, who has joyfully taken

our two small children camping, hiking, rafting, skiing and swimming on the weekends so that I may toil away on history papers without being nipped to death by the ducklings. And lastly, my parents, who I could never acknowledge enough. My Mom (Linda) taught me to ride a motorcycle, for which I am forever grateful, and she regularly demonstrates to me that it is totally possible to go on epic adventures well after retirement. My Dad (Erich) sparked in me the insatiable love of books and learning and, a historian himself, gleefully dragged our family to every battlefield, museum and roadside plaque up and down the east coast at least once. My parents always pick up the phone when I call, they have loved me unconditionally despite purple mohawks and two decades of vegetarianism, they continue to inspire me with their global adventures and local leadership, they offer patience and perspective and holidays full of crazy Lego creations, and most importantly they have always encouraged me to *follow my ghost*. Thank you.

Dedication

To Astrid and Björn, with unconditional love.

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Foreword

Fragments of this thesis appeared in *The History Teacher* journal: Hadley Sinclair Cluxton and René Harder Horst, “Problematizing the Past: An Overview of Teaching the History of Science in Latin America in the Anglophone Classroom and Its Major Issues,” *The History Teacher*, Vol. 52, No.2, February 2019.

Chapter 1

Introduction

"Instead of writing history, we are always beating our brains to discover how history ought to be written." – Hegel¹

The year before my daughter was born, I went to Mexico. I stayed in the colorful apartment of a distant relative, several long cobblestone streets away from San Miguel de Allende's centuries-old Gothic *Parroquia* and an easy walk to a tiny, cramped *tienda* for bottled water. It was February, and at over 6,000 feet above sea level, the days were warm, sunny and dry but at night the temperatures hovered just a few degrees above freezing. One cool morning, dressed in long pants and a light sweater, I set off on the long, hilly trek across the city to El Charco del Ingenio, a botanical garden and environmental education center. After passing the bustling, pastry-scented *panederias* and meandering past vibrant row homes draped in trailing red flowers, the city streets eventually ended, and I found myself on a long dirt road shaded irregularly with massive, scrubby trees. The entrance to El Charco was a welcome sight. In addition to an education center, a children's smell and touch garden, a solar observatory, a beautiful conservatory of Mexican plants and the rocky ruins of an old hacienda, El Charco is located on 170 acres of natural preserve with many walking trails. The entire preserve was carefully crafted to impart to visitors historic and scientific information about the flora and fauna of the Mexican highlands, in addition to protecting the landscape and its non-human inhabitants. Standing inside the carnelian-colored steel frame of the conservatory, reading the small plaques in front of a bounty of diverse native succulents, I was struck by how little I knew about Mexican environmental history, or about

Mexican science at all. Who collected and tended to these plants? Who visited El Charco to learn about them? Why was this science so important that a massive chunk of developable land in close proximity to a popular city was set aside as a preserve and education center? At the time, I had no answers for these questions.

The year after my daughter was born, I started graduate school. I had already earned two Bachelor's degrees, completed simultaneously: one in Spanish and one in the Comparative Studies of Science and Technology, and I had lofty aspirations of being able to teach the history of science one day. It was winter in Appalachia, and baby napped fitfully beside me as I churned through history books on the Tupac Amaru rebellion and African slavery in colonial South America. Nostalgia for undergraduate debates over ethics in science, or the misogyny of domestic technologies, or the unsung value of stainless steel crept into my sleep-deprived mind. I daydreamed of the warmth, and quiet, of my time in Mexico. I began to wonder again about science in Latin America. So, with the blessing of an engaged and astoundingly patient Latin American history professor, I embarked on an independent study on the history of science in Latin America. I fell immediately in love with my topic and yammered on like an obnoxious academic at anyone silly enough to stand still for too long. One of the most consistent reactions I received when I talked with others, including highly educated academics and professionals, about my new-found and accidentally-discovered passion for science in Latin America was: "Oh? I didn't realize Latin America *had* science."

Silence.

This widely-believed but ignorant stereotype of Latin America as lacking science has the direct effect, unconscious or not, of signifying that Latin Americans are inferior because

they did not follow the same historic scientific trajectory as, for example, Great Britain. This stereotype implies that there is one science, that science is universal, that the path to achieve science is unidirectional. It also equates privilege to intelligence and capability. In the modern United States, we, as students and as the general public, are sold an idea that “science in real” and that our history of science is *the* story about how heroic, ambitious, quirky and genius men (and occasionally women) uncovered the true nature of the world for the betterment of humankind. But this is only a partial history, a partial truth, and sometimes it is not a truth at all. The real histories of science are not triumphalist biographies of great men but rather weave through time and space, across cultures and languages, dancing on borders and pointing to more complex, and often darker, narratives. The histories of science are multiple, myriad, varied, and different, and depend on *who* is writing the history, and when, and why. This paper seeks to examine some of the ways that Anglophone historians have written about science in Latin America over the last seventy years, from dependency to decoloniality.

* * *

As the title suggests, this paper will only examine Anglophone (English-language) writing on the history of science in Latin America, and only from the last seventy years. The primary reason for this is because I wanted to find, and make visible, histories of Latin American science that could be used in classrooms where I live in the United States. While many languages are spoken here, and Spanish increasingly so, English is still the dominant language in schools. The time frame, 1950-present, was necessarily limited by both the scope of this project and the publications available about the subject, as will be examined further in the next chapter. While there will certainly be some attention paid to scholars

working within Latin America in this paper, because this work centers Anglophone histories it is also an assessment of how Western academia has, or has not, included the history of science in Latin America into its corpus. I recognize that because I chose to critically analyze English-language resources available to graduate-level English-speaking teachers in an English-speaking country, this thesis is by definition an elitist Eurocentric critique of Eurocentrism. While I admit that “centering the center” in this way is problematic, I hope that some of the information and resources provided in this paper encourage the reader to seek more information about the marginalized peoples and places that I discuss here. Ultimately, my goal is to have the histories of science in Latin America become more familiar to those of us in the West who have been raised with the ignorant stereotype of Latin America as lacking science. I want to see these histories incorporated into history curriculums from K-12 through graduate schools, included in textbooks and popular histories, illustrated in children’s books and epic graphic novels, and addressed in films and documentaries. I want this subject to become commonplace. The only way to dispel the ignorant stereotype of Latin America as lacking science is through education *at all levels* and *for all learning types*.

Complex Definitions

It is useful to begin with some definitions. The following terms are all complex, laden with years of cultural and academic critique. Entire books have been written about these words. What follows are working definitions for the purposes of this thesis.

Latin America: Generally speaking, “Latin America” is a social construct that allows people to speak of a particular part of the world as if it were an undivided whole.² The name “America” is commonly assumed to have derived from the Italian explorer Amerigo Vespucci in the first decade of the sixteenth century. In the 1830s, the French engineer Michel Chevalier first associated the term “Latin” with Spanish-colonized South America by claiming that part of the region was settled by Catholic Latin Europeans and therefore was affiliated with Latin Europe.³ Some Indigenous peoples have argued in favor of using their own names for the region, such as Abya Yala, rather than the name dictated by colonizers. For this paper, “Latin America” refers generally to South America, Central America, the southern parts of North America, and the Caribbean, with full acknowledgement that the term “Latin America” is historically complicated. This essay will treat Latin American regions and countries with broad strokes, occasionally touching upon specific instances to provide examples. This is admittedly homogenizing, and it is not to deny the incredible heterogeneity of these peoples and places, but rather to indicate overall trends.⁴

Science: The seemingly interminable academic debates rage on about what can, and can not, be considered science. For this thesis, I will be using Philosopher of Science Sandra Harding’s definition of science: “any systemic empirical study of ourselves and the world around us. Thus, a knowledge system or a set of inquiry practices will be referred to as a science if it is systematic and empirical, regardless of whether it is Western or non-Western, contemporary or ancient, obviously embedded in religious or other cultural beliefs or not apparently so.” Harding goes on to add “to regard all of these different knowledge (or practice) systems as sciences is not to regard them as equally accurate, comprehensive, or

useful with respect to any particular questions we might ask.”⁵ Furthermore, both science and technology will be discussed, because science and technology are not separate (or separable), but rather are co-created and co-produced (though not conflated with one another).

Western/Non-Western: The terms “Western” and “non-Western” are outdated over simplifications of complex histories and regions, more indicative of shifting centers of power than actual geophysical locations. Similarly misleadingly binomial categories that historians have used, sometimes contentiously, include “global South/North,” “developed/undeveloped,” and “First World/Third World.” Most historians of science distinguish between “Western” science and “non-Western” science, where “Western” science includes northern North America (the United States, Canada) and parts of Europe (Great Britain, France, Germany), while “non-Western” science denotes Africa, Arabic and Islamic countries, non-Arabic Asian countries (China, Japan, India), and Latin America. Iberian science is also classified as “non-Western” because it has been historically marginalized within Europe. All Indigenous science is considered non-Western regardless of the geophysical location of the Indigenous peoples. I will discuss some of the complications of the term “non-Western” in a subsequent chapter, but for the purposes of this thesis, I will follow standard definitions and write about Latin American science as non-Western. In truth, this is a false dichotomy that elides the complicated nature of Latin America geographically, as well as Latin American science historically.

Eurocentrism: The most accurate, and succinct, definition of Eurocentrism comes from Duke University professor and decolonial thinker Walter D. Mignolo: “Eurocentrism is an epistemic phenomenon that received its name from the territorial location of actors, languages, and institutions that managed to project as universal their own world sense and worldviews.”⁶ Additionally, Philosopher of Science Sandra Harding noted that Eurocentric practices can be overt or covert, institutional, societal, or civilizational, and that it is possible to despise and critique Eurocentrism while actively (if unknowingly) participating in Eurocentric behaviors and holding Eurocentric beliefs.⁷

Historic Barriers to Studying Science in Latin America

Science in Latin America has a rich and complex history, characterized by liminality, *nepantlismo*, an in-betweenness, a *mestizaje*, a hybridization of multiple Indigenous, Creole, imperial Iberian, and Western/Northern knowledge practices.⁸ Latin American science does not fit easily into the standard periodization of European histories of science, nor are most Latin American historians interested in wedging thematic studies of science and technology into the traditional Latin American historical periodization. This inability to effectively categorize or constrain Latin American science has meant that it has been excluded from both Western and non-Western histories of science as written about and taught by Anglophone historians in the West. Chinese, Indian and Islamic sciences dominate published books on non-Western histories of science. Apart from the occasional brief mention of the technology of pre-Columbian civilizations such as the Aztec, Inca and Maya, world histories of science

are silent on the subject of Latin America. This silence is not representative of the region's rich, albeit entangled, scientific history.

In addition to issues of categorization and periodization, language barriers have also prevented Anglophone historians of science from researching or teaching about science in Latin America. Until the end of the twentieth century, few English-language published works were available on any aspect of the history of science and technology in Latin America. The majority of the primary source documents that could illuminate this history were either in the languages of the colonizers (Spanish, Portuguese) or written in Indigenous languages once Iberians introduced alphabetic writing in the sixteenth century (Nahuatl in Mexico or Quechua in the Andes for example). Likewise, past and present Latin American scholars published much of their secondary-source analysis in Spanish or Portuguese, and to date much of this literature remains untranslated.

Scholars have encountered issues interpreting non-textual records as well, including images, maps, paintings and sculptures. Pre-Columbian Indigenous peoples sometimes used semasiographic forms of communication, which functioned independently of spoken language. These include Andean knotted *quipus* and both Mixtec and Aztec pictographs. Academics are still attempting to decipher the complex, colorful and densely knotted *quipus*, which resemble tangible computer code more than alphabetic language and may have been used for census data and other recordkeeping. Mayan hieroglyphics, though linguistically phonetic, also proved challenging for academics to decipher.⁹

Historically, Western nations have also viewed both Iberia and Latin America as backward, unscientific, and unworthy of study. Historian of science Jorge Cañizares-Esguerra argued that this disdain for Iberia began as early as the sixteenth-century conflicts

of the Reformation, which caused a violent schism between Catholic and Protestant peoples.¹⁰ The “discovery” of the Americas followed the centuries-long battle to expel the Moors (and subsequently the Jews) from Spain, and occurred simultaneously with the Catholic Inquisition.¹¹ Iberia’s scientific expeditions to the Americas had their foundations in this strongly Catholic *Reconquista* culture from which they ventured, and Catholic priests played an immense role, through the sometimes-violent spiritual subjugation of Indigenous peoples as well as ostensibly through Indigenous education. Around the time of these first Iberian voyages to the Americas, officials in Western Europe began a highly successful propaganda campaign called *La Leyenda Negra* (the Black Legend), which demonized Catholic Spaniards and perversely stereotyped Spanish history and culture. Bartolomé de Las Casas’ well-known mid-sixteenth-century account of Spanish brutality against Indigenous peoples in the Americas perpetuated the *Leyenda Negra*.¹²

While I completely agree with Cañizares-Esguerra that religious confrontation between Catholics and Protestants contributed to the West’s animosity for Iberia, I believe the fact that Moors ruled Iberia for seven centuries also played a role. Many of the early scientific and technological advancements claimed by the West in fact originated in Islamic countries, and only made it to England through the intermediary of Moorish Spain. In addition to the later anti-Catholic sentiments, anti-Black and anti-Muslim racism and xenophobia prevented Western nations from treating Spanish Moors as intellectual equals and contributed to the West’s negative perception of Iberia.¹³ These prejudices and the deliberate invisibilization of non-Western contributions to Western science persisted into Western scientific explorations of the Americas as well.

An additional factor that complicated the study of science history was that in the sixteenth century, the Spanish Crown jealously guarded all the information they received from and about the Americas. In many cases, royal officials never printed the scientific illustrations and data carefully boxed and shipped back to Iberia. Officials sometimes disseminated cartographic, mineral and lucrative botanic information to relevant parties (such as cosmographers, mining engineers or royal botanists), but more often these documents were carted off to the dusty and unsearchable royal archives. This suspiciousness and secrecy condemned much of Iberia's potentially useful newfound scientific knowledge to decay and disarray. Only now are historians scouring what remains of these scattered archives.

Epistemologies, Ontologies and Structural Inequalities

In addition to the historic barriers described above, another obstacle to studying the history of science in Latin America involves questions of epistemologies and ontologies. In other words, what is *history*? Whose history is being told, where, and by whom? Who has a voice in the histories? Likewise, what is *science*? Who can be considered scientists, and who gets to choose what constitutes science? Historically, Western science has crafted the appearance of universality and neutrality in a successful effort to legitimate the claims of Western scientists. However, both claims of universality and neutrality are false, and based on the elision of the culturally-situated ways in which knowledge is created. I will discuss these issues in more detail in later chapters.

Regarding academic structural inequality, the educational system in the United States has a significant impact on our current and future knowledge of Indigenous and Latin American sciences. There is a near-complete lack of representation of Latin American history at any level of schooling, let alone the history of science in Latin America. Furthermore, outside of niche graduate-level seminars or small groups of marginalized students and teachers advocating for themselves, there is an absence of discussion *about* this lack of representation in schools. At the undergraduate level, it is simply a given that if a student registers for a History of Science class, they will be learning about Western science, and reading triumphalist biographies of white men. As will be discussed more in the chapter on decoloniality, access to higher education has also been historically limited for marginalized peoples. Who gets to become legitimized as an “expert” is directly correlated to the privileges, the asymmetries of power, that benefit the dominant group in a culture. It is these “experts” who write books and teach classes. Western history of science still ignores and devalues non-Western histories of science because to truly examine these non-Western histories would require painful self-reflection on matters of race and racism, power, domination, misogyny and imperialism, among other contentious topics.

* * *

In my aforementioned graduate-school independent study of the history of science in Latin America, I began to notice some patterns in the ways in which Anglophone historians in the West have written about science in Latin America. From theories of dependency and development, as evidenced in Chapter 2, to the aspirational and activist standpoint of

decoloniality, as presented in Chapter 5, historians of science have dramatically changed the frameworks within which they write about Latin America over the last few decades. However, significant issues of race, gender, and colonialism, among other subjects, persisted in seemingly all the historical narratives that I read. This drove me to wonder, why did certain ideas prevail when they did, and why do some of these ideas endure, despite significant advances in historical, theoretical, scientific and cultural knowledge? I felt that I might begin to answer these questions by examining the ways in which historians have written about science in Latin America and the reasons that those frameworks dominated Western academia at a given time period. My hope is that we as academics can learn from our collective mistakes and begin a dialogue about more effective and inclusive ways to move forward. Furthermore, it is important to note that I am not interested in legitimizing the history of science in Latin America within the Western tradition. My desire is to re-frame the discussion entirely.

Chapter 2

Dependency Theory and Developmentalist Histories of Science

“There are always politicians and technocrats ready to show that the invasion of ‘industrializing’ foreign capital benefits the area invaded. In this version, the new-model imperialism comes on a genuinely civilizing mission, is a blessing to the dominated countries, and the true-love declarations by the dominant power of the moment are its real intentions.”¹⁴ - Eduardo Galeano

“It is a privilege of empires to make their histories appear as History”¹⁵ - Fernando Coronil

Dependency theory was the most influential perspective on Latin America throughout the twentieth century. It cast a long shadow over politics, education, activism, as well as science and technology. Dependency theory both highlighted, as well as perpetuated, the structural inequalities and asymmetries of power between Western nations such as the United States and Latin American nations. The United Nations Economic Commission for Latin America (ECLA) brought the ideas of the dependency school to the attention of the Anglophone academic world in the mid-twentieth century, and dependency thinking rose to prominence in the early 1960s. The proponents of this theory argued that the wealth of developed countries was both a direct result of and the primary cause of the underdevelopment of Latin American countries, and scholars redefined development issues from primarily internal to almost exclusively external factors. Dependency theory framed issues of development from the perspective of the “developing” countries themselves, and as such was considered to be a radical critique of Euro-U.S. developmentalist practices and ideas. However, dependency theory created an obstacle to studying the history of science in Latin America by prioritizing economics, by delegitimizing the technoscientific practices of

all Latin Americans, and by casting Latin Americans as incapable of stereotypical Western scientific development.

Part I: The History of Dependency Theory

Modernization Theory: A Precursor to Dependency Theory

In the post-WWII era, one of the most prevalent multidisciplinary schools of thought was the modernization school. Modernization proponents argued that societies progress unidirectionally and irreversibly from primitivism to modernity, evolving along a triumphalist arc towards the peak of development. The ultimate goal of nations, according to modernization theory, was to evolve into societies that resembled the United States or the countries of Western Europe, which were considered to be the apex of civilization. Modernization proponents argued that the traditionalism present in developing countries hindered their progress towards modernity. Modernization theory asserted that undevelopment was a result of internal factors as opposed to external factors. That is, domestic social, political or economic issues within the developing nation were to blame for undevelopment in lieu of any potential causes from outside (external to) the developing nation. As such, developing countries should seek guidance from Western countries to aid in the process of modernizing.¹⁶

Although modernization theory became popular with Westerners across a variety of disciplines, it found disfavor in the developing world. Critics of modernization theory argued that the process attempted to homogenize and Europeanize (or Americanize, as the case may be) developing nations by forcing them along a unidirectional path that sought to emulate the West. Surely, the critics argued, there could be more than one path to development than the one laid out by Western nations, which reeked of ethnocentrism and which ignored any viable non-Western alternatives. Critics of modernization also questioned the supposed dichotomy between modern values, which were to be desired, and traditional values, which were to be quashed in the process of modernization. They argued that traditional and modern values need not be mutually exclusive. Finally, and perhaps most importantly to critics of modernization from the developing world, Western nations wielded modernization theory as a justification to intervene in developing countries, as a pretext of what critics considered to be neo-imperialism.¹⁷

Modernization Theory and the History of Science

In 1967, the year after Andre Gunder Frank published his influential work *The Development of Underdevelopment* (elaborated below), historian George Basalla penned his treatise "The Spread of Western Science." Basalla's painfully Eurocentric diffusion model, which has since been widely discredited, described three overlapping stages in which Western European science "diffused" from Western European countries to "nonscientific" nations. Many scholars in the United States found favor with Basalla's diffusion model, which they considered to be common sense in the modernization era. In this model, the first

phase consisted of a (male) European who traveled to a "nonscientific" place and explored its geography, natural resources, flora, and fauna, then returned to Europe with this information. The second phase, which Basalla termed "colonial science," entailed a significantly larger group of Europeans who ventured to the new land and brought their science with them. In this phase, the "nonscientific" peoples depended upon the European-educated scientists and their attendant European sciences. Bizarrely, Basalla claimed that this phase did not imply scientific imperialism. The third and final phase was the "struggle to establish an independent scientific tradition" within the non-Western country. By this, Basalla meant that the Western European colonial scientific expeditions paternalistically attempted to force the growth of Western European science in non-Western places, especially through the suppression or supplantation of local cultural and religious beliefs.¹⁸ Historians and social scientists have widely criticized this Eurocentric and uni-directional model of science because its simplistic, linear account of scientific diffusion failed to address the complex nature of knowledge practices across multiple cultures.¹⁹ Historian of science Juan José Saldaña also argued that the omission of local context inherent in all diffusionist approaches "make the science of peripheral areas dependent on the mythical and, consequently, ideological scientific misoneism of a 'disinterested' Europe."²⁰ Despite the criticism, histories of science about non-Western places and peoples from the later decades of the twentieth century are rife with Basalla's diffusion method.

Modernization theory had its foundations in Western Enlightenment science and the belief in Western scientific rationality.²¹ What most scholars did not consider however, was that Western scientific rationality was itself based on the beliefs of a few imperfect human beings who had the power and privilege to impose their worldview onto all of humanity –

despite the fact that most people did not (and do not) reason with perfect scientific rationality. Those humans considered not rational – women, children, people of color, the poor – were treated as inferior. Despite the rapid popularization of science at the time, the Enlightenment also cultivated the perception that only certain people, those who were considered rational, could *legitimately* do science. Based on these Enlightenment ideals, modernization theory argued that the only legitimate scientists originated in the West, and by extension were both White and Male.²² These ideas combined to delegitimize any and all scientific and technological work done within Latin America, which, as a region, was largely ignored by Westerners until the 1959 Cuban Revolution.

The *Dependentistas* and Their Claims

Dependency theory evolved from within Latin America to counter the economic imperialism of modernization theory. In the 1950s, new technologies such as radio and television altered popular culture in Latin America, and allowed for a more rapid spread of revolutionary ideas, including the radical neo-Marxist views of Che Guevara and Fidel Castro.²³ Scholarly interest in dependency theory grew strongest in an era of increasing authoritarianism in Latin America. Between 1964 and 1974, authoritarian regimes took control of Argentina, Brazil, Bolivia, Chile, Ecuador, Peru and Uruguay.²⁴ Some of the first acts of these dictatorships was to defund universities and scientific research, and the brutal regimes evicted or disappeared many students and scientists, while others fled to safer

countries.²⁵ In many ways this repression stanching the creative scientific flow of the post-Cuban-Revolution era in Latin America.

In the early Cold War period of 1948, the United Nations Economic Commission for Latin America (ECLA, or CEPAL in Spanish) was founded in Santiago, Chile and included twenty-one Latin American nations and three Western European nations. Argentinian structural economist Raúl Prebisch became the head of the ECLA in 1950, the same year that he published his work *The Economic Development of Latin America and Its Principal Problems*. The ECLA attempted to demonstrate that *underdevelopment*, which was not the same as *undevelopment*, was the result of an imbalance in which one (developed) country benefitted at the expense of another (developing) country. In other words, the development of the West was contingent on the underdevelopment of the non-West. In his theory of unequal exchange, Prebisch argued that underdevelopment was a direct result of trade exploitation. Dependency theorists, also called *dependentistas*, drew from the ECLA and Prebisch's views to develop their own school of thought regarding underdevelopment in Latin America.²⁶

In addition to criticism of the modernization school's Eurocentric, unidirectional theory of development, dependency theorists also rejected orthodox Marxism in favor of neo-Marxism. Briefly, *dependentistas* argued that orthodox Marxism was based on the class struggles that were particular to Europe whereas neo-Marxism emerged from and had more relevance to the developing world. Furthermore, dependency theorists claimed that the orthodox Marxist view that a bourgeois middle class should be created first, then the bourgeois would instigate a revolution was outdated. Rather, the neo-Marxist *dependentistas*

argued that the developing world needed an immediate socialist revolution, and their views gained traction after the 1954 U.S.-led coup d'état in Guatemala and the 1959 Cuban revolution. According to the *dependentistas*, dependency was a direct result of the deleterious effects of global capitalism, an external factor, as opposed to internal factors such as class structure as orthodox Marxists claimed.²⁷ The Western technologies of resource extraction, such as mining, railroads and monocrop export agriculture, were key examples of the destructive and Euro-centered aspects of global capitalism as experienced in Latin America. Changes in everyday consumer habits also reflected the imposition of Western-style capitalism. As historian Sandra Aguilar-Rodríguez discovered, in 1951 a Philco refrigerator cost nearly 4,000 pesos in Mexico, whereas the average daily wage was barely over 3 pesos in the city and was less in rural areas. In part because of this gross discrepancy, fridges and other Western-origin domestic electric technologies became highly desired symbols of class, with Whiteness and wealth associated with them, while the traditional Latin American domestic tools such as the *metate* became associated only with poverty and Indigeneity, despite their widespread use.²⁸

The writings of German-American economic historian Andre Gunder Frank spurred the rise of neo-Marxist dependency theory in Europe and the United States, in large part because he published the majority of his works in English and disseminated them to English-speaking regions. Frank lived and worked in Latin America in the early 1960s, and in 1966 published the pivotal work “The Development of Underdevelopment.”²⁹ This work was well-received by the anti-war protesters in the United States who criticized U.S. neo-imperialism abroad, and these counter-culture scholars spread the dependency school further. Frank's argument, which was a simplification of the multiple dependency narratives

occurring in Latin America at the time (some of which are elaborated upon below), was that the impoverishment and deliberate underdevelopment of developing countries (the *periphery* or *satellite*) benefited the developed nations (the *core* or *metropolis*), who only sought to extract and exploit material wealth. According to Frank's formulation of dependency theory, the historical need for Latin American countries to export raw materials forced them to be dependent on the same countries who exploited them. This was in part because manufacturers in the imperial nation fashioned Latin America's raw materials into finished goods which were subsequently sold to the exploited nation in an economic transaction that benefited the imperial nation. Latin American countries, in Frank's view, could never follow the same modernization path as Western nations because of Latin America's long, violent history of colonialism, which Western nations never fully experienced and which Frank argued was a major contributor to underdevelopment.³⁰ The concepts of *metropolis* and *satellite*, popularized by Gunder Frank, became important frameworks for non-Western histories of science and technology, as will be examined in greater depth later in this chapter.

Another oft-cited dependency theorist, the Brazilian economist Theogony Dos Santos was best known for his work on the structure of dependence in the late 1960s. In Dos Santos's estimation, there have been three historic forms of dependence: colonial dependence, financial-industrial dependence and, most important to historians of science, technological-industrial dependence. Colonial dependence was "a trade monopoly complemented by a colonial monopoly of land, mines, and manpower (serf or slave) in the colonized countries"; financial-industrial dependence occurred at the end of the nineteenth century and was "characterize[d] by the domination of big capital in the hegemonic centers, and its expansion abroad through investment in the production of raw materials and

agricultural products for consumption in the hegemonic centers"; and the technological-industrial dependence of the post-World War II era was "based on multinational corporations which began to invest in industries geared to the internal market of underdeveloped countries."³¹

In colonial and financial-industrial dependence, production in the developing country was aimed almost exclusively for export: gold, silver, agricultural products and raw materials. These exports to a monopolized international market were also maintained through technological-industrial dependence. In Dos Santos' final stage of dependence, developing nations relied on the foreign capital from exporting goods to purchase foreign technology in order to industrialize. This reliance on export production limited the growth of internal markets and resulted in a negative balance of payments for the developing nation. According to Dos Santos, the developing nation was dependent upon its export sector, but as the price of raw materials and other exports dropped, the developing economy suffered. The international purchasers of raw materials, who also monopolized the market and thus the export price, then stepped in to offer financial aid to the developing nations. This resulted in crushing, enslaving debt for the developing nation while the developed nations conversely benefited. Dos Santos argued that this monopolization of the capitalist market underpinned dependence. His views also formed an economic basis for technological dependence.³²

Technological dependence became a foundational tenet of dependency theory, and important to early non-Western histories of technology. As Colombian professor Margarita M. Peña Borrero clearly stated, "the high technology comes sealed in 'black boxes,' and it depends on the provider for its innovation, maintenance, and reproduction."³³ In the technological dependence model, Western nations functioned as technological gatekeepers.

They controlled the transfer not only of technology itself (whether railroads and telegraph lines in the nineteenth century or the sophisticated machines used by research scientists in the twentieth century) but they also owned the patents to said technology, provided (or did not provide) the education necessary to either operate or fix the technology, and they decided who benefited from the technology, where and when. In 1963, UNESCO's Director General René Mahewu said simply: "The development of a nation cannot be achieved if science and technology do not cease to be an *imported magic*, to become a custom of its people" (emphasis added).³⁴ The modes of technology transfer as a function of dependence became a major focus of *dependentista* literature.

Economists Magnus Blomström and Björn Hettne wittily commented that "with a slight exaggeration it might be said that there were as many 'dependency theories' as there were dependency theorists."³⁵ A few other notable *dependentistas* are listed here for reference, as their ideas on dependence have influenced various segments of social science and humanities over the years, including the history of science. The first is Mexican sociologist Rodolfo Stavenhagen, who in 1965 published "Seven Erroneous Theses on Latin America." Stavenhagen's work, which, interestingly, was originally published in the Mexican newspaper *El Día* instead of a peer-reviewed journal, had a significant impact on the field of anthropology.³⁶ French-Egyptian economist Samir Amin, who is credited with coining the term "Eurocentrism," contributed his ideas on the transition to peripheral capitalism to dependency theory.³⁷ The Brazilian sociologist Fernando Henrique Cardoso, who later abandoned dependency theory and became the 34th president of Brazil, published the seminal book *Dependency and Development in Latin America* with Chilean sociologist Enzo Faletto.³⁸ Finally, the North American Congress on Latin America (NACLA) first

published Susanne Bodenheimer's piece "Dependency and Imperialism: the Roots of Latin American Underdevelopment," in 1970, which, as Cardoso lamented, spread like wildfire through English-speaking academia.³⁹ The article was later republished in a slim, biting volume titled *Readings in U.S. Imperialism* alongside articles by Bertrand Russell, Fidel Castro, Eduardo Galeano, Theotônio Dos Santos, Andre Gunder Frank, Stokely Carmichael and Ernesto Che Guevara, among others. In her scathing critique of economic imperialism, Susanne Bodenheimer's article blamed the predatory capitalism of Europe and the United States for Latin American underdevelopment. Her work, especially published alongside other radicals, influenced Left-leaning Anglophone academics.⁴⁰

Criticisms of Dependency Theory

The criticisms of the dependency school were numerous and varied. The modernization school argued that dependency theory was mere propaganda for Marxist ideology, while orthodox Marxists criticized *dependentistas* for overstating the external factors of dependence while failing to take into account internal factors such as class structure. Other critics have asserted that dependency theory was Eurocentric and lacked adequate consideration of the complex dynamics of race and ethnicity in Latin America. Neo-classical economists essentially ignored dependency theory as an unscientific internal schism of Marxism. Still other critics complained that dependency theory was too abstract. A few critics also contended that *dependentistas* were plainly wrong about the concept of technological dependence, pointing to cases such as Argentina and Mexico as counter-examples. One peculiar critique even asserted that in focusing on Western technologies and

technological knowledge, dependency theory ignored the disastrous environmental consequences of Western technologies used to satiate rapacious Western consumption. One prominent economist also questioned the *dependentistas*' basic understanding of capitalism.⁴¹

The dependency school ultimately collapsed from the criticism that its economic principles failed if and when governments actually chose to enact them, such as the import substitution industrialization that failed in Latin America. By the mid-1970s, even eminent *dependentista* Andre Gunder Frank had abandoned dependency theory as outdated, although Frank did defend the dependency school as appropriate for the era of the 1960s.⁴² Despite the intense criticism of the dependency school, dependence-based articles and books continued to be published throughout the 1970s and 1980s, and sometimes dependence narratives still crop up in obscure circles of academia, despite the theory's decline half a century ago. Parts of dependency theory have also made their way into other economic theories of underdevelopment still in use, such as the so-called "resource curse" theory, in which proponents of resource curse theory claim that countries with abundant natural resources tend to be less developed economically, politically, and socially than countries that lack such resources.⁴³

Part II: Dependency Theory in the Historiography of Science in Latin America

The history of science as an academic discipline was still relatively new when dependency theory rose to prominence in the early 1960s, and in many regards historians of

science were attempting to forge a new path for themselves in academia. The first university programs in the history and philosophy of science were formed in the 1950s and 1960s. Western historians of science, especially those who subscribed to contemporary Whiggish views of history, may not even have been aware of dependency theory initially, although ideas of modernization and development were widespread. In the post-World War II era, Latin America was little more than “the Third World” to many Western scholars.⁴⁴ In many regards, at that time non-Western histories of science consisted entirely of anthropological and archaeological works, though career historians of science at that time would have dismissed such anthropological research as “unscientific.” Historian Bart Karstens maintained that “next to presentism three other Whiggish ‘sins’ can be associated with history of science, namely judgmentalism, triumphalism and internalism. All these four aspects of Whiggism apply to the historiography of science that was produced until roughly the 1960s.”⁴⁵ Apart from presentism, these three “sins” also aptly defined the modernization school’s approach to underdeveloped nations. Despite the decline of Whig historiography, such unidirectional, triumphalist, evolutionary narratives can still be discerned in even the most recently-produced works, whether concerning Western or non-Western sciences.

The publication of Thomas Kuhn’s *Structure of Scientific Revolutions* in 1962 radically transformed the focus of the history of science by demonstrating, among other principles, the fallacy of logical positivism while simultaneously hinting at the social context within which science is done. Kuhn’s *Structure* introduced the concept of paradigms in science, which implied that scientific ideas were not merely “uncovered” from true nature as Francis Bacon argued, but were also socially constructed (although Kuhn did not use the neologism “social construction” itself). Kuhn’s ideas had massive implications across the

entire discipline of the history of science, and especially for histories about people, places, and knowledge practices outside of the narrowly-defined focus of Western science. The 1960s sounded the death knell for the domination of Whiggish narratives of science, as will be evidenced in subsequent chapters.⁴⁶

In contrast, dependency theory, as well as its precursor modernization theory, affected the historiography of science in Latin America by creating a theoretical construct which permitted Western scholars to ignore Latin America's historical contributions to science and technology. Implicit in the theory was the idea that Latin American countries had nothing to offer the West apart from their material resources, and that the technologies used for exploiting raw materials were imported to Latin America by Western nations and used exclusively by Westerners working in Latin America for Western corporations (Maheu's "imported magic"). Dependency theory did not just highlight asymmetrical power systems and economic dependency, it also incorrectly cast Latin American cultures as inherently scientifically and technologically impoverished and thus unworthy of study by Western historians of science.

As a result of this prejudice against Latin American knowledge systems there were very few traditional histories of science published about Latin America during the dependency era. Western historians of science tended to ignore the knowledge systems and scientific practices of Indigenous, creole, provincial or even Iberian and European intellectuals working in Latin America. Finding Anglophone histories of science and technology written before the 1980s, apart from primary source accounts, means scouring economic and political histories, industry reports, and occasionally histories about the ancient civilizations of the Inca, Maya, Aztecs (because apparently many Western scholars

fascinated by pre-Columbian societies believed that the scientific history of Latin America ended with Spain's Invasion). Most of these histories are deeply Eurocentric examinations of Western industry in non-Western locales, usually modernization or developmentalist narratives if written from the typical Western perspective or critiques of the neo-imperialism of modernization and developmentism if written from the *dependentista* perspective. Although the dependency school was considered a radical critique of the modernization school, the technoscientific narratives of both read very much like two sides of the same coin. An historian could argue that the dependency era highlighted more of a history of the obsession with Western technology and industry than that of Latin America's scientific past. Dependency narratives of technology and industrialization inevitably painted the West as the leading character and Latin American nations as tangential, passive recipients, incidental to the Western triumphalist narrative that was being thrust upon them.

The Core/Periphery Binary

One of the *dependentistas'* most important contributions to the history of science was the rise in popularity of the core/periphery binary, also sometimes called the center/periphery or metropolis/satellite binary. Some accounts give credit to Raúl Prebisch and his comrades at the ECLA for making core/periphery a focal point for social scientists, in which the emphasis became the perspective from the periphery rather than from the core. Other accounts recognize Andre Gunder Frank's work on the metropolis/satellite model, in which constellations of increasingly large metropolises (rural village to semi-rural town to city to regional hub to national hub to international Western cities, and so forth) extract wealth from

their respective satellites.⁴⁷ Regardless of which *dependentista* made the binary most famous, this model perpetuated the idea that science and scientists originated in the (usually European/U.S.) center, while only passive reception of science occurred in the (non-European) periphery. Thus the core/periphery binary reflected and perpetuated the asymmetries of power between West and non-West.⁴⁸ The same pattern held true for analyses of industrialization, a prime goal of Western development scholars who believed that bringing Western industry to the periphery would benefit developing nations' evolution to Western-style modernity. Often external industrialization had the opposite effect, as mentioned previously in the section on technological dependence. Sociologist-turned-President Fernando Henrique Cardoso used core/periphery terminology to point out the inequalities of industrialization in his book *Dependency and Development*: "Peripheral industrialization is based on products which in the center are *mass consumed*, but which are typically *luxurious consumption* in dependent societies."⁴⁹ Core/periphery analysis often highlighted the problems with modernization and development theories and practices by shifting the point of view from the center (Europe, the United States) to the periphery (in this case, Latin America).⁵⁰ Core/periphery therefore sometimes called attention to the asymmetric power and knowledge relationships of technological (and other) dependency.⁵¹ However, as Historian of Science Marcos Cueto made clear, core/periphery tended to ignore the impact of Latin American scholars working outside of Latin America who bring to their work the knowledge and influence of both their places of origin as well as their present localities.⁵²

Economics in/as the History of Science

In many ways, the histories of science in Latin America as written during the dependency era were economic histories: histories of technology and of industrialization from the perspective of Western academics keen on contributing to the “development” of other regions of the world. From the perspective of scholars within Latin America, these same technologies and industries posed as trojan horses, insidiously entering their homeland in the guise of “help” while actually bent on extracting all the wealth and well-being possible. The subject index for Cardoso and Faletto’s *Dependence and Development*, while ostensibly a political science/economics book according to the back cover, almost reads like a history of Britain’s Industrial Revolution: Industrialization, Cement, Copper, Nitrate Industry, Dye, Gold, Iron, Mining, Railroad, Silver, Steamboat, Steel, Technology, Tin, Urbanization, and so on.⁵³ Many other economic histories of Latin America followed this pattern. While few traditional histories of science in Latin America were written during this period, a particular perspective on Latin America’s science and technology can be gleaned from scouring the plethora of economic and political histories published both in the West and in Latin America.

A notable historical work based on dependency theory is renowned Uruguayan historian and writer Eduardo Galeano's *Las venas abiertas de america latina (Open Veins of Latin America)*, published 1971). In the book, Galeano wielded vibrant prose to highlight the ways that developed nations had relentlessly extracted material wealth from Latin American nations, leaving impoverishment and underdevelopment in their wake. Galeano skewered Western countries for pillaging Latin America, from sixteenth-century imperialism to

twentieth-century neo-imperialism. He stated, “the symbols of prosperity are symbols of dependence. Modern technology is received as railroads were received in the past century, at the service of foreign interests which model and remodel the colonial status of these countries.”⁵⁴ Galeano’s famous book, while wide-ranging in its critiques, heavily centered on Latin America’s industrial and technological dependence.

Technology Transfer

A method of analysis within the history of technology that is related to both Basalla's diffusion theory and technological dependence is that of technology transfer, in which technologies are disseminated from the "center," usually presented as a Western nation, to a "periphery," which is generally represented by a non-Western place. Sometimes the center is a large metropolis and the periphery is a rural area within a single nation. Common in histories of agriculture and railroads, analyses of technology transfer are still relatively prevalent in modern Western histories of technology in Latin America.⁵⁵ As historian Arnold Pacey adeptly pointed out, "the deficiency of this phase is that it implies a process in which the recipients of a new technique passively adopt it without modification. The reality is that transfers of technology nearly always involve modifications to suit new conditions, and often stimulate fresh innovations." Pacey preferred the terms “technological dialogue” and “inventive exchange.”⁵⁶ As Pacey implied, it is thus theoretically possible to write about technology transfer in a more inclusive manner, in which the standard unidirectional and top-down narratives are problematized. An example of this approach is one of the chapters in *Beyond Imported Magic*, "Tropical Assemblage: The Soviet Large Panel in Cuba," by Hugo

Palmarola and Pedro Ignacio Alonso. In the essay, the authors demonstrated the way in which the Cuban construction of a Soviet-financed factory that manufactured large concrete panels for housing developments evolved into a hybrid Soviet-Cuban technology that was uniquely Cuban in design and symbolism.⁵⁷

Periodical Review: Dependency and Development

Hunting down published works specifically on the history of science in Latin America from the 1960s posed a formidable challenge (as opposed to the voluminous quantity of economic histories that contained scientific or technological information, many of which are still available in university libraries). A periodical review from five of the peak years of dependency theory sheds some light on the ways in which academics were thinking about science and technology in Latin America during this era. I examined every issue from three Latin American peer-reviewed journals and three peer-reviewed History of Science journals from the years 1968-1972, including several critical bibliographies. For date reference, Andre Gunder Frank's pivotal dependency work *Capitalism and Underdevelopment in Latin America*, published 1967, was reviewed by the *Hispanic American Historical Review* in 1968.

The three Latin American journals were: the *Hispanic American Historical Review* (published by Duke University Press), the *Latin American Research Review* (published by the Latin American Studies Association) and *The Americas* (published by Cambridge University Press). These three distinguished journals had very few articles or reviews that

focused on science or technology. A more detailed review is below. The three History of science and technology journals were: *The British Journal of the History of Science* (published by Cambridge University Press for the British Society for the History of Science), *Isis* (published by the University of Chicago Press for the History of Science Society), and *Technology and Culture* (published by the Johns Hopkins University Press for the Society for the History of Technology). Latin America was extremely under-represented in these journals. The articles and reviews in the history of science journals generally focused on aspects of science or technology that were of economic interest to western Europe or the United States, such as mining and metallurgy, railroads and transportation history, the impact of Western science and technology on Indigenous cultures (often ethnographies), industry or industrialization accounts, and, especially, issues of development. A more detailed review is below.

The British Journal for the History of Science

The quarterly *British Journal for the History of Science* (BJHS) began publishing in 1962, preceded by the *Bulletin of the British Society for the History of Science*, founded in 1949. The BJHS contained no articles or reviews on the history of science in Latin America for the five years 1968-1972. To put this in perspective, the journal did contain several articles and book reviews on science in Islamic cultures, China, Japan, India and Russia. In the “Books Received” section at the end of each issue several potential books of interest were listed, including two histories of science of Cuba and one of Mexico, although none were ever reviewed. Whether this was due to lack of interest or because the books were published

in Spanish is unknown, but it is consistent with the general prejudice against Latin American histories of science during this period, especially from European academics.⁵⁸

Isis

Belgian-American historian George Sarton founded the quarterly history of science journal *Isis* in 1913, including the massive yearly *Isis Critical Bibliography* (now known as the *Isis Current Bibliography*). *Isis* is considered to be the preeminent journal of the history of science. In each issue, articles and book reviews were separated by time period (such as antiquity) or area of study (such as “Far East”). In the years reviewed, *Isis* included sections about India, “Islamic and Related Cultures,” and the “Far East.” Interestingly, all the articles or reviews about the history of science in Japan were intermixed with the rest of the Western science articles as opposed to an area studies section. The journal did not include Latin America as a section, and still does not to the present day. A large portion of the articles and reviews on non-Western locales involved Western science or scientists in non-Western places, as opposed to examining local science or scientists. In the five years of review, *Isis* published no articles on science in Latin America, but it did publish four book reviews of potential interest to historians of science in Latin America; one was an ethnography of Indigenous peoples in what is now Texas, another was an examination of a nineteenth-century Spanish scientific expedition to South America; a third was a book about Mexican herpetology and, finally, a book review about the sugar hacienda originally founded by Hernán Cortés which included technological information.⁵⁹

Of greatest use, however, is the 237-page long *Isis* Critical Bibliography for 1968, which lists numerous articles and books of interest to the historian of Latin American science. However, since Latin America is not considered its own category (apart from a remarkably empty category “35.3 Pre-Columbian America (to c. 1500),”) the listings are scattered throughout a wide variety of sections and thus the entire bibliography must be scoured for relevant material. As such, I only examined one year of the annual Critical Bibliography. For the year 1968, the bibliography contained 3,345 entries, not including the eighteen pages of book review listings at the end.⁶⁰ Discounting the seventeen listings specifically about Spanish history of science that do not concern Latin America,⁶¹ the 1968 *Isis* bibliography listed twelve published articles about the history of science in Latin America. Of the twelve, one was written in German and four in Spanish. Five articles dealt with pre-Columbian history of science, three with medicine, two with chemistry, one with natural history and one with a Spanish metallurgist who spent three decades in Mexico.⁶² Numerically, twelve listings out of 3,345 represents 0.035% of the total entries, or 0.02% if only counting English-language entries. Although the listings indicated that a few scattered scholars (usually Latin Americanists) were examining the scientific histories of Latin America, the extreme under-representation is again indicative of the invisibility of the region for historians of science during this time.

Technology and Culture

The Society for the History of Technology (SHOT) founded the quarterly academic journal *Technology and Culture* (T&C) in 1959, with historian of technology Melvin

Kranzberg as co-founder and editor-in-chief. In the five year period of review, the journal published only one four-page article tangentially concerning Latin American history.⁶³ T&C also published six book reviews related to the history of technology in Latin America, five of which focused on issues of “development” and one on mining in Mexico from 1890-1950.⁶⁴ T&C published an additional six book reviews primarily concerned with some aspect of technology transfer to underdeveloped/developing countries, at least some of which mention Latin America.⁶⁵

Similar to *Isis's* Bibliography in the History of Science, *Technology and Culture* publishes an annual Bibliography in the History of Technology. However at a mere 47 pages, the *T&C* bibliography for 1968 pales in comparison to *Isis's* massive tome.⁶⁶ Despite the bibliography's relative slimness, it included ten references to histories of technology about Latin America: two on railroads, one on pre-Columbian gem-cutting techniques, one on Mexican military arms, one on mining and five on industry and development initiatives.⁶⁷ Again, Latin America was significantly under-represented. Also, more than the two journals devoted to science, T&C as a technology journal focused heavily on issues of industry, and more often portrayed Latin America negatively. In a book review about an apparently optimistic economic appraisal of Latin American labor and development, the reviewer repeatedly inserted his own critical thoughts on the matter, overshadowing any potential upsides within the book itself. The reviewer grumbled: "The picture is bleak; however fast they run, Latin Americans seem to get left behind."⁶⁸ The book reviews in T&C largely painted the development issues within Latin America as internal faults, possibly able to be rectified by North-South technology transfer or the “assistance” of Western nations. These economic histories of non-Western industrialization are precisely the types of works that

dependentistas rejected. Unfortunately, in the period under review the T&C did not give any space to *dependentista* analyses.

The Americas

The Americas is a quarterly academic journal on Latin American studies, published by Cambridge University Press on behalf of the Academy of American Franciscan History. The journal has been in print since 1944.⁶⁹ In the five years 1968-1972, *The Americas* published three articles somewhat of relevance to the historian of science: one on early seventeenth-century civil engineering, one on Jeremy Bentham's plan for a canal in Nicaragua and one of dubious relevance about industrial trade associations.⁷⁰ The journal also published one helpful review on mining in Bourbon Mexico, plus six marginally relevant reviews on industrialization and economic development.⁷¹ The over-emphasis on developmentalist ideas, while expected in the three above journals that focused on the history of Western science and technology, was rather disappointing in one of the oldest journals of Latin American studies. The lack of interest in histories of science was not surprising.

Latin American Research Review

In 1965, a "consortium of U.S. universities" founded the triannual Latin American Research Review (LARR), which merged the following year with the newly-founded Latin American Studies Association.⁷² For the five years 1968-1972, LARR published three articles of potential relevance to historians of science in Latin America: one on ancient

agriculture, one on Maya archeology, and one on health initiatives.⁷³ Beginning in the Spring 1971 issue and continuing for every issue until the Fall of 1974, LARR also published a “Publications” section, in which it listed publications received and new or suspended periodicals.⁷⁴ After 1974 the journal only printed the “Publications” section sporadically. The publications were grouped into categories, and one relatively small category was “Natural and Applied Sciences.” Pamphlets from the Pan American Health Organization dominated this category, frequently alongside printed works from the United States Department of Agriculture. Occasionally an academic book was listed.⁷⁵ There was also a massive “Social Sciences” category, which had a rotating variety of sub-categories including Anthropology, Archaeology, Economics, Folklore, Geography, History, Law, Political Science, Psychology and Sociology. Development/desarrollo titles dominated the books in categories such as “Sociology” and “Economics,” and occasionally even “History,” although a close examination uncovered a book on mining filed under “Economics,” two books on technology transfer filed under “Education” and a book on cosmography in the “Philosophy” section.⁷⁶ As with the previously addressed four academic journals, histories of science in Latin America were generally absent in LARR while developmentalist narratives were abundant.

Hispanic American Historical Review

A group of Latin American historians from the American Historical Association founded the quarterly *Hispanic American Historical Review* in 1916, making it the oldest journal of Latin American history. Duke University Press took over publication in 1926.⁷⁷

HAHR published six articles of interest to the historian of science in Latin America over the five years 1968-1972, the greatest number of all of the journals reviewed. One article covered transportation history, three were histories of silver mining and two examined medicine and disease.⁷⁸ Over the five years, HAHR also published eighteen relevant book reviews, again surpassing the other five journals under review. Of the eighteen book reviews, ten examined issues of industrialization and technology transfer.⁷⁹ Three of the remaining reviews explored the history of mining,⁸⁰ one review covered aboriginal watercraft,⁸¹ one analyzed a history of Darwin in South America,⁸² one review lauded a book on the history of epidemic disease in Mexico City,⁸³ one reviewer skewered a book on a nineteenth-century Spanish expedition to Latin America,⁸⁴ and a final review reported on a book about the scientific institutions of Latin America.⁸⁵ Of the five years (1968-1972) and six journals examined in this periodical review, the *Hispanic American Historical Review* eclipsed the other journals in original content and book reviews pertaining to the history of science in Latin America, and HAHR also far exceeded other journals in non-developmental content.

Some Conclusions

The dependency school impacted histories of science and technology written in the West by Western historians during the 1960s by prioritizing economics over science and technology, delegitimizing all Latin American technoscientific practices, and crafting the narrative of Latin America as being backward and incapable of Western scientific development. The isolated historian who chose to write a traditional history of science in

Latin America at this time did so from personal interest or passion rather than from scholarly trends. Of the subjects most frequently published, mining and metallurgy as well as disease and medicine topped the list. Despite this under-representation in traditional histories of science, the *dependentistas* significantly impacted the dialogue within economic and political histories as the concepts of dependency and neo-imperialism spread throughout the academic underground. In the 1960s, scholars viewed Latin America in economic terms, and through the lenses of development and industrialization. Economic and political histories written during this era often reflect *dependentista* thinking, and include issues of technological dependency and examples of unequal exchange based on peripheral industrialization. The dependency school reframed the asymmetrical power relationships between the centers and the peripheries from the perspective of the “Third World,” with Europe and the United States dominant but no longer considered benevolent. At the time, intellectuals considered dependency theory to be a radical critique, one that pried open new spaces for dialogue and debate around Latin America’s role in international relations. All of this occurred at a point in time when Western historians of science became embroiled in intense debates about socio-cultural aspects of science and the battering down of Whig histories. New ways of thinking about Latin America’s relation to Western nations (dependency theory) and new ways of thinking about the production of science (the science debates of the 1960s) combined productively in later decades as the discipline opened up to new interpretations of science in Latin America. Furthermore, the dependency school sparked controversies within historians of Latin American science that laid the foundations for the subject of the following chapter: the social construction of science.

Chapter 3

The Social and Cultural Turns, Constructivism and the Foundation of STS

The publication of Thomas Kuhn's *Structure of Scientific Revolutions* in 1962 heralded a new era in science studies: the dawning of the expansive and multidisciplinary Science and Technology Studies (STS). STS emerged out of the relatively new field of social history and incorporated the subsequent field of cultural history, as well as aspects of the sociology and philosophy of science. The increasingly rich and nuanced social and cultural histories of Western science first published in the 1970s formed a sharp contrast with the bleak political and economic works that formerly dominated traditional histories of Western science. Political turmoil in Latin America in the 1970s and early 1980s meant that Anglophone academia saw only a slow trickle of publications about the region. As a result, dependence and development narratives of science in Latin America did not begin to abate until the 1990s, well after both the social and the cultural turns within the discipline of history had become entrenched in Western academia. However, the 1990s witnessed a boom in historical writing about science in Latin America, both in terms of quantity and the diversity of topics. As one historian has pointed out, "there was a lot going on" in the world when social histories of science in Latin America exploded on the academic scene.⁸⁶ The most important factors for the boom of the late 1990s was the intersection of self-reflective critique within Anglophone academia and the rise of liberal democracies in Latin America which renewed the scholarly scientific work in the region. Latin Americans living and working abroad were pivotal to this development, because they embodied this scholarly/political intersection and were in a position to leverage their interests into published

works. Social and cultural histories and the related field of STS radically changed the way that histories of science were written, and they are still one of the most widely utilized methods of historical analysis of science in Latin America. As such, this chapter will examine both events occurring within Latin America in these decades and the critiques happening within Anglophone Western academia, then discuss how these issues intersected to impact studies of the history of science in Latin America.

The Foundations of Social History in and of Latin America

Social histories of science from within Latin America drew from geographically diverse academic inspirations, prominent among them were intellectuals from France, Great Britain and the United States. Only in a limited way was this a result of foreign academics working in Latin America at the time; to a greater extent this influence arose from Latin Americans who had either studied abroad and returned home, or, especially in the politically tumultuous 1970s and 1980s, as a consequence of displaced Latin American academics earning doctorates and working in Western countries. The Cold War, the Civil Rights era, second wave feminism, environmental awareness, anti-war demonstrations, the sexual revolution and diverse social justice initiatives of the late 1960s and 1970s impacted the climate in which Western academics and Latin Americans abroad studied and worked.

Within Latin America, the late 1960s through the 1980s were largely decades of political and social turmoil. A laundry-list of tragic or polarizing events could never capture the horror of those years in Latin America, but it could hint at the vast scope of the

destruction: the Mexican Dirty War of the 1960s and 1970s, notably the 1968 Tlatelolco massacre of several hundred students; the 1972-1979 military rule of Ecuador; the 1973 violent military coup to overthrow democratically-elected Chilean President Salvador Allende, followed by the brutal regime of General Augusto Pinochet; the 1973 military coup of Uruguay; the decade-long tragic violence and oppression of U.S.-backed Operation Condor, primarily implemented by Argentina, Brazil, Bolivia, Chile, Paraguay and Uruguay in which the governments killed an estimated 60,000 people, “disappeared” another 30,000, and arrested and imprisoned an additional hundreds of thousands of people; the 1976 military coup in Argentina; the 1979 Nicaraguan Revolution; and in 1982 the beginning of the vast and crippling foreign debt crisis, sparked when the U.S. interest rates skyrocketed and Mexico defaulted on its payments. Later events included the 1989 U.S. invasion of Panama, the end of the Cold War in 1990, and the simultaneous signing of NAFTA and the uprising of the EZLN (Zapatistas) in 1994.⁸⁷

To state that these events impacted the work of intellectuals in Latin American countries seems redundant. The expulsion, persecution and oppression of scientists, university academics, intellectuals and students shattered the burgeoning institutions dedicated to science and the studies of science. In Argentina alone, over 547,000 people fled the country by the 1970s. In one example, prominent scientist and Argentine Nobel Laureate Cesar Milstein was forced to abandon his position as the head of the Division of Molecular Biology at the National Institute of Microbiology in Buenos Aires and flee to Europe to escape military persecution.⁸⁸ Milstein’s case is not unique. As authoritarian regimes shuttered scientific programs in Latin America and drove scientists into exile or worse, large private foundations from the United States, such as the Ford Foundation, stepped in to

construct private research centers in the region, largely for their own benefit.⁸⁹ The power of the United States and the supposed prestige of their academics at the time prevented Latin American governments from expelling the foundations.

The widespread violence could also be juxtaposed to the social and cultural changes caused by globalization and increased awareness of social justice issues within Latin America. Media such as radio, television and films altered urban views of society and culture and also launched a new era of political propaganda dominated by radio and television.⁹⁰ In those violent decades, some priests in the Catholic Church in Latin America renewed their support of social justice issues and their support of the poor and the landless. Indigenous social movements also cohered and gained prominence in the 1980s.⁹¹ By the end of the 1980s and into the 1990s, societies across Latin America widely desired liberal democracies.⁹² The failure of science and technology policies to help relieve debt and deprivation within several countries also ignited a reflexive national interest in the social studies of science.⁹³

The academic study of society and culture, which are neither a binary nor mutually exclusive of one another, encompassed areas which traditional political and economic histories tended to neglect: ideas and beliefs, religion, labor, gender, women's histories, urban and rural studies, race and ethnicity, communities, art, architecture, environmental histories, and so forth. In the late 1960s these issues became of prime importance both in the West, which was heaving from cultural revolution, and within Latin American countries, several of which were struggling to survive brutal dictatorial regimes.

The academic origin of social histories dates back much further. In 1929, the French Annales school published the first issue of its journal *Annales d'Histoire Economique et*

Sociale, which stressed the importance of examining the *longue durée* and a socio-economic approach to history. Though their influence occurred several decades later, the Annales school appealed to Latin American historians who craved an alternative to the political histories of the region.⁹⁴ In the early 1970s, U.S. historian and social scientist Immanuel Wallerstein also drew from the Annales school to develop his World-System Analysis, which in many regards succeeded dependency theory in developmentalist discourse in the 1970s and into the 1980s.⁹⁵ Both the Annales school and Wallerstein's World-System Analysis blended social aspects of history with economic aspects, which provided something of a segue between the dour economic dependence narratives and the new social and cultural histories that were seeping into academic discourse at the time.

Two other factors that impacted historical analyses of Latin America were the New Social History developed in the United States, which leaned heavily on quantitative and demographic analyses, and the class-based, bottom-up, social histories published in Britain, such as E.P. Thompson's 1963 *The Making of the English Working Class*. Reading outside of disciplinary boundaries also provides some rich historical material on science in Latin America. Anthropological and archaeological publications covering topics such as ethnobotany, ethnomathematics, archaeoastronomy, architecture, agricultural and civic engineering of the ancient civilizations (Aztec, Maya, Inca) often analyzed technological and scientific achievements in relation to their religious or social significance. For example, Karen Olsen Bruhns' well-regarded 1994 anthropological work *Ancient South America* included chapters explicitly dedicated to ancient metallurgy, ceramics, textile production and transportation, all of which can be considered valuable histories of technology.

Science and Society

Social studies of science, a close cousin to social and cultural histories, largely followed the trends of social histories developing elsewhere. Interdisciplinary academic programs such as Science and Technology Studies (STS) emerged across the globe in 1960s and 1970s, and published works not infrequently crossed borders between the history, philosophy and sociology of science and technology. These disciplinary boundaries still remain quite tenuous at best. Historians and philosophers of science located in the West began to more urgently question the epistemic universalism underpinning historical narratives of science, particularly as told from Western perspectives.⁹⁶ The idea that the society and culture within which a scientist lived fundamentally dictated the questions that they asked strongly contradicted the positivist narrative that scientists simply uncovered nature's truth. For example, in the late twentieth century Western social historians of science started asking more fervently *who* asked such research questions, *where* did the questions get asked, *why* did a particular question get asked or a particular solution get adopted at a specific historical time period, and *what* social or cultural factors influenced such research.⁹⁷ Historians of science developed a new and more self-reflective interest in non-Western sciences during this period, including Latin American histories of science.

Constructivism

In the much-lauded 1979 publication of *Laboratory Life: The Social Construction of Scientific Facts*,⁹⁸ sociologists of science Bruno Latour and Steve Woolgar (French and British, respectively) observed the scientists at the Salk Institute for Biological Studies in San Diego, California as if they were an unknown tribe. While the specific details of their novel ethnographic study are not relevant here, what is valuable is that their work not only illustrated ways in which science and technology were socially constructed, but, as a result, also showed that so-called “universal” Western sciences are instead local sciences.⁹⁹ *Laboratory Life* was one of the foundational texts that sparked a new methodological movement across Western social sciences: constructivism. Constructivism, though a Western theoretical concept, was important to studying the history of science in Latin America because it allowed historians to ask questions about aspects of history that had previously been assumed to be universal. Constructivism therefore paved the way for more radically inclusive postcolonial and decolonial histories of science, as shall be evidenced in the next two chapters.

Constructivism, as defined by historian Jan Golinski, “[drew] attention to the central notion that scientific knowledge is a human creation, made with available material and cultural resources, rather than simply the revelation of a natural order that is pre-given and independent of human action.”¹⁰⁰ Golinski then elaborated that constructivism did *not* reduce science entirely to social interactions or even to the level of a collective delusion, as some extremists on both sides of the debate had occasionally argued. As a simple example, the debate was not over the objectively scientific fact that pure water will boil at a specific

temperature in a specific atmospheric pressure, but rather, what impact did society have on the nature of this scientific fact? Some constructivist questions might be: What system of temperature was used and why? Where was the temperature system developed, and how did its use/imposition affect the wider cultures? Who developed the concept of atmospheric pressure, and why was that question scientifically important at the time? What mechanisms caused these systems to be adopted more broadly in a specific time and place? And so forth. These questions could help illustrate that, although humans across the globe have boiled water for millennia, the “fact” that pure water boils at 212° Fahrenheit at sea level did not exist before the early eighteenth century, when the German physicist Daniel Gabriel Fahrenheit developed his temperature system. And to the modern day, this system is only used in the United States and a few minor island nations. In this sense, the fact that pure water boils at 212° Fahrenheit at sea level is a social construction.

The boiling water example is an overly simplistic view of what ended up being a widespread but complex and controversial viewpoint and methodology. As with most ideas, intellectuals split into different camps that argued for competing visions of constructivism. Overall, however, social scientists across a variety of disciplines and differing visions have deemed concepts such as race, gender, beauty, science, and morality as social constructs.¹⁰¹ Historian Ann Laura Stoler also made the excellent point that even the categories of “colonizer” and “colonized,” so important in Latin American studies, are constructions in need of unpacking.¹⁰² Although all of these major issues, especially race and gender, influence the history of science in Latin America, the most important issue to our discussion is the social construction of scientific knowledge (SSK). If, as social scientists contested, social interactions influenced the production of scientific knowledge, then constructivism

fatally undermined the belief in the epistemic universalism of science.¹⁰³ Rather than being a universal, transnational, value-neutral undertaking, science began to be understood as highly localized and influenced by a particular society's values and beliefs. Constructivism therefore helped self-reflective Western historians reassess not only Western biases of and influences on the history of science in Latin America, but also to reappraise the value of Latin America's complex pre- and post-colonial sciences and technologies.

Eurocentric Critiques of Eurocentrism: Science Becomes Local

As in Latour and Woolgar's *Laboratory Life*, Western academics first scrutinized Western science for hints of its local (as in, particularly Western) nature. This was primarily because up to this point in the mid-late twentieth century, all science in non-Western locales was either considered an extension of Western science, or was already assumed to be highly localized but not "real" science (think: early Western perceptions of Islamic astronomy or Chinese medicine). In a sense, constructivism was the first in-depth Eurocentric critique of Eurocentric studies of science. In her book *Is Science Multicultural?*, philosopher of science Sandra Harding discussed several cultural aspects of modern Western science that demonstrate its local nature. According to Harding, a few of the overarching, local cultural traits of Western science include a basis in laws of nature that drew both from Christianity and models of European royal authority, an understanding of nature based on the experience of and drive toward European expansion, and a deliberately unequal distribution of scientific and technological practices that are both uniquely advantageous to and hidden from the bulk

of their beneficiaries in the global North.¹⁰⁴ More specific traits could easily be drawn from these basic themes, such as the ways in which Judeo-Christian views of women influenced early naturalists' perceptions of nature as female, either a wild woman in need of human (male) domination or as a giving and nurturing mother.¹⁰⁵ As mentioned in the previous chapter, the Enlightenment view of reason and rational/non-rational people is also local to the West. Even the idea of science as "value-neutral" is a trait that is specific to Western science. Western scientific perspectives were not shared across geographically diverse cultures, or even within European cultures before the hegemony of Western science obliterated dissenting perspectives. The heterogeneous pre-Columbian Indigenous peoples of Latin America certainly did not hold Western scientific perspectives.

This critical re-examination of Western science as local and socially constructed quickly led to a new interest in non-Western sciences and knowledge practices. If "Science" is actually just "science" and "History" is just "history," what other sciences and histories had been overshadowed by the hegemonic universalization of Western science and Western history? Helaine Selin, who edited the massive *Encyclopedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, argued that academics should "accept that every culture has a science, that is, a way of defining, controlling, and predicting events in the natural world. Then we must accept that every science is legitimate in terms of the culture from which it grew."¹⁰⁶ She went on to point out that, unlike Western science, sciences in non-Western places often coexisted with religion or magic and that this intermingling should not exclude such practices from the role of "science" in a particular culture. After all, modern chemistry had its foundation in the esoteric magical practice of alchemy, and the eminent English natural philosopher Sir Isaac Newton was an alchemist and

a radically religious man. While Newton's extreme religiosity is often elided from histories about him in order to emphasize his role in the origin of modern Western science, Anglophone historians often highlight the religious or cultural origins of non-Western science in an effort to pose a stark contrast between Western "rational" science and non-Western "irrational" practices.

In Latin America, pre-Columbian civilizations such as the Aztec and the Maya had sophisticated scientific practices, ranging from astronomy and civil engineering to agriculture and architecture, all of which were enmeshed in the religious practices of their particular cultures. For example, some ancient Maya codices and pieces of Maya pottery depicted deities practicing, writing and teaching mathematics.¹⁰⁷ Historians of ancient science have written about the Yucatec Maya's astronomical preoccupation with the planet Venus, which melded inextricably with their religious practices.¹⁰⁸ These practices were combinations of science and religion that would not have found favor in histories Western scientific knowledge practices before the social and cultural turns of the 1960s and 1970s. These types of social/cultural histories became far more prevalent in Anglophone academia by the mid-1990s, as detailed above. By the 1990s, some Western historians leaned toward a more radical constructivist approach, arguing that "mathematical ideas, like any other ideas, are humanly constructed" and that mathematics was "one of the most powerful weapons in the imposition of western culture."¹⁰⁹ Social and cultural histories of science, and later constructivism, provided an outlet for Anglophone academics to analyze such religious-scientific practices outside of the disdain of "value-neutral" Western science. These new types of histories also opened up a space for other fertile discourses, such as the intersections of race, gender and science; environmental histories; and science and imperialism. Having

new frameworks allowed historians to be able to more adequately approach the complex and entangled histories of science in Latin America. And as we will see below, these rich intersections of science, technology and society may have begun in history, but they often overflowed the bounds of any single academic discipline.

Professional Histories of Science in Latin America

Very little has been published in English about the development of the multidisciplinary Science and Technology Studies within Latin America, or even *about* Latin America, although the general consensus within niche academic circles is that STS in and about Latin America fully came into fruition in the 1980s and 1990s.¹¹⁰ As the Venezuelan social scientist Hebe Vessuri, one of the most prominent academics to examine the social studies of science in Latin America, noted, “the trends in Latin American and national thinking have always intermingled with contemporary theories, themes, and intellectual trends from Europe and the United States.”¹¹¹ Latin American scientists and engineers working within Latin America published the majority of the early social studies of science in the 1960s and 1970s. These papers primarily focused on regional needs, such as issues of poverty and disease, and they attempted to bring science and technology into public debate.¹¹² Three Argentine scientists in particular helped shape the course of social science in the Southern Cone before the 1976 military coup that cut off most academic endeavors. The first was the mathematical physicist Oscar Varsavasky, who, among many notable scientific accomplishments, contextualized scientific efforts within the framework of

Argentine society, critiqued the failures of Argentina's science teachers and conceptualized future scientific work through the lens of social justice. Next was geologist Amilcar Herrera, who in 1971 published one of the first social histories of science within Latin America: *Ciencia y política en America Latina*. Then in 1975, Argentine metallurgist Jorge Sabato published an edited volume titled *El pensamiento Latinoamericano en la problemática ciencia-tecnología desarrollo-dependencia* which examined the influence of Latin American ideas and policies (as opposed to external economic factors) on continued scientific and technological dependence.¹¹³

As the Latin American scientific institutions crumbled under the oppressive, nationalistic military and dictatorial regimes in the context of the Cold War of the 1960s and 1970s, the influence of foreigners on the social sciences ironically expanded. North American foundations established private research centers, and existing institutions rallied scholarship funds to send promising students to Europe and the United States to learn and work.¹¹⁴ It would seem as if this combination of scientific neocolonialism and intellectual brain drain would be the death knell for the social studies of science in Latin America, but surprisingly it was not. The late 1980s witnessed scientific growth in the region, notably in Argentina, Brazil and Mexico, and concomitantly an expansion of the social studies of science occurred. In this time, primary academic areas of interest in the social sciences included studies of scientific institutions and their development, national scientific communities, specific scientific disciplines such as chemistry or physics, biographies of scientists, science policy, and industrialization.¹¹⁵ A literature review from the 1970s through the end of the 1980s also showed a high interest in issues of medicine, public health and disease.¹¹⁶ In 1984, Mexico published the region's first peer-reviewed journal on the

history of science, titled *Quipu*, which ceased publication in 2013. Juan José Saldaña, editor of the seminal 1996 book *Science in Latin America: A History* and a professor in the History of Science at the Universidad Nacional Autónoma de México in Mexico City, edited the highly-regarded *Quipu* during its tenure.¹¹⁷ A new peer-reviewed academic journal, edited by Leandro Rodríguez Medina of the Universidad de las Américas in Puebla, Mexico published its first volume in 2018. The journal, *Tapuya: Latin American Science, Technology and Society*, covers the complex intersectional issues of science, technology, colonialism, society and culture from a Latin American perspective. Though ostensibly an STS (Science and Technology Studies) journal, the first issue clearly aspires to decolonial aims and will be discussed further in the final chapter on decoloniality.¹¹⁸

The Boom

By the 1990s, Latin America had witnessed the fall of military dictatorships and the rise of liberal democracies. Indigenous activists played a significant role in toppling the regimes, and they used media technologies such as television, radio and newspapers to document and publicize the human rights abuses of the governments and to recruit international NGOs to their causes.¹¹⁹ With the spread of democracy (though not without its own significant problems), scientific activity within Latin America also increased. Scholars founded groups such as the Andean Project of Technological Campesinos (PRATEC), which teaches and researches from an explicitly Andean worldview and which rejects scientific universalism.¹²⁰ As evidenced above, at this time in Western academia social histories,

cultural histories and, especially, constructivism, had dramatically changed the frameworks for historical narratives about science and technology. The rapidly changing West-Latin America political dynamic, combined with the more self-reflective and self-critical constructivism of Western academia, provided an opening for more histories of science about Latin America. As we will see in the next chapter, the 1992 quincentennial of Christopher Columbus's "discovery" of the Americas also provided fodder for both White Western scholars and Indigenous scholars, who used the opportunity to address five centuries of asymmetries of power.

This entangled, scholarly confluence became the source of rich inspiration for historians. In the 1990s, Latin American historians living and working in the West, as well as Anglophone Western historians living and working within Latin America or with deep academic ties to Latin America, began to publish extensively about issues of science and technology in Latin America. One example is the esteemed Peruvian historian of science Marcos Cueto, who earned his PhD at Columbia University in New York and was a postdoctoral fellow at the Science, Medicine, and Society Program at the Massachusetts Institute of Technology from 1990-1991.¹²¹ In 1994, Cueto published the edited volume *Missionaries of Science: The Rockefeller Foundation and Latin America*.¹²² That same year, Argentinian scholar Walter Mignolo, then working at Duke University, co-edited a book with U.S. scholar Elizabeth Hill Boone titled *Writing Without Words: Alternative Literacies in Mesoamerica and the Andes*. Although a book on literacy might not seem relevant to the history of science, the contributors in the volume illustrated the variety of intellectual pursuits of pre-colonial and colonial Latin Americans (including cartography and mathematics) and undermined culturally Western ideas of literacy. This book was also the

precursor to other important books that will be addressed in subsequent chapters, such as *Indigenous Intellectuals: Knowledge, Power, and Colonial Culture in Mexico and the Andes*, edited by Gabriela Ramos and Yanna Yannakakis.¹²³ The U.S. historian Elinor Melville, who later moved permanently to Mexico, published her environmental history *A Plague of Sheep: Environmental Consequences of the Conquest of Mexico* in 1997.¹²⁴ In 2000, Gregory Cajete, an Indigenous scholar from New Mexico, U.S., published his book *Native Science*. In the book, Cajete included significant information about Indigenous Latin American contributions to science and technology.¹²⁵ In 2003, Argentinian historian Diego Armus, now a visiting professor in the United States, published his book *From Malaria to Aids: Disease in the History of Modern Latin America*. In 1993, U.S. Philosopher of Science Sandra Harding published the edited volume *The “Racial” Economy of Science: Toward a Democratic Future*, which included a wide variety of articles and which addressed the complex and politically charged issue of science and race across the globe. These books are just a smattering works on science in Latin America that scholars published from the beginning of the 1990s onwards.

Criticism of Social Histories of Science

The criticisms of social histories, cultural histories and interdisciplinary science and technology studies vary widely depending on who is doing the critiquing and from what standpoint. The scope of these critiques, like the full historical breadth of these extensive disciplines, is beyond the nature of this work. However it is easy to point out some glaring

issues such as the dearth of historical publications that focus on Latin American women's or Indigenous peoples' contributions to science. For the most part, these subjects are relegated to lonely chapters in highly specialized books. In Latin America, academics critiqued the early preoccupation with dependence and its subsequent devolution into despair over the West's scientific and cultural hegemony.¹²⁶ The most volatile critiques erupted from debates over constructivism. While the fact that both race and gender are performatively real *and also* social constructs is well established in academia, the idea that scientific knowledge could be socially constructed caused significant controversy. Constructivism's potential to undermine Western scientific authority threw some scholars into a screaming panic over relativism.¹²⁷ In the United States, what became known as the "science wars" ensued.

Western critiques of constructivism ranged from tepid to radically reactionary. In the mild range, philosopher of science Ian Hacking called attention to the fact that when academics analyzed "the construction of X" (where X is an object or subject), that X represented the *ideal* of X rather than X itself, thus eliding the nuances that ultimately differentiate one X from another. Hacking also acknowledged the underlying fear of historical revisionism as well as the fact that some people used constructivism as a weapon in their open hostility to science.¹²⁸ Feminist STS scholars seemed split into two camps. Some, like philosopher of science Sandra Harding, promoted strongly objective constructivism on the basis that it opened up more spaces for marginalized groups in science studies. Other feminist scholars such as Donna Haraway criticized constructivism for reducing scientific knowledge to little more than dubious power relations and unreliable authority figures.¹²⁹

The charge of relativism, though, was the critique that foes of constructivism returned to again and again. Opponents argued that if one knowledge claim was equally as worthy as

any other claim, how were scholars to determine the value of such claims? This was a particularly complex and heated topic in debates over the truth of scientific knowledge and formed the basis of the Western academic “science wars” in the 1990s.¹³⁰ Anglophone scientists in particular took issue with the constructivist idea that scientific research was neither universal nor value-neutral. This came to a head in 1996, when U.S. mathematical physicist Alan Sokal published a hoax science paper in the journal *Social Text* and simultaneously published a paper in the journal *Lingua Franca* that revealed his hoax. Sokal’s goal was to demonstrate that the postmodern and constructivist turns in the cultural studies of science was nonsensical garbage.¹³¹ This sparked years of vitriol between polarized camps: those in favor of a social and cultural understanding of science and those adamantly opposed. This debate rages on in scholarly circles and shows no sign of being resolved in the near future.

Conclusions

From the early years of socio-economic analyses to the constructivist boom of the 1990s, the social and cultural turns in the latter half of the twentieth century radically altered histories of science in the West and in Latin America. Breaking from the bleak economic dependence narratives of the region, the new histories opened up space for fusions of science and technology with race, gender, religion, environmental concerns, labor and art just to list a few of the vigorous academic discourses. These new frameworks allowed historians to more adequately address the complex and entangled histories of science in Latin America. The

productive early years of social and cultural histories also ushered in a new wave of critical colonial studies that focused on the impact of colonialism and neocolonialism on Latin American culture. The rich intersection of postcolonial theory and science and technology studies is the subject of the following chapter.

Chapter 4

Postcolonialism

Introduction

At the end of the twentieth century, literature on the history of science in Latin America exploded both creatively and quantitatively. Many of the academics who published these works formed their intellectual foundations on a postcolonial standpoint that sought to analyze, critique or change hegemonic understandings of science both in the West and in non-Western locales. In the history of science, the most important purpose of postcolonial theory is to dismantle the triumphalist, unidirectional narrative of Western science and to undermine the epistemological universalisms of modern science. This chapter will briefly address the origin of postcolonial theory within a subset of Western academia, postcolonialism in Latin American studies, postcolonial science and technology studies (STS) and Latin American postcolonial STS. Postcolonialism is a complex subject, so much of the first part of this chapter will focus on important background and foundations before moving into specifics about postcolonial Latin American science and technology studies.

The original temporal use of the term “post-colonial” emerged at the end of World War II in reference to the physical de-colonization of parts of Africa and Asia that occurred around that time.¹³² However postcolonialism as a theory (as opposed to an historical temporality) evolved out of the social and cultural turns in Western academia, initially with the works of Edward Said, among others, in relation to literary studies of Asia, North Africa and the Middle East. Said’s *Orientalism*, published in 1978, is considered to be the

foundational text for postcolonial studies. In this seminal work, Said wielded French theorist Michel Foucault's concepts of power and knowledge to demonstrate that "the Orient has helped to define Europe (or the West) as its contrasting image, idea, personality, experience" and that the West used the idea of "Orientalism" to dominate and control "the Orient."¹³³ The relationships between power and knowledge are still central to many postcolonial critiques. Said also popularized the notion of binarisms (such as West/Orient) that postcolonial thinkers continue to struggle with and against. Postcolonialism (as a theory) is now well-established across a broad swath of academic disciplines in the Global North.

As with most theories or "isms," and as evidenced in the previous chapters on dependency theory and social constructivism, postcolonialism is heterogeneous, not monolithic.¹³⁴ Most postcolonial theorists would agree, however, that postcolonialism is generally anti-colonial.¹³⁵ Postcolonial theorist Bill Ashcroft stated that the "European colonialist histories and institutional practices, and the responses (resistant or otherwise) to these practices on the part of all colonized peoples" is foundational to postcolonialism.¹³⁶ That said, the specifics of historical colonization may be incidental to the postcolonial narrative, which may choose to focus instead on its effects, such as institutionalized racism or sexism, differential access to health care or education, privileged knowledges, cultural hegemonies, and so forth. It is the *effect* of physical and mental colonizations that take center stage in postcolonial writings, and these wide-ranging effects of colonialism occurred not only in the colonized countries, but also in the West itself. In most cases, the postcolonial standpoint can be considered to be an activist standpoint in the sense that it seeks to change widely-held viewpoints on a plethora of historical issues. As such, postcolonialism as a theoretical framework moves beyond the standard model of white, male, Western histories by

problematizing and disrupting the dominant discourses. Postcolonial theory also creates intellectual space for historically marginalized peoples to speak and to have agency by re-contextualizing, re-localizing, and re-framing historical narratives. In this way, postcolonial histories can also function to promote and disseminate transnational social justice issues.¹³⁷ Venezuelan theorist Fernando Coronil stated succinctly that postcolonial studies' "central intellectual challenge" is "to view colonialism as a fundamental process in the formation of the modern world without reducing history to colonialism as an all-encompassing process and [...] to contest modernity and its Eurocentric forms of knowledge without presuming to view history from a privileged epistemological standpoint."¹³⁸

In addition to the general anti-colonialism of postcolonial histories, there are other common themes and ideas that pervade the published postcolonial works. Though a detailed analysis is beyond the scope of this chapter, it is important to briefly note a few of the prominent issues. The first is the idea that from *where* a scholar speaks, epistemologically, impacts the direction of their work. This concept was briefly discussed above. A second idea is *how* concepts and ideas are discussed and what language or terminology is used will also affect the work. English is the dominant language in academia, but it is also a problematic one for a multitude of reasons, not least of which is that it is not the primary language in Latin American countries. Another example is that terminology such as “Third World” or even “Latin America” are homogenizing and historically problematic in themselves, as addressed in the introduction to this thesis. A third common theme in postcolonial writings is the Foucauldian notion of *discourse*, more specifically Said and Bhabha’s examinations of *colonial discourse*. Summarized by Ashcroft, Foucault’s discourse is “is a system of statements within which the world can be known. It is the system

by which dominant groups in society constitute the field of truth by imposing specific knowledges, disciplines and values upon dominated groups."¹³⁹ Colonial discourse, then, assumes the superiority of the colonizer's culture and the inferiority of the colonized culture in constructing this "field of truth." This brings us to the fourth common theme of postcolonial works, that of *universalism*. Postcolonial critiques often argue explicitly against universalisms, whether it is the Eurocentric idea of a unidirectional path to Western development or the positivistic unitary theory of science. Universalisms are viewed as imposed and hegemonic, and therefore harmful. This leads nicely into the fifth frequently-addressed theme in postcolonial writings: agency. Often, postcolonial histories seek to examine the myriad and sometimes obscure ways in which marginalized groups have asserted agency, rather than portray such groups as little more than victims or passive in their own histories. Finally, many postcolonial histories aim to be *intersectional*. That is, they address on some level the complex intersections of race, gender and class.

Historical Background: Latin America

Colonialism in Latin America began with the first European voyages to the New World at the end of the fifteenth century, and anti-colonialist works began to be published not long afterward. Historian Robert J.C. Young considered the first European anti-colonial critique to be that of Bartolomé de Las Casas, the Catholic bishop who penned *A Short Account of the Destruction of the Indies*, published in 1542.¹⁴⁰ The colonial Latin American wars for independence did not occur until the late eighteenth and early nineteenth centuries,

several hundred years after the beginning of colonial relations in the region. This is a significantly longer period of time than almost every other formerly colonized region in the world. The wars for independence were incited by the American Revolution in what is now the United States, as well as the Haitian Revolution, which began in the 1790s and concluded with Haitian sovereignty in 1804. Most Latin American nations did not gain political sovereignty until the first decades of the nineteenth century, and Cuba remained a Spanish colony until the Spanish-American War of 1898. Although Cuba gained independence in 1898, it was the United States and Spain who negotiated the deal through the Treaty of Paris, from which Cuban officials were excluded and through which the United States came to occupy, influence and generally assert neocolonial controls over Cuba, Puerto Rico, Guam and the Philippines. Some parts of Latin America are still colonized, such as Puerto Rico, which is now referred to as a “territory” as opposed to the less savory term “colony.” The majority of what are now independent countries in Latin America were therefore colonized for three centuries or more, or in the case of Cuba, over four centuries.

Colonialism did not end with political sovereignty, however. Latin American nations still dealt with both internal colonialism as well as neocolonialism. Without delving in to the complex political history of a dozen specific nations, the peninsular elites (transplants from Iberia) or creole elites (born in the Americas but exclusively of Iberian descent) generally remained in control of Latin American countries after the various wars of independence. These elites retained many Western notions, including racialized and gendered notions of power and even the idea of the nation-state itself. Indigenous peoples, African-descended peoples, many mixed-race peoples (of which there were many hierarchized categories in the

Americas) and women did not have any say in the governance of the newly formed nations. This, in essence, was internal colonialism.

Neo-colonialism was different from internal colonialism. The concept of neocolonialism was first described by the first president of Ghana, Kwame Nkrumah, in his 1965 book *Neocolonialism: The Last Stage of Imperialism*: “The essence of neocolonialism is that the State which is subject to it is, in theory, independent and has all the outward trappings of international sovereignty. In reality its economic system and thus political policy is directed from outside.”¹⁴¹ This succinct definition sums up the tangled webs of military, economic, political and cultural controls that nations such as the United States or Great Britain wove in the newly-formed Latin American nations to exert power and control in Latin America. The United States in particular has been guilty of some of the most egregious forms of neocolonialism since the signing of the Monroe Doctrine in 1823. This piece of legislation was ostensibly to protect the countries of the Americas from further European colonization, but it in actuality gave the United States a pretext to repeatedly intervene in Latin America. From 1898 to 1920, the United States intervened militarily twenty times in the Caribbean, and in the century between 1898 and 1994, the United States successfully interfered to change the governments of Latin American nations at least 41 times.¹⁴² So although most countries of Latin America may have been officially sovereign and independent, they still suffered from the neocolonial incursions of outside countries, most notably the United States.

Latin American Postcolonial Studies

Latin American postcolonial studies are notoriously challenging to define. As discussed earlier, "postcolonial" does not necessarily refer to a period in time after a nation achieves political independence from another, colonizing nation; rather, postcolonial analyses specifically focus on the effects of colonialism and neocolonialism on societies and cultures. With very few exceptions, Latin America has ironically been largely ignored in the compilation and publication of edited volumes on postcolonialism.¹⁴³ This is ironic considering that Latin America was burdened by external colonialism for over three hundred years, much longer than other areas of the world. In part, the elision of Latin America in edited volumes is because the region's temporal history of post-colonization significantly preceded other nations' post-colonization, in some cases by centuries. Meaning, the focus of much academic postcolonial writing is on nations that have only relatively recently achieved independence. It is challenging to avoid arguments of Latin American exceptionalism in this regard.

Many of Latin America's postcolonial works have their roots in the radical anti-colonialist neo-Marxism of the late 1960s. As historian Florencia Mallon articulated, "By the 1960s and 1970s, then, as my generation came of age in the United States and Latin America, schooled in about equal parts by Cuba, 1968, Vietnam, and the cultural and youth revolutions, many of us chose a different path from those academics and intellectuals who had gone before. We were convinced that we faced an unavoidable choice between solidarity with popular, anti-imperialist, social-justice struggles in Latin America, on one hand, and complicity with hemispheric repressive forces, on the other."¹⁴⁴

One of the best-known and most widely-adored radical neo-Marxists of the era was the Argentine Che Guevara. In his 1967 Message to the Tricontinental, issued a few months before his execution in Bolivia, Guevara shifted the Communist focus from Marx's general "workers of the world" to the anti-colonialist and counter-hegemonic "we, the exploited people of the world" and "we, the dispossessed." Historian Robert Young argued that with these words, Guevara effectively manifested the epistemology of the postcolonial subject.¹⁴⁵

The anti-imperialist struggle of the Cuban Revolutionaries never fully died out. New, pipe-smoking guerrilla revolutionaries, anonymized with black ski masks, appeared on January 1st, 1994, on the same day that the North American Free Trade Agreement (NAFTA) was signed into law. The Ejército Zapatista de Liberación Nacional (EZLN), better known as the Zapatistas, initially consisted of a group of Indigenous Mayan men, women and children who took control of several small towns in the Mexican state of Chiapas. Among other demands, the Zapatistas demanded the right to autonomy for the Indigenous communities of Mexico.¹⁴⁶ Although the Mexican army reclaimed the towns and many lives were lost in the process, the Zapatista movement did not disappear. The movement persists to the modern day, and has had a significant impact on subaltern, postcolonial and decolonial studies of Latin America, as will be discussed in the next chapter. The Zapatistas have become romanticized as anti-imperialist revolutionaries in a similar way as Che Guevara's struggle for "we, the exploited people" became romanticized, but their foundations lay in much older and more widespread anti-imperialist efforts of Indigenous and First Nations peoples across the globe.¹⁴⁷

In academia, two occasions in the early 1990s indirectly expanded the influence of postcolonialism in histories of Latin America. The first was the 1992 quincentenary of

Columbus' first voyage to the Americas. While part of the world lauded the adventurer as a hero, an increasing awareness of the two-sided nature of the "discovery" began to change the tone of the celebration. After all, what does it mean to talk about a "discovery" or a "conquest" when you are on the "wrong" end of the "conquest"? Some academics centered issues of Indigenusness and colonialism, while a few rogue historians of science published papers on the impressiveness of Iberian science and technology. Whether focused on the destructive nature of the Columbian encounter or on the oft-neglected Iberian contributions to the history of science, it was clear that the Western understanding of the "voyages of discovery" had begun to change and to reflect the complexity of the history as opposed to the simplistic (and inaccurate) triumphalist narrative.¹⁴⁸

Also in 1992, Latin American literature and culture studies professors John Beverley and Ileana Rodríguez¹⁴⁹ founded the Latin American Subaltern Studies Group, modeled after the South Asian Subaltern Studies Group. *Subaltern* is a term co-opted from Italian philosopher Antonio Gramsci's explorations of hegemony, and the word generally means a group of people of inferior rank, or a subset of the population that is subject to the hegemony of the dominant group. In the United States, all people of color and all women are considered subaltern. Most subaltern studies focus on a more narrowly defined group however, such as Afro-Latinx women, trans people, differently-abled people of color, and so forth. Like postcolonialism, subaltern studies were not monolithic. However, also like postcolonialism, subaltern studies tended to highlight marginalized groups' agency or forms of resistance to the dominant culture. As Venezuelan scholar Fernando Coronil pointed out, both subaltern studies and postcolonial studies focus in one way or another on marginalized groups of people, making the early subaltern studies sometimes difficult to discern from their

postcolonial brethren.¹⁵⁰ Though the group published a well-regarded reader in Latin American subaltern studies, the association eventually collapsed. Some of its members, such as co-founder Ileana Rodríguez, went on to explore more explicitly postcolonial topics. Others, such as Argentinian scholar Walter D. Mignolo, ultimately rejected postcolonialism as not being radical enough.

A major interest of many postcolonial thinkers is binarism and the related concept of borderlands, and this is especially true for Latin American postcolonial studies. Binarism is the typically Western imperial practice and ideology of separating the world into strict binary opposites such as colonizer/colonized, civilized/primitive, white/black, good/evil, and is primarily used to describe relations of dominance between the West and “the rest.” There are a multitude of problems with binarisms, but one of the preoccupations of postcolonial studies is that binarisms elide the liminal, the interstitial, the indeterminate, the ambiguous. In short, the borderlands.¹⁵¹ Borderlands can be physical, mental, emotional, intellectual, tangible, metaphorical, religious, or anything really. Borderlands are the space between, betwixt, not really here nor there, part of one thing, part of another but not really either. Borderlands are the *mestiza*, the *nepantla*, the Afro-Latinx, the Chicana, the border wall, the syncretism, the third-culture-kids, the halal tacos, the Mayan honey-seller at a flea market in the Southern United States. In Latin American postcolonial studies, borderlands are the richest spaces of examination and analysis because they are complex and confusing and problematize and seek to dismantle the overly simplistic binarisms often constructed by people seeking to impose or uphold Western norms and values.¹⁵² A key text in U.S. Chicana studies, and later in Latin American postcolonial and decolonial studies, is *Borderlands/La Frontera* by Gloria Anzaldúa. Anzaldúa’s writings have also influenced broader feminist and borderlands work

outside of Latin American studies. Latin American postcolonial studies thus evolved in part from the neo-Marxist anti-imperialism of the late 1960s and fully came into its own through (literal and figurative) boundary-crossing borderlands work.

Postcolonial Science and Technology Studies (STS)

Postcolonialism has its own history within the field of science and technology studies (STS). The term “postcolonial” is most associated with “STS” as opposed to “history of science” because postcolonial critiques frequently cross disciplinary boundaries, much to the chagrin of strict disciplinarians in academia. In the history of science, the most important function of postcolonial analyses is to further dismantle the triumphalist, unidirectional narrative of Western science and to undermine the epistemological universalisms of modern science. Postcolonial histories of science critique the idea that knowledge could be produced without being influenced by geophysical location, culture or standpoint. They also demonstrate the fact that science was wielded in the process of colonization, from the imposition of Western sciences to the deliberate destruction of other cultures’ scientific practices. Analyzing the impact of colonialism on science not only sheds light on previously unknown histories, but also shines a bright light on the fallacies, inaccuracies, imperialism and generally unsavory foundations of culturally Western scientific practices.

The relations between power and knowledge are also vital to postcolonial science studies. It is power which decides what does and does not constitute knowledge. In the case of colonialism (whether in India or the Americas or Africa), the imperial colonial powers

appropriated into their own practices what knowledge they deemed useful, often erasing the origin in the process, and dismissed or actively suppressed any knowledge practices that did not suit the imperial needs. As Indian environmentalist Claude Alvares said, "Science should have been critically understood not as an instrument for expanding knowledge, but for colonizing and controlling the direction of knowledge, and consequently human behavior, within a straight and narrow path."¹⁵³ The asymmetries of power, first addressed in the social and cultural histories of the previous chapter, became a more concentrated focus of research for postcolonial historians of science.

Feminist postcolonial science studies further dismantled the hidden universalisms inherent in many histories of science. Not only did feminist scholars point out the fact that most histories of science focus on men and the male experience, but also that when women were included at all, it was often in contrast or comparison to the white, middle class Western woman and a Eurocentric ideal of what constituted the feminine. These intellectuals, spearheaded by the work of Indian postcolonial theorist Chandra Mohanty, wrote about how the West's vision of the stereotypical "Third World Woman" homogenized and victimized a highly heterogeneous subset of the population. Western academics inaccurately presented these women as universally impoverished, ignorant, illiterate, oppressed, needy and passive as a result of their Indigenesness, rural lifestyles or their geophysical location.¹⁵⁴

Colombian anthropologist Arturo Escobar called these representations, and the actions and beliefs that stemmed from them, "regimes of representation."¹⁵⁵ Postcolonial scholars also began to question how the *absence* of women from scientific practices and historical narratives has influenced the production of science in the West and in non-Western places. In a similar vein, Colombian anthropologist of science Tania Pérez-Bustos and her

colleagues examined the ways in which female scientists are often elided from public discussions and how “feminized” science is devalued and often invisible work.¹⁵⁶ Feminist theorists also addressed the fact that gender is relational, and that colonialism had a significant and lasting impact on relations between multiple genders as well as between gender, class and race.¹⁵⁷

Latin American Postcolonial STS

Some Latin American histories of science are explicitly postcolonial (for example, they may state in the introduction that they take the postcolonial standpoint), whereas many other publications are only implicitly so. Though the line may be subjective, I consider histories to be postcolonial if the authors examine many of the themes outlined in this chapter’s introduction from an explicitly activist standpoint: marginalized epistemologies, failure of universalisms, languages and terminology, colonial discourse, subaltern agency and intersectionality. In postcolonial histories, scholars portray Western science as one of multiple voices, not *the only* voice; postcolonial historians remove Western science from its exalted position of universality and neutrality. In these histories, Western Europe and the United States are no longer the central focus; they are part of the narrative but not the entirety.¹⁵⁸ As stated by renowned Latin American semiotician Walter D. Mignolo, Latin American postcolonial studies are about “decentering the center or multiplying it” and altering the “loci of enunciation.”¹⁵⁹ Unlike some earlier social constructivist histories, postcolonial histories are not social histories of subaltern peoples from a Western

perspective. Instead, postcolonial histories deconstruct traditional narratives of the Western history of science that include, but do not center, marginalized people, places and scientific practices. Postcolonial histories differ from simple social or cultural histories in these transnational social justice or activist aspects.

Postcolonial scholars write about a plethora of topics but there are four widely addressed subjects within Latin American postcolonial science and technology studies: anthropology, cartography, environment and medicine. An additional umbrella theme is that of transculturation.

As mentioned in the first chapter, the first published academic works on the history of science in Latin America were anthropological in nature: ethnographies and archeological reports. While Western historians of science dismissed these histories as “unscientific,” academics who took the postcolonial standpoint critiqued these anthropological papers for entirely different reasons. Postcolonial scholars argued that anthropology, especially ethnographies, functioned in tandem with colonialism by constructing a perspective of the West’s “primitive others.”¹⁶⁰ While anthropologists often touted the neutrality of participant observation – when an outside anthropologist is present within a group to watch, ask questions, listen, record data – postcolonial critics pointed out that none of these actions are value-neutral. The epistemology of the anthropologist affects their choice of questions, what they record, what they can even understand of the other culture. Although anthropologists portrayed their work as “uncovering” a culture (similar to other scientists’ claims of “uncovering” true nature), postcolonial scholars pointed out that the anthropologists were in fact constructing a culture based upon preconceived notions, bias, and epistemological and

even ontological differences. In essence, the anthropologist's own culture could never be absent from their study of other cultures. Rather, anthropological works constructed and reinforced imperial binarisms such as colonizer/colonized, civilized/primitive (or civilization/barbarism) and white/black. Some anthropological works were also extremely sexualized, portraying the "primitive other" as highly sexed and sometimes promiscuous, in opposition to the modest White European. Additionally, these anthropological characterizations reinforced, and sometimes created, racial hierarchies and stereotypes.¹⁶¹ In short, early anthropological works were foundational in crafting the *colonial imaginary*. Postcolonial scholars have been key in dismantling the assumptions and inaccuracies of anthropological works, including those on Latin America. More recent publications in anthropology, such as the edited ethnographic-style volume *Mestizo Genomics*, accept and address the aforementioned problems in traditional ethnographies. The authors achieve this in part by tackling issues of complexity in race and science and history rather than eliding information to simplify their narrative. In this, the authors succeed in presenting a difficult topic (race and genetic science) as both heterogeneous and understandable.¹⁶²

In addition to anthropology, geography and cartography were also early targets of postcolonial scholars. These academics examined the ways in which colonialism influenced not only the construction of maps, but also the naming or renaming of places and even the epistemological differences between Western peoples and Latin American peoples in viewing and utilizing the land and stars. For example, in *Indigenous Intellectuals*, historian Eleanor Wake analyzed the ways in which the spatial consciousness of Indigenous peoples was in many ways fundamentally different from the colonizing Europeans, from the differences in geographical reckoning to the incommensurability of the Western concept of

cardinal directions.¹⁶³ Postcolonial intellectuals also examined the ways in which the Western sciences of measurement and the Western practices of land appropriation and ownership were imposed upon Indigenous peoples of the Americas, or what Walter Mignolo termed the “colonization of space.”¹⁶⁴ These scholars also addressed how Indigenous peoples may have found a form of agency within the imperial cartographic practices through wise use of the imposed colonial legal system. Geographer J.B Harley was one of the early proponents of the idea that Indigenous geographical knowledge was hidden within many colonial maps and that Amerindians appropriated European mapmaking skills “as tools of resistance in a colonial struggle” in order to serve their own community needs.¹⁶⁵ Other historians, such as Barbara Mundy, have taken this legacy into decolonial territory as will be evidenced in the next chapter.

One of the first environmental histories to be published in the 1970s was Alfred Crosby’s *Columbian Exchange*, which he followed with his book *Ecological Imperialism*. While disease and agriculture were certainly important topics in both books, the overall theme was that of the environmental impact of colonialism on the Americas. Though Crosby’s books were more cultural histories than postcolonial critiques, his books sparked an interest in environmental histories of Latin America, which remains one of the most popular subjects in the histories of science of the region. In addition, Crosby’s *Columbian Exchange* was one of the first books to fatally undermine the triumphalist narrative of European discovery and conquest. In the book, Crosby presented evidence for haphazard and accidental destruction of the Indigenous Americans through the introduction of European diseases like smallpox, invasive European plants such as wild artichokes, and the rampant spread of feral European pigs, among countless other catastrophic imports.

Environmental racism is a frequent topic in postcolonial environmental histories. The standard meaning of the term *environmental racism* is when a racially marginalized group is exposed to a disproportionately large amount of environmental hazards such as toxins in the land or water, air pollutants, or degradation such as that caused by mining or deforestation. *Environmental injustice* includes gender and class as well as race in its definition. In some cases, environmental injustice is in the form of *slow violence*, such as the gradual accumulation of toxins within the body through environmental contamination. It may take years or even decades, but exposed persons will eventually be harmed or even killed. As historian Kendall Brown illustrated in his excellent book *A History of Mining in Latin America*, the widespread practice of mining in Latin America, from the colonial era to the present, has been notorious for environmental injustice.¹⁶⁶

Historian of science Jorge Cañizares-Esguerra presented an entirely different form of environmental racism in his book *Nature, Empire and Nation*, in which he proffered evidence that European interactions in the Americas formed what later came to be called *scientific racism*. Most notoriously articulated by the Comte de Buffon in the eighteenth century and later promoted by the adventurer Alexander von Humboldt, the degeneracy theory of disease claimed that Indigenous Latin Americans, and later, any resident of Latin America despite their heritage, were lazy, effeminate and inferior as a result of Latin America's climate. In response to this climate-based racism, peninsular and creole elites formulated an alternative theory (what Cañizares-Esguerra termed a "patriotic astrology") that retained the idea of inferior Indigenous and African-descended persons while exempting themselves from the so-called degenerating effects of climate. Around the same time, the rector of the University of Mexico compiled the *Bibliotheca Mexicana*, which was an

annotated bibliography of all known Indigenous and Creole works written since the European Invasion in the late fifteenth century, as evidence of Latin Americans' excellent intellectual ability.¹⁶⁷ Historian Richard H. Grove also argued that this focus on climate and environment as pivotal to politics and social morality elevated the early discussions (and controversies) of climate science and helped build the foundation of modern environmentalism.¹⁶⁸

As mentioned in the previous chapter, histories of medicine, public health and disease were some of the earliest and most prevalent social and cultural histories to emerge from Latin America during the latter half of the twentieth century. This was in part because of the poverty and lack of health care in rural areas and those affected by war or violent governmental regimes, but it was also because of the long history of colonial and neocolonial impositions on the health and well-being of Latin Americans. Historian Londa Schiebinger has been influential in new analyses of the marginalized botanical histories of parts of Latin America, particularly the intersections of botany, medicine and Indigenous and African-descended plant medicine. Schiebinger pointed out that, despite the intense European interest in botanical knowledge, they were limited in their understanding by an epistemological framework based on humoral medicine and a lack of understanding of Indigenous languages such as Taino or Arawak. A result was a European collection of botanical specimens "stripped of narrative," much like an encyclopedia with words but no definitions, histories or contextual background information.¹⁶⁹ Other postcolonial historians of science focus on how the politics of race, class and gender influence the medical decisions that a person is able to make for themselves or for another member of their community. Historian Martha Few, who has written extensively on gender and family medical issues in

Latin America, covered such topics as postmortem cesareans and the politics of supposedly “unnatural” births. In these histories, Few addressed not only the intersectional aspects of medical decisions but also the complex transnational nature of medicine in Latin America, where Indigenous, European and syncretic practices often overlapped and competed in what Few termed “medical mestizaje.”¹⁷⁰

Transculturation is an overarching theme that clearly impacts each of the above subjects, as well as other topics such as technology, media and laboratory work to name just a few. Cuban anthropologist Fernando Ortíz coined the term *transculturation* to describe the merging of cultures in his 1947 book on Afro-Cubanos, *Cuban Counterpoint: Tobacco and Sugar*.¹⁷¹ Transculturation is not simply the imposition of one culture on another, or the appropriation of certain external cultural elements into an Indigenous culture, but rather the reciprocal influence of two (or more) cultures on one another. The word “entangled” is often used in Latin American histories of science. In addition to transculturation, the aforementioned borderlands are also important spaces of Latin American postcolonial science and technology studies. Borderlands can be, but are not always, literal or figurative places of transculturation. As can be seen from the examples described above, the postcolonial standpoint on the history of science in Latin America is complex and multi-layered, often addressing intersectional issues of race, gender and class within a single work.

Criticism

The most common general criticism of postcolonialism is that it is a product of elite academics in the West. Despite the criticism that postcolonialism emerged from the privileged West, many of the first academics who worked to develop the postcolonial standpoint within Western academia themselves originated from colonized spaces, such as Homi Bhabha or Gayatri Spivak from India, or Jamaican-born Stuart Hall.¹⁷² British postcolonial historian Robert J. C. Young also correctly pointed out that an academic's physical location may not accurately indicate whether their intellectual standpoint is Western or not. Academics outside of the West can be "thoroughly westernized," whereas some academics working within Western academia may speak from a non-Western space epistemologically, politically or culturally.¹⁷³ This complicates the common criticism that postcolonialism is entirely the product of the West. That said, postcolonialism is without a doubt a product of privileged academics, many of whom lived, worked and died in wealthy metropolitan centers, often in Britain or the United States.

Another salient issue with the application of postcolonialism is that the term itself implies that Latin America has moved past colonialism, which is not entirely true. Post-independence Latin American nations have had to deal with the almost continuous neocolonial and imperialistic incursions of many Western nations, from France and Britain to the United States and Russia, among others.¹⁷⁴ Additionally, as will be detailed in the next chapter, some Latin American scholars have argued that the co-construction of modernity and coloniality means that there is no such thing as *postcolonial*, rather, the modern world is founded on a continuation of the structures of colonialism.¹⁷⁵

There is no singular, cohesive, institutionally-recognized body of work in Latin American history that can be pointed to as “postcolonial,” despite the large numbers of published works that take the postcolonial standpoint. In many cases the line between subaltern studies and postcolonial studies is blurry, if it even exists at all.¹⁷⁶ This is not to say that postcolonial histories do not exist; on the contrary, there are a plethora of them. Rather, Western academia does not have a specific foundational corpus of writings on Latin America as it does for Africa and India. This leads into another potential criticism, that of Western academic colonialism, in which privileged academics who are located in the West appropriate the ideas, theories, or narratives of historically marginalized scholars or scholars working within historically marginalized places. One response to this has come from Argentine academic Walter D. Mignolo, who has lived in the United States for many years and who has a prestigious position as a professor at Duke University: “The issue is not whether one who is born in Holland should be a miller and one born in New York a stockbroker nor whether someone born in Holland or in New York has more authority when it comes to mills or the stock market but rather who is talking about what where and why.”¹⁷⁷ In other words, a scholar’s geophysical location is ultimately less important than the epistemological position from which they speak.

Finally, some feminist scholars believe that many postcolonial analyses either leave out women and gender relations entirely or assume that women and men are equally affected by science and colonialism. This is often done by either taking the men’s perspective only, or by lumping people into groups which again privileges the male perspective. Some feminist postcolonial academics such as Sandra Harding have directly addressed feminist science studies in their work.¹⁷⁸ One of the most important differences between traditional

second-wave feminist studies and postcolonial feminist science studies is that postcolonial analyses take the specific differences of non-white, non-Western women into account. This poses significant challenges since historically these women were less likely to record their own stories or even have their stories recorded by others.

Conclusion

As a radical evolution of earlier social and cultural histories, postcolonial science and technology studies represents the most prevalent current standpoint for academics working in Western countries (whether Latin American scholars or otherwise) to approach the history of science in Latin America. Postcolonial histories of science address the effects of colonialism and neocolonialism, as well as work to dismantle triumphalist and universalist Western histories of science. This is achieved by writing from a social justice standpoint in which marginalized epistemologies, subaltern agency and intersectionality take the forefront. However radical postcolonial histories may seem, as will be illustrated in the next chapter, some academics do not believe that postcolonialism is radical enough. The following chapter tackles the burgeoning standpoint of decoloniality.

Chapter 5

Decoloniality

Introduction: The Coloniality of Power

Decoloniality is a burgeoning intellectual framework that historians may wield to analyze the history of science, particularly marginalized histories. Whereas the postcolonial theory addressed in the previous chapter emerged from Western academia, *decoloniality* (as a corollary to *coloniality*) is the product of Latin American thinkers, specifically the modernity/coloniality group that included such multi-disciplinary scholars as Walter Mignolo, Aníbal Quijano, Fernando Coronil, María Lugones, Arturo Escobar, Enrique Dussel, and others. Although decoloniality evolved in the 1990s from Peruvian sociologist Aníbal Quijano's concept of the *coloniality of power*, the first English-language writings related to these thinkers were published in the early 2000s in the peer-reviewed journal *Nepantla*.¹⁷⁹ While postcolonial histories distinguished themselves from standard social or cultural histories by their activist standpoint, decolonial scholars believed that postcolonialism was not radical enough in its critiques.

Coloniality is not the same as colonialism. Coloniality specifically refers to the structures of power and hegemony that were constructed with the beginning of the modern era at the end of the fifteenth century. In its original meaning formulated by Aníbal Quijano, coloniality of power referred to the matrix of authority, labor, sexuality, and subjectivity that evolved from the interaction between Europeans and Indigenous peoples in the fifteenth century. Decolonial thinkers believe that there is no modernity without coloniality, that

modernity and coloniality were co-constructed. In other words, our modern society would not exist as it does without the structures of colonialism and neo-colonialism that persist to the present. According to decolonial thinkers, the current global structures of racism, sexism and patriarchy were first constructed through the interactions between Europeans and global Others over five hundred years ago.¹⁸⁰ Argentinian scholar and Duke professor Walter D. Mignolo stated clearly that “from a decolonial perspective there is no outside of coloniality from where coloniality can be observed.”¹⁸¹ Just as the structures of modernity/coloniality have existed for five centuries, so has decolonial resistance to those structures.¹⁸²

Decoloniality is not hegemonic, monolithic or universal, nor do decolonial thinkers adhere to disciplinary (or other) boundaries. Decolonial critiques are not Eurocentric critiques of Eurocentrism, as postcolonial critiques have often been accused of being. Postcolonial scholars often founded their works on Western scholars and theoreticians, whereas decolonial thinkers work to bolster the voices of non-Euro-centered intellectuals. Decolonial scholars actively aim to change the *terms* of discourse as opposed to merely changing the *content*.¹⁸³ In this way, decolonial works are explicitly founded within a scholar’s particular epistemological experiences (usually of marginality), and decolonial projects aim to reveal and re-value these epistemological silences.¹⁸⁴ Part of this re-existence involves dismantling Western hegemonies, powers, and universalisms.¹⁸⁵ Decoloniality is thus a standpoint, a situated knowledge, an ongoing project, and it is closely tied to activism and social justice issues across the Americas. Decoloniality is radical.

There are some basic commonalities within decolonial works: intersectionality, pluriversality and heterogeneity, and thinking Otherwise. Intersectionality, as previously described in the postcolonial chapter, is recognizing the interconnected and relational ways in

which gender, race and class, as well as geophysical location, interact in the modern/colonial world system. Intersectionality is a form of *relationality* (*vincularidad* in Spanish), or understanding the world in terms of relations as opposed to discrete entities.¹⁸⁶ Pluriversality is the concept that “the diversity of the world is infinite” and that a single understanding of the world (such as the Western scientific universal) is too narrow and exclusive to encompass such diversity.¹⁸⁷ Pluriversal decoloniality/decolonial pluriversality promotes heterogeneity as the only “universal.”¹⁸⁸ Thinking Otherwise entails a fundamental shift in the way in which one perceives the world, perhaps decolonially analogous to the now-overused concept of “getting woke” in Black U.S. culture or having a Pollan-esque “change of mind.”¹⁸⁹ Decolonial scholarship is radical and idealistic and stems from the rage and pain and frustration of the colonial wound.

Decoloniality and Indigeneity

Latin American thinkers coined the term *decoloniality* as a corollary to Aníbal Quijano’s *coloniality*, but these scholars built upon a growing push within Indigenous communities across the Americas (and the world) to address the continuing detrimental legacy of settler colonialism. Argentine scholar and Duke professor Walter D. Mignolo is one of the most vocal academic proponents of decoloniality, and he has recently started his own series on decoloniality at Duke University Press. Mignolo was originally a member of the Latin American Subaltern Studies Group, but left because he believed the group was not radical enough in its rejection of Western colonialism. In addition to the work of the

modernity/coloniality group, Mignolo credits global Indigenous movements (notably the Zapatistas in Mexico and the Buen Vivir movement in Ecuador) with shaping his perspectives on decoloniality.

Historian Thomas Ward pointed out in his book *Decolonizing Indigeneity* that the way in which Western intellectuals have written about Indigenous people has been as “subjects twice removed from the perceived paradigm of culture and language.”¹⁹⁰ In the original Spanish colonists’ writings, Indigenous people were simply *indios* or *naturales*, which was not only geographically incorrect (since they were not in India) but also erased their self-identified nationalities, homogenizing and stereotyping a highly heterogeneous population of humans.¹⁹¹ This tendency persists to the modern day, where historians such as Erick Langer and Ken Coates have pointed out that even the terms “Native American” or “Indigenous” promote an incorrectly monolithic vision of diverse peoples.¹⁹² In a similar vein, some activists have argued for a return to Indigenous languages, many of which are still officially recognized by Latin American governments.¹⁹³ In some places, such as the Mayan archeological site of Uxmal in the Yucatan, historical markers are posted in two or three languages: Yucatec Mayan, Spanish and sometimes English.¹⁹⁴ Even within spoken Mayan, there are 29 officially recognized and specifically-named Mayan languages (not just dialects) across Guatemala and Mexico, of which Yucatec Mayan is just one.¹⁹⁵ There continues to be heated scholarly debates over language, in particular languages of colonization and domination versus languages of liberation. In addition to fighting the elision of nation-hood by colonial language, Indigenous and Afro-descended peoples have increasingly challenged the nationalist ideologies of *mestizaje*, originally crafted in the post-Independence eras as a form of unifying image of Latin American nation-states.¹⁹⁶ Although *mestizaje* has been

effectively wielded in the borderlands work of some decolonial thinkers such as Gloria Anzaldúa, others believe that the concept explicitly excludes the Indigenous and Afro-descended peoples of Latin America.

One of the most prominent Indigenous resistance movements to affect Latin American decolonial scholarship was/is the Ejército Zapatista de Liberación Nacional, or Zapatistas.¹⁹⁷ As discussed in the postcolonial chapter, the Zapatistas are a group of Indigenous Maya-descended peoples in what is now southern Mexico and Guatemala. Their initial guerrilla takeover of several small towns in the Mexican state of Chiapas and the subsequent Declarations from the Lacandon Jungle by Subcomandante Marcos sparked a scholarly interest in Other ways of existing in modernity. Some of the first published Latin American academic decolonial works focused on the revolutionary Declarations that emerged from the Zapatistas. These early academic papers were printed in the peer-reviewed journal *Nepantla*, a Nahuatl word roughly translated as “in-betweenness” and used by the border-thinker Gloria Anzaldúa. One of the most fascinating aspects of the Zapatista movement for the historian of science is the ways in which the revolutionaries effectively wielded modern technologies such as the radio, video and the internet to communicate their messages to a broader international audience.

In an entirely different part of Latin America, the Quechua and Aymara peoples of the Andes founded the Buen Vivir movement (also called *sumak kawsay* in Quechua) in the early 2000s as a reaction against the increasing encroachment of exploitative multinational corporations and the governmental failures to protect Indigenous and natural rights. As Columbian anthropologist Arturo Escobar phrased it, "Buen Vivir subordinates economic objectives to the criteria of human dignity, social justice, and ecology."¹⁹⁸ One of the aspects

of the Buen Vivir movement that interests historians of science (and especially environmental historians) is their belief that ecosystems (not just humans) have a right to exist and thrive on their own accord. In 2008, this ecological focus culminated in the ratification of comprehensive Rights of Nature articles in the Ecuadoran Constitution.

In addition to the influence of Indigenous intellectuals on Latin American decoloniality, Black African and African-descended scholars have helped shape the discourse around Latin American decoloniality. In particular, Frantz Fanon's *Black Skin, White Masks* and *The Wretched of the Earth* are regularly cited, although the early twentieth-century scholar W.E.B. Dubois is also considered among the Black decolonial canon. Both men were also scientists in their time, Fanon a psychiatrist and Dubois a sociologist. As Dubois noted, "One could not be a calm, cool, and detached scientist while Negroes were lynched, murdered and starved."¹⁹⁹ Afro-Latinxs in academia are also increasingly focusing on decolonial thought as a standpoint for expressing their often fraught and complex racial histories in the Americas.

Decolonial Feminisms: The Coloniality of Gender

In the last few years, some feminist thinkers have rightly pointed out the absence of women both as authors and as subjects in the earliest Latin American decolonial publications.²⁰⁰ This dearth might stem in part from the dominance of men within higher academia and from the (stereotypically) machista culture of many regions in Latin America. Some of the male academics accused of eliding women from their decolonial writings,

including most notably Walter D. Mignolo and Arturo Escobar, have responded quickly to the criticism and have subsequently made significant efforts to include female intellectuals in their ranks. Mignolo's most recent book, *On Decoloniality*, was co-authored with decolonial feminist Catherine E. Walsh, and Escobar addressed women's particular epistemological "positionality" in his recent essay "Worlds and Knowledges Otherwise."²⁰¹ Decolonial feminists argue that gender and coloniality were co-constructed, in what is commonly referred to as the *coloniality of gender*.²⁰²

Decolonial feminists emphasize the pluriversality of feminisms, and as such, intersectional feminism is fundamental to understanding the relations between race, gender, class, geophysical location. As Maria Lugones pointed out, "It is only when we perceive gender and race as if intermeshed or fused that we actually see women of color."²⁰³ Like postcolonial feminists, decolonial feminists reject the universalist White, bourgeoisie feminism that has prevailed in the United States for decades. Some scholars, such as philosopher Mariana Ortega, argue that the decoloniality of male U.S.-based Latin American scholars such as Mignolo is different than the decoloniality of U.S. Latinas of color such as herself.²⁰⁴ Both Walsh and Ortega center the writings of Chicana and Latina thinkers such as Chela Sandoval, who developed the idea of differential consciousness, and Emma Perez, who wrote about the decolonial imaginary.²⁰⁵ In Anglophone science studies, the White, United States-born philosopher of science Sandra Harding has been the most vocal proponent of postcolonial, and now decolonial, feminist technoscience. In addition to writing extensively on difficult issues of race and gender in science, Harding has authored a recent (late 2017) paper on Latin American decolonial feminist science studies and also sits on the board of the Latin American peer-reviewed journal of science and technology called *Tapuya*.²⁰⁶ The

subfield of decolonial feminist science studies is so new that few writings have been published, but it is rapidly becoming part of the curriculum in cross-disciplinary science studies and women's studies programs in U.S. universities.²⁰⁷

Decolonizing Science: The Coloniality of Knowledge

Three intersecting topics of intellectual pursuit have evolved over the last decade and a half: the coloniality of power, the coloniality of gender and the coloniality of knowledge. It is the coloniality of knowledge which most interests historians of science.²⁰⁸ Decolonial scholars view science and colonialism as being co-emergent and co-produced, meaning that science and colonialism would not exist without each other.²⁰⁹ In a multitude of ways, Europe was produced by the Americas. For example, the so-called voyages of discovery spurred revolutions in navigation and cartography; European encounters with different peoples sparked anthropology and archeology as well as constructions of racial categories and hierarchies; new environments triggered the competitive pursuit for medicinal and economically viable botanicals; the discovery of new foods such as potatoes, corn, chocolate, tomatoes, among many others, revolutionized world cuisines; and the discovery of gold and silver lodes provoked technological improvements in mining and metallurgy as well as providing funding for multiple world powers to expand their domains. Indigenous men and women provided knowledge and functioned as guides, translators and healers for European men seeking their fortune in the Americas, all while Europeans sought to suppress, oppress or simply destroy Indigenous technologies, sciences and medical practices in order to

subjugate Indigenous peoples physically and intellectually.²¹⁰ Simultaneously, Europeans imposed their own scientific and technological culture on Indigenous peoples, supplanting centuries-old mathematical, astronomical, medical, and other practices with those preferred by the Europeans. In the process, Europeans crafted the narrative of true, value-free, neutral and universal science. According to decolonial thinkers, the imposition of epistemic scientific universalism is a major component in the coloniality of knowledge.

Walter D. Mignolo argued that “it was through the control and management of knowledge that the colonial matrix of power was created, managed, transformed, and controlled.”²¹¹ Mignolo believed that the coloniality of knowledge was initially theological and later became secular, but other historians and decolonial academics disagree.²¹²

Anthropologist Jennifer A. Hamilton made a more specifically pointed statement regarding the history of science: “The process of articulating science as a singular endeavor was a colonizing project, just as colonization was a scientizing project.”²¹³ Most academics do agree with Mignolo’s claim, however, that in order to decolonize *being*, “we have to start by decolonizing knowledge.”²¹⁴ What does it mean to decolonize knowledge? How would this affect the history of science in Latin America and, more broadly, across the world? There are, as yet, no definitive answers to these questions, however decolonizing knowledge would almost assuredly produce more intersectional and inclusive histories of science, and broader access to such histories.

Decoloniality may be a burgeoning academic standpoint, but it has been in practice since the beginning of modernity/coloniality, from the works of Quechua nobleman Guaman Poma in the sixteenth century to the feminist borderlands thinking of Gloria Anzaldúa at the end of the twentieth century. Unlike postcolonialism, decolonial scholars emphasize the

importance of listening to thinkers (and doers) outside of academic institutions, in part because the historical and present barriers to higher education and tenured positions are still overwhelming for many marginalized intellectuals. According to decolonial thinkers, the goal of decoloniality is not simply to illuminate the epistemic silences that Western universalisms have carefully maintained over the centuries, but to delink from the coloniality of power and knowledge wherever possible and craft new, radically pluriversal, ways of re-existing. In some cases, this manifests as what humanities professor Catherine Walsh called “moving from a posture of ‘studying about’ to ‘thinking with.’”²¹⁵

The few decolonial academic histories of Latin American science that have been published in peer-reviewed journals or by university presses are illustrative of this desire for epistemic reconstruction. Unlike postcolonial works that often start from an acknowledgement of the dominance of Western science before denouncing such Eurocentrism, decolonial works simply begin from entirely different standpoints. For example, one peer-reviewed article took the standpoint that Western science and Indigenous sciences were epistemically incommensurable. The author, philosophy professor James Maffie, then presented evidence showing that asking the same questions of Indigenous scientific practices as Western scientific practices privileged Western universalisms.²¹⁶ Decolonial historians of science argue that re-definitions of words like “intellectual” or “science” should be used. Decolonial academics also often make the case that completely different, locally-relevant questions should be asked, framing the history of science within the worldview in which it evolved rather than judging it by a fundamentally foreign worldview. These histories are complex, challenging, and mind-expanding.

Alongside the modern Indigenous struggle to retain/reclaim ancestral lands is a decolonial academic interest in how colonialism and colonality have altered and continue to impact Latin American geography and cartography. A large part of the discussions surrounding decolonizing geography and cartography understandably revolve around a re-valuing of pre-Columbian Indigenous science and technology. In some cases, however, decolonial scholars choose to focus on the ways in which post-Invasion peoples have survived and adapted culturally, linguistically and ethnically. Some of these works include art historian Barbara Mundy's book *The Mapping of New Spain*, Spanish professor Thomas Ward's work *Decolonizing Indigeneity*, and historian Raymond Craib's chapter "Cartography and Decolonization" in the edited volume *Decolonizing the Map*.²¹⁷

Another frequent topic of discussion in decolonial histories of science is ecology and the environment, a topic that has been vital to Indigenous peoples since the beginning of settler colonialism.²¹⁸ Following the Indigenous demographic collapse caused by invading Europeans and their attendant diseases against which Indigenous people lacked immunity, large swathes of land were appropriated by the foreign settlers for agriculture, animal grazing and/or mining. As the decades and centuries trudged on, foreign interests penetrated even the densest interiors of Latin America seeking to extract material wealth.²¹⁹ Modern Indigenous movements utilize everything from guerrilla tactics to the bureaucratic legal systems in an effort to reclaim and/or protect what the land and resources that have been stolen from Indigenous peoples. What differentiates typical environmental activism from decolonial environmental activism is the pluriversality of desired outcomes resulting from the needs of the marginalized peoples leading the efforts.²²⁰

Another direction for Indigenous decolonial environmental activism might be more unsettling than the fights against extractivism, land appropriation or clearcutting. While permaculture and renewable energy technologies such as solar photovoltaic and wind turbines have been lauded by White, Western environmentalists as the sustainable future, these technologies are themselves fraught with hidden issues of structural inequality. Decolonial thinkers, especially Indigenous activists across the globe, have been pivotal in bringing these problems to the world's attention. Solar and wind technologies require the destructive and unhealthy mining of precious metals and minerals, assembly in manufacturing plants by low-paid technicians who are often people of color and who often reside in Asia, and the location of both solar farms and wind turbines are NIMBY (not in my backyard) battlegrounds in which White Westerners fight to put their sustainable energy sources on Indigenous lands or in sensitive ecological environments.²²¹

Not all decolonial histories are published in peer-reviewed journals. In contrast to earlier historical "turns," decoloniality begins from the premise that scholars outside of academia should be valued, in part because until relatively recently, the only people who had access to institutions of higher education were wealthy White men. Women, people of color and lower-income people continue to struggle against structural and institutional barriers that make attaining higher education challenging or even impossible. These barriers can include lack of childcare or parental leave, high cost of living and the financial burden of paying for tuition, lack of access to social and professional networks, artificial cultural barriers such as the "glass ceiling," widespread internalized white supremacy and internalized misogyny, or even just the inability to be in a place where social, cultural, or ethnic differences are accepted, let alone celebrated. In some cases there is no access (or very limited access) to K-

12 education, which often precludes access to higher education later in life. Sometimes K-12 education is available but a myriad of common structural barriers prevent an otherwise capable child from graduating. In other cases, bright and motivated students are discouraged from pursuing higher degrees because an adult (counselor, parent, employer) insists that they are not “college material.” Decolonial scholars insist that simply because these individuals have not attained a Ph.D. does not mean that they and their ideas should be dismissed.

As Catherine Walsh argued, decolonial pedagogy involves unlearning to relearn.²²² Part of the unlearning includes an ability to accept nontraditional works as valid and valuable material towards the goal of decolonizing; in this case, decolonizing the history of science. A key component is the fascinating use of technologies that compose the modern internet. Open source movements, crowd-funded science, digital/online science culture, new open-access academic journals and even the illicit access of scientific papers has deeply impacted the way that science and science history is learned, shared and perceived in twenty-first century.²²³ The internet and digital technologies have also shaped decolonial communications, beginning with the first Zapatista Declaration from the Lacandon Jungle at the end of the twentieth century, which spread rapidly across the globe and persists in myriad spaces across the internet.²²⁴

Conclusion

Decoloniality is both new, in the sense that the global mainstream is just now beginning see the revolutionary potential of decolonization, and it is not new, because

decolonial struggles have occurred since the first colonizers crested the horizon with their weapons, religions and supposedly superior cultures. Scholarly efforts to decolonize the history of science are in their infancy, with peer-reviewed publications and non-academic writings just beginning to trickle out as 2020 fast approaches. As such, there are more questions than answers for the future-history of decolonized science. What constitutes scientific truth, who gets to decide and why? How do decolonial historians of science plan to deal with the charges of relativism or anti-intellectualism in an era of “alternative facts?” What would change if the fundamental narrative about science changes? How do important ideas spread and become powerful agents of decolonial structural change and what role do science and technology play in this revolutionary transmission? Should the history classroom double as a social justice classroom to help “unlearn to re-learn,” or is a classroom even necessary? Is a decolonial history of science overly idealistic or improbable? Is a decolonial future possible, and does this question just perpetuate the hegemonic colonial status quo? What do our decolonial futures look like? What do our future decolonial histories of science look like?

Chapter 6

Preliminary Conclusions

The year after I started graduate school I gave birth to my son. Two long and busy years later, I packed a large tote bag full of snacks, small books, Hot Wheels cars and Boxcar Children audiobooks and boarded an airplane back to Mexico, this time with both of my children in tow. We rented a car and made our way across the Yucatán peninsula to Mérida, stopping along the way to scope out Cenote Zaci in Valladolid and admire the Caracol observatory at Chichen Itza. The children drank bright green chaya juice, climbed the Mayan ruins at Uxmal and Kabah, and devoured *paletas* while overlooking one of the oldest churches in the Americas.

Although my children are still very young, they have taught me one incredibly important lesson that extends to my understanding of history and, one day, will shape my work as a teacher. This is also a lesson that I have seen reflected in the different ways that Anglophone historians in the West have written about science in Latin America, as evidenced in this thesis. The lesson is one of respect. Respect is particularly important in situations where asymmetries of power exist, such as parent/child, teacher/student, White/non-White, West/non-West. I do not refer to respecting elders, or respecting “authorities,” or other ways in which the less-powerful are compelled to pay respects to the more-powerful. I am specifically referring to the respect that, in whatever situation, those with more perceived power offer to those with less perceived power. The respect between human beings.

When my daughter chooses to wear three mismatched sweaters instead of her warm coat and a combination of leggings and puddle boots under a crazily-askew tutu to go to the

playground in the winter, it is my responsibility as a parent to respect her (notably weather-appropriate) wardrobe choice, rather than make her put on an outfit that *I* think looks nice. When my son asks to play with Legos instead of finishing his lunch because he is already full, I respect that his body feels full and do not make him eat beyond his limits by requiring him to “clean his plate” before getting up from the table. I do not force my children to hug anybody they do not wish to hug, even family members or close friends. I ask for my children’s opinions and input whenever possible, and I listen to their responses. These seemingly trivial examples are ways in which I, as a parent, extend my respect to other human beings in a situation where the asymmetries of power are in my favor. These small acts help my children to grow up feeling that they are in control of their own bodies, that their choices and their consent matters, and that other human beings should be respected in the same way.

Anglophone historians of science in the West have been slow to acknowledge their own power to craft (or ignore) narratives. Until fairly recently, historical writing about science in Latin America mirrored the controlling and dominating parent who was unconcerned with the ways in which they violated other people’s autonomy (the difference between the dependency framework and the decoloniality framework). Everybody wants to be right, everybody wants to be in control; and for the moment, White, Western-located historians control the historical narratives. Power and control are alluring, intoxicating, and difficult to relinquish. This also holds true for Western science, which is based on Eurocentrism and White, male supremacy. Western science has cultivated a particular social and political standing for itself in modern Western nations, but that does not mean that it is infallible, nor does it prevent scientific practices and discourses from changing. Indeed, as

evidenced in this thesis, both science and the histories of science have changed considerably just within the last few decades. However, more radical inclusivity is required, beginning with introducing the youngest and most marginalized children to accessible and understandable scientific practices in which marginalized peoples are represented. Education – not indoctrination, and representation – not exclusivity – are vital. Anglophone historians of science in the West have the power to publish these narratives, and the power to respect and elevate marginalized peoples when they write their own, possibly quite different, narratives.

Furthermore, as historians of science it is important to present science as *fact*, but framed within the complex and often unsavory histories that birthed such facts. Scientific facts are *not relative* – pure water boils at a specific temperature at sea level, human beings require oxygen to live, climate change is real – but the complex, entangled histories of scientific facts have been hidden away for too long. In some cases, such as medicine, exposing these hidden histories can also expose the faulty foundations upon which scientific facts are built and help modern scientists construct *more accurate facts* based upon more inclusive data. This sometimes painful historical self-reflection is required in order to build a more equitable, and scientifically and historically accurate, future. It should not be the responsibility of marginalized peoples to educate more powerful academic or political elites about *what* their subaltern history is and *why* it matters. However, when marginalized peoples choose to illuminate blinkered historians, we as historians should listen and *respect* what is said, even when it differs radically from our own ideas and beliefs.

I have no definitive answers for the questions that I posed at the end of the last chapter, and nor does any other historian or scholar. And that is okay. What is important is

intersectional dialogue, and steady progress, and pluriversal change and *respect* in an effort to address the asymmetries of power enmeshed in our historical narratives and in those people who are privileged to write and read such histories. However, when we fail as a nation to adequately teach our youth about our own histories of slavery and sexism in the United States, our capability to impart complex and entangled historical narratives about such seemingly distant lands as Mexico or Argentina feels overwhelming. It is my opinion that we as historians need to venture outside of our Ivory Tower, and publish beyond the impenetrably dense books that are only written for a niche group of highly educated, extremely privileged, academics. We as historians need to give teachers, librarians, parents, caregivers and children themselves ready access to the tools to tackle difficult questions of race, gender, colonization and asymmetries of power in histories of science. Moving forward, we need more vibrantly illustrated children's books and graphic novels – in many languages – as well as films, television shows, interactive digital books, popular fictions and histories, even representative action figures or tabletop board games, in order to engage and educate our youth. We as a Western nation need to move beyond corporate research labs and lobbying to change who gets to ask scientific questions, and about what. We as human beings should not equate privilege – the privileges of race, ethnicity, gender, sexual orientation, class, or geophysical location – with intelligence and capability. Above all else, in order to de-center the Euro-center, the hidden, marginalized, entangled histories of science need to be given a voice.

Appendix A

A Thematic Book List

The following is a thematic list of books (and a few articles) about the history of science in Latin America. They are a mixture of academic and general histories. I have read most, but not all, of the books listed below. This list can be used to craft syllabi on the history of science in Latin America, or it could be a helpful starting point for personal reading. I have already created a college-level syllabus for the history of science in Latin America and anyone is welcome to incorporate it in their curriculum or extract ideas for younger ages. The syllabus can be found in the February 2019 issue of *The History Teacher* journal, where a version of this book list was first published.

Foundational & Background Reading

Barrera-Osorio, Antonio. *Experiencing Nature: The Spanish American Empire and the Early Scientific Revolution*. Austin, TX: University of Texas Press, 2006.

Bleichmar, Daniela, Paula De Vos, Kristen Huffine, Kevin Sheehan, editors. *Science in the Spanish and Portuguese Empires, 1500-1800*. Stanford: Stanford University Press, 2009.

Cañizares-Esguerra, Jorge, and Cueto, Marcos. "Latin American Science: The Long View." *NACLA Report On The Americas in Political Science Complete*, 35, no. 5: 18 (2002).

Cañizares-Esguerra, Jorge. *Nature, Empire, and Nation: Explorations of the History of Science in the Iberian World* (Stanford: Stanford University Press, 2006).

Chambers, David Wade, 'Locality and Science: Myths of Center and Periphery', in *Mundialización de la ciencia y cultura nacional*, edited by A. Lafuente, A. Elena, and M. L. Ortega (Madrid: Doce Calles, 1991), 605–18.

Galeano, Eduardo. *Open Veins of Latin America: Five Centuries of the Pillage of a Continent*. 25th Anniversary Edition, New York: Monthly Review Press, 1997.

Glick, Thomas. "History of Science in Latin America," *The Cambridge Encyclopedia of Latin America and the Caribbean*, 2nd ed. (Cambridge: Cambridge Univ. Press, 1992), p.451-457.

Mann, Charles. *1491: New Revelations of the Americas Before Columbus*. New York: Knopf, 2005.

Mann, Charles. *1493: Uncovering the New World Columbus Created*. New York: Knopf, 2011.

Portuondo, María. "Constructing a Narrative: The History of Science and Technology in Latin America." *History Compass* 7/2 (2009): 500–522.

Ramos, Gabriela and Yannakakis, Yanna, editors. *Indigenous Intellectuals: Knowledge, Power, and Colonial Culture in Mexico and the Andes*. Durham: Duke University Press, 2014.

Wendt, Helge, editor. *The Globalization of Knowledge in the Iberian Colonial World*. Max Planck Library for the History and Development of Knowledge: Proceedings, 2016.

Saldaña, Juan José. *Science in Latin America: A History*. Translated by Bernabé Madrigal. Austin: University of Texas Press, 2006.

Saldaña, Juan José, 'Western and Non-Western Science: History and Perspectives', in *Science and Cultural Diversity. Filling a Gap in the History of Science, Cuadernos de Quipú*, 5 edited by Juan José Saldaña (México: Sociedad Latinoamericana de Historia de las Ciencias y la Tecnología, 2001), 123–44.

Cueto, Marcos and Jorge Cañizares Esguerra, "History of Science in Non-Western Traditions: Latin America," History of Science Society.
https://hssonline.org/resources/teaching/teaching_nonwestern/teaching_nonwestern_latam/

Cartography & Geography & Cosmography

Akerman, James R. *Decolonizing the Map: Cartography from Colony to Nation*. Chicago: The University of Chicago Press, 2017.

Appel, John Wilton, *Francisco José de Caldas: A Scientist at Work in Nueva Granada* (Philadelphia, PA: American Philosophical Society, 1994).

Craib, Raymond B., *Cartographic Mexico: A History of State Fixations and Fugitive Landscapes*. Durham, N.C.: Duke University Press, 2004.

Dym, Jordana and Offen, Karl, editors. *Mapping Latin America: A Cartographic Reader*. Chicago: University of Chicago Press, 2011.

Mundy, Barbara M., *The Mapping of New Spain: Indigenous Cartography and the Maps of the Relaciones Geográficas*. (Chicago, IL: University of Chicago Press, 1996).

Portuondo, María. *Secret Science: Spanish Cosmography and the New World*. (Chicago: University of Chicago Press, 2009).

Safier, Neil, *Measuring the New World: Enlightenment Science and South America*. (Chicago: University of Chicago Press, 2008).

Environment, Natural Resources, Botany

Boyer, Christopher R. *Land between Waters: Environmental Histories of Modern Mexico*. Tucson: University of Arizona Press, 2012.

Brown, Kendall W. *A History of Mining in Latin America: From the Colonial Era to the Present*. Albuquerque: University of New Mexico Press, 2012.

Candiani, Vera. *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City*. Stanford University Press, 2014.

Crosby, Alfred W. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Westport, CT: Praeger, 2003.

Johnson, Sherry. *Climate and Catastrophe in Cuba and the Atlantic World in the Age of Revolution*. Chapel Hill: University of North Carolina Press, 2011.

Melville, Elinor. *A Plague of Sheep: Environmental Consequences of the Conquest of Mexico*. Cambridge, University of Cambridge Press, 1997.

Miller, Shawn William. *An Environmental History of Latin America*. New York: Cambridge University Press, 2007.

Monzote, Reinaldo Funes. *From Rainforest to Cane Field in Cuba: An Environmental History since 1492*. Chapel Hill: University of North Carolina Press, 2008.

Santiago, Myrna I. *The Ecology of Oil: Environment, Labor, and the Mexican Revolution, 1900-1938*. Cambridge: Cambridge University Press, 2006.

Simonian, Lane. *Defending the Land of the Jaguar: A History of Conservation in Mexico*. Austin: University of Texas Press, 1995.

Steele, Robert R., *Flowers for the King: The Expedition of Ruiz and Pavón and the Flora of Peru*. (Durham, NC: Duke University Press, 1982).

Tucker, Richard P. *Insatiable Appetite: The United States and the Ecological Degradation of the Tropical World*. Berkeley: University of California Press, 2000.

Varey, Simon, Chabrán, Rafael, and Weiner, Dora B., editors, *Searching for the Secrets of Nature: The Life and Works of Dr. Francisco Hernández*. Stanford, CA: Stanford University Press, 2000.

Wakild, Emily. *Revolutionary Parks: Conservation, Social Justice, and Mexico's National Parks, 1910–1940*, Tucson, University of Arizona Press, 2011.

Humboldt, Darwin

Helferich, Gerald. *Humboldt's Cosmos: Alexander von Humboldt and the Latin American Journey that Changed the Way We See the World*. New York: Gotham Books, 2004.

Leitner, Ulrike. "Humboldt's Works on Mexico." *Quipu*, Vol. 13, No 1 2000, 7-23.

Moreno, Roberto. "Mexico." in *The Comparative Reception of Darwinism*. Glick, Thomas, editor. Austin: University of Texas Press, 1974.

Novoa, Adriana and Alex Levine. *From Man to Ape: Darwinism in Argentina, 1870-1920*. Chicago: University of Chicago Press, 2010.

Medicine, Public Health and Disease

Agostoni, Claudia. *Monuments of Progress: Modernization and Public Health in Mexico City, 1876–1910*. Boulder: University Press Colorado, 2003.

Alchon, Suzanne Austin. *A Pest in the Land: New World Epidemics in a Global Perspective*. Albuquerque: University of New Mexico Press, 2003.

Alchon, Suzanne Austin. *Native Society and Disease in Colonial Ecuador*. Cambridge: Cambridge University Press, 1991.

Armus, Diego editor. *From Malaria to Aids: Disease in the History of Modern Latin America*. Durham, Duke University Press, 2003.

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Bliss, Katherine Elaine. *Compromised Positions: Prostitution, Public Health, and Gender Politics in Revolutionary Mexico City*. Pennsylvania State University Press, 2001.

Cueto, Marcos, editor. *Missionaries of Science: The Rockefeller Foundation and Latin America*. Bloomington: Indiana University Press, 1994.

Cueto, Marcos and Steven Palmer. *Medicine and Public Health in Latin America: A History*. Cambridge: Cambridge University Press, 2015.

- Few, Martha. *For All of Humanity: Mesoamerican and Colonial Medicine in Enlightenment Guatemala*. Tucson, AZ: The University of Arizona Press, 2015.
- Gómez, Pablo F., *The Experiential Caribbean: Creating Knowledge and Healing in the Early Modern Atlantic*. Chapel Hill: University of North Carolina Press, 2017.
- Hendrickson, Brett. *Border Medicine: A Transcultural History of Mexican American Curanderismo*. New York: New York University Press, 2014.
- Jarcho, Saul. *Quinine's Predecessor: Francesco Torti and the Early History of Cinchona*. Baltimore: Johns Hopkins Univ. Press, 1993.
- Lanning, John Tate, *The Royal Protomedicato: The Regulation of the Medical Profession in the Spanish Empire*. Durham: Duke University Press, 1985.
- Martín, José R. *The Black Doctors of Colonial Lima: Science, Race, and Writing in Colonial and Early Republican Peru*. Montreal: McGill-Queen's University Press, 2014.
- Palmer, Steven. *From Popular Medicine to Medical Populism: Doctors, Healers, and Public Power in Costa Rica, 1800–1940*. Durham, N.C.: Duke University Press, 2003.
- Rodríguez, Julia. *Civilizing Argentina: Science, Medicine, and the Modern State*. Chapel Hill: University of North Carolina Press, 2006.
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- ⁴ Hebe M. C. Vessuri, "The Social Study of Science in Latin America," *Social Studies of Science*, Vol. 17, No. 3 (Aug., 1987), p.549, note 6.
- ⁵ Sandra Harding, *Science and Social Inequality: Feminist and Postcolonial Issues*, (Urbana: University of Illinois Press, 2006), p.10, 11.
- ⁶ Walter D. Mignolo, "Part II," in *On Decoloniality: Concepts, Analytics, Praxis*, by Walter D. Mignolo and Catherine E. Walsh, (Durham: Duke University Press, 2018), p.194.
- ⁷ Sandra Harding, *Is Science Multicultural?: Postcolonialisms, Feminisms, and Epistemologies*, (Bloomington, IN: Indiana University Press, 1998), p.12-14.
- ⁸ "And I now call it *Nepantla*, which is a Nahuatl word for the space between two bodies of water, the space between two worlds. It is a limited space, a space where you are not this or that but where you are changing. You haven't got into the new identity yet and haven't left the old identity behind either—you are in a kind of transition. And that is what *Nepantla* stands for. It is very awkward, uncomfortable, and frustrating to be in that *Nepantla* because you are in the midst of transformation." Gloria Anzaldúa, *Borderlands/La Frontera: The New Mestiza* (San Francisco, CA: Aunt Lute Books, 1987), 13. The term *mestizaje* is a Spanish word that originally meant the mixing of races, particularly the mixing of a person with Spanish lineage (a *peninsular* or a Creole) and an Indigenous person. The term has since developed wider cultural implications and connotations. Historically nationalistic forms of *mestizaje* have also been critiqued as being gendered, and as eliding Afro-Latinx and Indigenous peoples; This fragment first appeared in *The History Teacher*: Hadley Sinclair Cluxton and René Harder Horst, "Problematizing the Past: An Overview of Teaching the History of Science in Latin America in the Anglophone Classroom and Its Major Issues," *The History Teacher*, Vol. 52, No.2, February 2019.
- ⁹ Elizabeth Hill Boone and Walter Mignolo, *Writing Without Words: Alternative Literacies in Mesoamerica and the Andes* (Durham, NC: Duke University Press, 1994), 15-22.
- ¹⁰ Jorge Cañizares-Esguerra, "Introduction." in *Science in the Spanish and Portuguese Empires, 1500-1800*. Daniela Bleichmar, Paula De Vos, Kristen Huffine, Kevin Sheehan, editors, (Stanford: Stanford University Press, 2009), 1.
- ¹¹ Robert J.C. Young, *Postcolonialism: An Historical Introduction*, 15th Anniversary Edition, (West Sussex, UK: Wiley Blackwell, 2016), p.21.
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- ¹³ At the time, Muslim countries were far superior scientifically to Western European nations.
- ¹⁴ Eduardo Galeano, *Open Veins of Latin America: Five Centuries of the Pillage of a Continent*, translated by Cedric Belfrage, (New York: Monthly Review Press, 1973), quotation page 227.
- ¹⁵ Fernando Coronil, "After Empire: Reflections on Imperialism from the Américas," in *Imperial Formations*, edited by Ann Laura Stoler and Peter Purdue, (Santa Fe, NM: School for Advanced Research Press, 2007), quotation page 245.
- ¹⁶ Alvin Y. So, *Social Change and Development: Modernization, Dependency, and World-Systems Theories*. (Newbury Park, CA: Sage Publications, 1990), p33-34, 54; Magnus Blomström and Björn Hettne, *Development Theory in Transition: The Dependency Debate and Beyond : Third World Responses*. (London: Zed Books, 1984), p71.
- ¹⁷ So, *Social Change and Development*, p.53-58, 96, 169.
- ¹⁸ George Basalla, "The Spread of Western Science: A three-stage model describes the introduction of modern science into any non-European nation." *Science*, 156 (1967): 611-622.

- ¹⁹ María Portuondo, "Constructing a Narrative: The History of Science and Technology in Latin America." *History Compass* 7/2 (2009): 500–522; Warwick Anderson, "Introduction: Postcolonial Technoscience." *Social Studies of Science*, Vol. 32, No. 5/6 (Oct. - Dec., 2002) 648; Roy McLeod, "Introduction." *Osiris*, Volume 15: Nature and Empire: Science and the Colonial Enterprise. MacLeod, Roy, editor. (Chicago: University of Chicago Press, 2000).
- ²⁰ Juan José Saldaña, "Introduction: The Latin American Scientific Theater," in *Science in Latin America: A History*, edited by Juan José Saldaña and translated by Bernabé Madrigal, (Austin: University of Texas Press, 2006), 13.
- ²¹ Sandra Harding, "Introduction - Beyond Postcolonial Theory: Two Undertheorized Perspectives on Science and Technology," in *The Postcolonial Science and Technology Studies Reader*, (Durham: Duke University Press, 2011), p.2.
- ²² Susantha Goonatilake, *Aborted Discovery: Science and Creativity in the Third World*, (London: Zed Books, 1984), p.113.
- ²³ Ana Del Sarto, "Foundations: Introduction," in *The Latin American Cultural Studies Reader*, edited by Ana Del Sarto, Alicia Ríos, and Abril Trigo, (Durham: Duke University Press, 2004), p. 154.
- ²⁴ Hebe Vessuri, "Academic Science in Twentieth-century Latin America," in *Science in Latin America: A History*, edited by Juan José Saldaña, translated by Bernabé Madrigal, (Austin: University of Texas Press, 2006), p.216.
- ²⁵ Hebe M. C. Vessuri, "The Social Study of Science in Latin America," *Social Studies of Science*, Vol. 17, No. 3 (Aug., 1987), p.529.
- ²⁶ Blomström & Hettne, *Development Theory in Transition*, p. 39, 43, 81.
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- ²⁰⁴ Mariana Ortega, "Decolonial Woes and Practices of Un-knowing" *Journal of Speculative Philosophy*, Vol. 31, No. 3, 2017, p.507.
- ²⁰⁵ Ortega, "Decolonial Woes and Practices of Un-knowing," p. 508; Walsh, Part I, *On Decoloniality*, p.34 ; see also Cela Sandoval, *Methodology of the Oppressed*, (Minneapolis, MN: University of Minnesota Press, 2000) and Emma Perez, *The Decolonial Imaginary: Writing Chicanas into History*, (Bloomington: Indiana University Press, 1999).
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- ²²³ See: Tapuya Journal, open-access <https://tapuya.la/our-journal/> ; See: Chana Prescod-Weinstein's "Decolonising Science reading List," it is mostly Indigenous and Black/African and/or Asian but still a vital resource <https://medium.com/@chanda/decolonising-science-reading-list-339fb773d51f> ; See: "Digital Colonialism & the Internet as a tool of Cultural Hegemony," Knowledge Commons Brasil, this article brings up many un-considered points as to how the new digital mediums can actually perpetuate existing colonial structures <http://www.knowledgecommons.in/brasil/en/whats-wrong-with-current-internet-governance/digital-colonialism-the-internet-as-a-tool-of-cultural-hegemony/> ; In addition to the aforementioned article, also see: Anjuan Simmons, "Technology Colonialism," Model View Culture, Issue 27, 2015, <https://modelviewculture.com/pieces/technology-colonialism>; for examples of open- and crowd-sourced science in Latin America, see: "Open Science Map: Charting the development of Open Science practices in Latin America," Steps Centre, August 8th, 2018, <https://steps-centre.org/blog/open-science-map-charting-the-development-of-open-science-practices-in-latin-america/> ; another of the many examples of crowd-sourced science that crosses international boundaries: Sue Palminteri, "Scientists combine crowd-sourced field observations with land-use and climate models to identify steps for migratory bird protection." Mongabay, August 18, 2017, <https://news.mongabay.com/2017/08/scientists-combine-crowd-sourced-field-observations-with-land-use-and-climate-models-to-identify-steps-for-migratory-bird-protection/> ; An example of some super-fascinating open-hardware groups in Central and South America: "Open hardware groups spread across the globe," Open Source, June 7th, 2017, <https://opensource.com/article/17/6/open-hardware-latin-america> ;
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Vita

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