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Decolonizing Science: Undoing the Colonial and Racist Hegemony of Western Science

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Background: Decolonization is the complicated and unsettling undoing of colonization. In a similarly simplified definition, science is a structured way of pursuing knowledge. To decolonize science thus means to undo the past and present racist and colonial hegemony of Western science over other, equally legitimate ways of knowing.

Purpose: This paper discusses the paradigmatic prerequisites and consequences of decolonizing Western science. Only if Western science is toppled from its pedestal and understood in a cultural way can it engage with other sciences at eye level. Such equal collaboration that results in the cocreation of new knowledge based on the scientific method and Indigenous scientific inquiry is what decolonizing science is all about.

Setting: General/worldwide, with examples drawn mainly from a Canadian context.

Intervention: Not applicable.

Research Design: Desktop study.

Data Collection and Analysis: Desktop study.

Findings: What decolonizing science looks like in practice is highly variable, as there is no one-size-fits-all approach due to the fact that Indigenous knowledge is rooted in the local, the land. Therefore, decolonizing science is much more a path than a destination. This path, however, will also pave the way to a new multiparadigmatic space. Decolonizing both the theory and the practice of science will have ripple effects by enabling and fueling the decolonization of academia, education, health care, evaluation, and eventually all aspects of society.

Keywords: *decolonization; Indigenous science; Western science; multi-paradigmatic space; ways of knowing*

Introduction

Decolonization [1] is the complicated and unsettling undoing of colonization, involving the colonized as well as the colonizers and settlers and affecting all aspects of society, from politics, economics, and land rights to law, justice, culture, and education. Science, one of the hallmarks of Western society, is not exempt from the decolonization process. In this paper, I will distinguish between "science," denoting—in a very general manner—a systematic way of producing knowledge, and "Western science," the modern science that emerged in Europe during the Enlightenment and has become a standardized method of producing knowledge in a (seemingly) entirely rational and objective way. While it began as a localized cultural practice in Europe, Western science was soon exported to all corners of the earth through colonialism and imperialism (Renn, 2012). It is thus not surprising that Western science is often regarded as the one and only science (Mellor, 2003). Some philosophers of science, too, have understood Western science as a universally applicable tool and the only legitimate way to generate new knowledge (e.g., Russell, 1935). Philosophers of feminist and postcolonial theory, on the other hand, view science as a cultural practice that is localized / contextualized /socially constructed (e.g., Harding, 1998; Longino, 1990). That means that there are many different sciences employed around the world. Each is a time-tested way for a group to generate useful knowledge for its current situation (Snively & Corsiglia, 2016). Each of these sciences is a legitimate way of knowing, but due to the undiminished hegemony of Western science, other sciences (e.g., Eastern, African, Maori, Cree) are not regarded as equal in places like politics, education, and academia.

In this paper I will first briefly outline the history of the philosophy of science and list the paradigms under which scientific inquiry is currently being conducted. I will also highlight the philosophical underpinnings of Indigenous sciences. I use the adjective "Indigenous" with a capital "I" to refer to an ethnic culture still present and rooted in its homeland and part of neither a colonial nor a settler society [2] (as opposed to "indigenous," which denotes being of a place or local in a broader sense). This is, of course, a generalization, and so is "Western," as both terms refer to homogenous groups of peoples / societies / cultures. I will then outline how Western and Indigenous science interact in a colonial setting and contrast this with how decolonization envisions the interplay. I will argue that the decolonization of science can only happen if a multicultural view of science is adopted and Western science's dominant role toppled. Further, I will discuss the paradigmatic prerequisites and consequences of decolonizing science and argue that the fruitful collaboration of Western and Indigenous sciences will have to occur in a multiparadigmatic space that is neither Western nor Indigenous.

Positionality

I include this section here because who we are shapes how we understand—and engage with—the world. Stating one's positionality is particularly pertinent when discussing worldviews and knowledge systems, particularly the power relations between differing ontologies and epistemologies.

I come from a position of privilege. Born and raised in Western Europe, I am now a settler in Mi'kma'ki, the ancestral and unceded homeland of the Mi'kmaq people, the largest Indigenous people traditionally occupying what is now the Maritimes in Eastern Canada. I am an academic with training, research, and teaching experience in several subjects, including geography, education, biology, and marine management. Most recently, as part of my studies in the Interdisciplinary PhD Program at Dalhousie University, I have been interested in bridging the realms of Western science and Indigenous ways of knowing, specifically with regards to resource management.

I believe that science is a powerful tool for understanding the world. I also believe that Indigenous knowledge, stemming from the land and being multigenerational, is a legitimate

[1] The term "decolonization" used to refer to the withdrawing of a state from a former colony, releasing it into independence. Today, the term is used much more broadly, encompassing the undoing of all sorts of colonial structures, from physical entities and institutions to ideologies and theories (Peace Direct, 2021). In this article, I will use the term in its broadest sense, namely as decolonization of any aspect of life that has been affected by colonization.

[2] This usage of the term "Indigenous" follows the understanding put forward and used by the United Nations. In addition to being based on self-identification, the United Nations understand "Indigenous people" as a people who is a nondominant group of society; has a continuity with pre-colonial and/or pre-settler societies; has strong links to territories and their natural resources; and has distinct social, economic, and political systems as well as distinct language, culture, and beliefs (United Nations Permanent Forum on Indigenous Issues, n.d.).

knowledge source. Even though I am not an Indigenous person, I do have experiential and medicinal knowledge that was passed down to me from my ancestors. Of course, this is just a smidgeon compared to the deep knowledge Indigenous peoples have about their environment, but it is a precious reminder that we all possess knowledge that was acquired by means other than the scientific method. While, from a philosophical point of view, Western scientific knowledge and Indigenous scientific knowledge are rather different, which I will explain below, I believe that the two can be brought together to provide a deeper joint understanding of the world.

However, I also recognize that science has a systemic tendency to extract knowledge from Indigenous communities rather than collaboratively build new understanding. I, too, have experienced this predisposition, which is still widespread in academia. In my case, the dominant attitude of science, paired with my inexperience as a researcher, made me value time and money over relationship building and thus engage in research with Indigenous people that was far from being truly collaborative and decolonizing (Held, 2020). Alas, it is not uncommon that early-career scientists are put in a position of power over research participants when doing community-based research (Nordling, 2018). Aspiring to engage in decolonizing research has not been an easy path for me. Thus, I am all the more excited to see research projects located on Indigenous lands being undertaken in an equitable and collaborative manner with the local peoples (e.g., Bishop et al., 2022; Polfus et al., 2016).

A Very Brief History of the Philosophy of Western Science

Modern Western science arose during the Age of Enlightenment, the dominant philosophical movement in Europe in the 18th century, and has been evolving ever since. "Science knows no country because knowledge belongs to humanity, and is the torch which illuminates the world" (Dubos, 1950, p. 85). This is what Louis Pasteur, a French biochemist best known for his scientific breakthroughs in the understanding of the cause and prevention of disease and for inventing techniques to stop bacterial contamination, wrote about science in the wake of the Franco-German war of 1870–71. While Pasteur often designated his achievements to the glory of his native country, especially since his fiercest rival, bacteriologist Robert Koch, was German, he also regarded science as a universal instrument in the pursuit of mastering the natural world (Dubos, 1950).

The view that science (modern Western science, to be precise) is a universal tool to gain knowledge has prevailed for many years. In 1942, sociologist Robert Merton described the normative structure of science as a complex set of values and prescriptions shared by the social group made up of all science practitioners. While conceding that the institution of science is embedded in a larger social context, Merton (1973) posited universalism as one of four norms of Western science. In the context of Merton's universalism, it is much more important *how* science is conducted, namely in a value-free and methodological manner, and *what* knowledge is being claimed about the world, than *where* the research was conducted or *by whom*—a view that was widely adopted in the early decades after World War II (Storer, 1973). Due to its methodologically prescribed approach, Western science is perceived as rational and objective. This supposed objectivity has set science apart from other ways of gaining knowledge and has led to a persistent conclusion that science is positioned at the "top of a hierarchy of ways of knowing" (Mellor, 2003, p. 512). For some philosophers of science, among them the famous 20th-century British mathematician and philosopher Bertrand Russell and contemporary leading philosopher of science Alex Rosenberg, the only source of knowledge about reality is science (Rosenberg, 2011) and the only way to attain this knowledge is by scientific methods, for "what science cannot discover, mankind cannot know" (Russell, 1935, p. 243).

In the second half of the 20th century, the view of science's universal rationality was challenged by a cultural view of science, for even the scientific method can be seen as deeply historical and cultural in nature. Austrian-British philosopher of science and social commentator Karl Popper considered himself a "critical rationalist." For him, knowledge was objective; yet the creation of new knowledge required imagination (to formulate theories), stemmed from a desire to solve real-world problems, and was thus embedded in cultural and historical contexts (Popper, 1962). Another prominent proponent of treating modern sciences as historical, sociological, cultural, and political phenomena was Thomas Kuhn, a physicist turned historian and philosopher of science. Studying the history of science, Kuhn (1962) characterized it as long periods of "normal" science interrupted by scientific revolutions, also known as paradigm shifts, in which the previously "normal" science is replaced by formerly "revolutionary" science. Such paradigm shifts, during which an emerging

paradigm becomes the new leading one, cannot be forced, nor do they happen for fully rational reasons. Kuhn (1962) argued that scientific revolutions require a certain degree of faith and are often aided by peer pressure. The thesis that new paradigms are not chosen in a rational fashion based on objective evaluation criteria weakens the claim that science itself is a rational and objective endeavor.

Questioning both the desirability and the attainability of scientific objectivity, other philosophers of science have time and again criticized the idea(l) that both scientists and scientific claims, methods, and results are not influenced by interests, biases, values, or overall worldviews (Reiss & Sprenger, 2020). According to Weber (1949, as cited in Reiss & Sprenger, 2020), values can influence science at four stages: when choosing what (not) to research, when gathering and (not) considering evidence, when (not) accepting a hypothesis or theory, and when (not) disseminating and applying research results. Whether science is value-free or not was fiercely debated in the 1990s, mainly by American feminist epistemologists and philosophers of science who consider values, particularly social values, not as a recurring risk to science but as a relevant part of the scientific process. Helen Longino (1990) posits science as social knowledge due to the social context in which science is happening and claims that even objectivity is social and communal in nature. According to Sandra Harding (1998), our knowledge of the world can be rendered even more objective by giving voice to the perspectives of the marginalized and oppressed and by analyzing why and how they were excluded in the first place. Thus, every lived experience is considered a valued source of knowledge (Harding, 1998).

Eventually, post-Kuhnian philosophers of science as well as postcolonial and feminist science theorists came to the same conclusion, namely that science cannot be understood as one single and unique entity; on the contrary, science is a collection of principles and practices, varying among branches of science as well as individuals, social groups, and cultures (Harding, 1998). In other words, there is a multitude of sciences, and they all have roles to play in increasing humanity's knowledge about the world. Thus, European or Western science is just one of many localized and contextualized sciences.

Similarly, there are multiple ways of doing science within Western science; in other words, scientific research can be performed using different paradigms. Such paradigms, defined by Kuhn (1962) as particular coherent traditions of scientific research, are sets of assumptions regarding the ontology, epistemology, axiology, and methodology of knowledge and research. Based on the history of natural science discoveries, such as the replacement of the geocentric model of the solar system with the heliocentric model, Kuhn (1962) argued that consecutive paradigms are incommensurable, i.e., a new paradigm cannot coexist with an old one but has to replace it; however, he acknowledged that this view only holds for the natural sciences, not the social sciences. Indeed, for many decades now there have been several paradigms for social inquiry. Their vying for legitimacy and, potentially, hegemony is now seen as a proliferation rather than a succession of paradigms (e.g., Dillard, 2006; Lather, 2006; Lincoln et al., 2011).

The proliferation and rivalry are ongoing. Thus, different scholars delimit and group the various paradigms differently. Lincoln et al. (2011) list positivism, postpositivism, "critical theory et al.," constructivism, and participatory paradigms in their chapter on paradigmatic controversies in qualitative research, while Mertens (2020) and Chilisa (2020) include the postpositivist, constructivist/interpretive, transformative, and pragmatic paradigms among the major Western paradigms. Borrowed from the natural sciences, the positivist (or empiricist) paradigm is realist in its ontology, is objectivist in its epistemology, excludes values, and employs an experimental, quantitative, and decontextualized methodology focused on the verification of hypotheses (Chilisa, 2020; Lincoln et al., 2011; Mertens, 2020). The postpositivist paradigm, adapted from the positivist paradigm, differs from the latter in that it concedes that reality can never be fully understood. The constructivist or interpretive paradigm is based on a relativist ontology and a subjectivist epistemology, includes values as formative, and uses qualitative methodologies informed by hermeneutics and phenomenology. What Lincoln et al. (2011) label "critical theory et al."—an umbrella term not to be confused with critical theory itself—is very similar to what Mertens (2012, 2020) developed into the "transformative paradigm," namely a paradigm that can be informed by a number of theories and discourses (e.g., critical theory, feminist and race theories, and postcolonial discourses) but is consistent in its critique of the exclusion of marginalized people(s) and its quest for transformation, emancipation/empowerment, and social justice. The "critical theory et al." paradigm and the transformative paradigm are both based on a historic / social realist ontology and an intersubjective and experiential epistemology; both include values as formative, and both employ a

dialogic/dialectical methodology, combining qualitative and quantitative methods (Chilisa, 2020; Lincoln et al., 2011; Mertens, 2020). The pragmatic paradigm is geared toward pragmatic solutions; its ontology is realist, but beliefs regarding knowledge, values, and methodology largely depend on the context and specifics of a particular study (Chilisa, 2020; Mertens, 2020).

The ongoing proliferation of research paradigms shows that what constitutes Western science and its methodologies is neither clear-cut nor set in stone. This flux is a promising prerequisite for engaging in the advancement of other sciences—including Indigenous sciences, whose philosophical underpinnings I will examine next.

Indigenous Philosophies of Science

Indigenous sciences are sciences developed, used, and refined by Indigenous peoples. Despite the tragic and brutal history of colonization and regardless of the attitude of the governing nation states, Indigenous peoples are sovereign nations. At its core, sovereignty means that Indigenous peoples are Indigenous nations who have the right to self-determination (Palmater, 2015). This sovereignty includes rights to their lands, histories, and cultures; to legal, political, economic, and social systems; and to their knowledge and ways of knowing. These and other rights are specified and affirmed in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which was adopted by the United Nations General Assembly (UNGA) in 2007. Article 31 of the declaration specifically affirms Indigenous peoples' "right to maintain, control, protect and develop their … traditional knowledge … as well as the manifestations of their sciences, technologies and cultures…." (UNGA, 2007).

Given the diversity of Indigenous peoples around the world, a single definition of Indigenous science is elusive. Generally speaking, Indigenous sciences are time-tested, rational, methodical, and empirical ways of pursuing and producing knowledge that advance the respective Indigenous societies and cultures (Snively & Corsiglia, 2016; Wiredu, 1977). As such, they are highly localized and contextualized endeavors, as they are rooted in the land (Dei et al., 2000; Henderson, 2000a). For Indigenous peoples, land is more than physical space or property; it encompasses spirituality, relationships, ecosystems, cultures, and laws, as well as knowledge, memory, and history (Lawrence & Dua, 2005). For example, Inuit science stems from the land on which the Inuit have lived for thousands of years; it helps them sustain themselves on that land, live in harmony, and prosper (Okalik, 2013). The rootedness of Indigenous sciences in the local, in the land, is on the one hand what makes them unique. On the other hand, this close and reciprocal relationship between the environment and Indigenous philosophy and identity is also what is thought to be the reason for the metaphysical consistency among Indigenous worldviews (Deloria, n.d., as cited in Hill, 1994; McKenzie & Morrissette, 2003). This congruence of the philosophical underpinnings of Indigenous sciences allows us to posit a general Indigenous philosophy of science vis-à-vis the Western paradigms, a move that has also been suggested by Indigenous scholars (e.g., Chilisa, 2020; Chilisa et al., 2017; Wilson, 2008).

Indigenous science is holistic in its approach, for it is embedded in its respective holistic worldview; thus, knowledge cannot be separated from beliefs, practices, or skills (Houde, 2007; McGregor, 2004; Reo, 2011). The goal of Indigenous science is to support a balanced, harmonious, adaptive, and humble life in sync with an environment that is in constant flux and in which everything is related (Henderson, 2000a; Okalik, 2013; Whyte et al., 2016). In Indigenous worldviews, everything is relational. Thus, the relational nature of both reality and knowledge (both are based on a multitude of relationships) does not allow for a clear distinction between the ontology and the epistemology of an Indigenous philosophy (Chilisa, 2020; Wilson, 2008). Indigenous inquiry is further guided by a value stance (axiology) that promotes respect and reciprocity through relational accountability and a methodology that is participatory, liberatory, and relational (Chilisa, 2020; Wilson, 2008).[3] As all beings are embodied, sacred, and related, respectful behavior extends beyond human relations (Hoffman, 1997; Wildcat, 2013, as cited in Whyte et al., 2016; Williams & Snively, 2016). Therefore, Indigenous scientific inquiry is always also a spiritual endeavor and cannot be separated from protocols, that is, attitudes about how to approach the world, for research *is* ceremony (Whyte et al., 2016; Wilson, 2008). Wilson uses this

[3] It becomes clear from this brief overview that the four basic beliefs, namely regarding ontology, epistemology, axiology, and methodology, that have been put forward by Guba and Lincoln (2005) to describe and differentiate Western research paradigms, are themselves a Western construct that is ill-fitted to describe Indigenous philosophical assumptions about science and research (Wilson, 2008).

seemingly simple equation to express that Indigenous research is grounded in the reality of the lived Indigenous experience and to tie Indigenous research and its methods to the land, the manifold relationships involved, and the local philosophers and ancestors, while also expressing that research is guided by respectful reciprocity and unselfish motives and alluding to the inseparability of ways of being, ways of doing, and ways of knowing.

Indigenous knowledge is collective rather than individual, with a strong focus on the commons and on caring for the world in the sense of preserving or restoring balance and harmony (Henderson, 2000a; Kawagley & Barnhardt, 1999; Whyte et al., 2016). It is also multigenerational. Comprising many generations of observation and experimentation, Indigenous science is based and focused on a long-term commitment (Houde, 2007; Kawagley & Barnhardt, 1999). Finally, Indigenous science for millennia has been undertaken—from conceptualization, procedure, and interpretation to verification and dissemination—in an entirely oral process. Findings, instead of being written down, have traditionally been condensed into metaphorical oral stories which allow the information to be readily stored and accessed in an organized manner (Snively & Corsiglia, 2001).

Despite its long and rich history Indigenous science is rarely referred to as science. Instead, it appears camouflaged as Indigenous knowledge or an Indigenous knowledge system, as a way of knowing or a worldview. The choice by Western scholars not to use the label "Indigenous science" is an act of ongoing colonialism and a way to keep Western science at the top of the hierarchy of ways of knowing: Others may pursue knowledge, but not in a scientific way. Yet what is the systematic pursuit of knowledge if not science? Thus, Indigenous science is science (not Western science, just science), even though Indigenous peoples do not usually use the term either (Harding, 2015).

Western and Indigenous Sciences in Ongoing Colonialism

Colonialism/imperialism and Western science are indelibly intertwined, and their interplay is ongoing. The modern Western scientific tradition that has emerged in Europe since the Age of Enlightenment was later exported to virtually every corner of the world through political, commercial, and cultural influence in the wake of European powers' colonial and imperial expansion efforts (Renn, 2012). Science was no longer only a tool to understand and master the natural world; it also became an accessory in the subjugation of colonized peoples and their cultures and, more than once, a justifier of atrocities committed on the oppressed, such as medical experiments without consent (e.g., Mosby, 2013) or the apartheid regime in South Africa (Nordling, 2018). Despite its claim and efforts to be rational, objective, value-free, and secular, Western science is not and has never been a neutral activity, for it is guided by its underlying philosophical assumptions and occurs in political, social, and cultural contexts (Smith, 2012).

Yet philosophers of Western science never claimed that Western science is a Western achievement, nor that it is better than other sciences; instead, they claimed that it is a universal tool to understand the world and gain new insights (Henderson, 2000b). Universalism renders Western science the only accepted and valid scientific inquiry, elevating it to a given rather than an option. It is only a short step from claiming universalism to aspiring to domination, as both the oppressor and the oppressed believe that the power imbalance in their relationship is part of the natural order of things (Noël, 1989/1994, p. 79). Under universalism, Western science and knowledge *have* to view themselves as the only possible way of knowing, as their legitimation can only come from judgments based on their own terms of reference (Suchet, 2002). This self-legitimation constitutes a circular argument that has been aptly described as an all-knowing self who centers itself in a hall of mirrors to narcissistically only see, hear, smell, taste, touch, and engage with itself (Rose, 1999; Suchet, 2002).

With universalism comes exceptionalism, as alternative sciences and knowledges are excluded; they are silenced, ignored, denigrated, devalued, and undermined (Harding, 2015; Suchet, 2002). In concert with colonial ideologies and power dynamics, this view of Western science as the only true science has left an ongoing legacy of oppression, inequality, and racism. The environment, too, has been compromised by resource management and conservation approaches exclusively based on Western science. From development projects and managing pollution to the exclusion of humans for species and/or area protection (e.g., Borrows, 2015; Eichler & Baumeister, 2018; Makki, 2014; Suchet, 2002), Indigenous conservation ethics and efforts have been undermined and overridden. Many other areas, such as health and healing (e.g., Brown et al., 2012; McNally & Martin, 2017) and education (e.g., Battiste, 2000, 2013; Williams & Snively, 2016), have also been governed by dominant Western

scientific methods. In its entirety, as Mohawk scholar Taiaiake Alfred (2009) concludes:

> Colonialism is best conceptualized as an irresistible outcome of a multigenerational and multifaceted process of forced dispossession and attempted acculturation—a disconnection from land, culture, and community—that has resulted in political chaos and social discord within First Nations communities and the collective dependency of First Nations upon the state. (p. 52)

Due to colonialism and the imposed Western ways of approaching the world, Indigenous peoples everywhere have been disconnected from their lands and worldviews. In this process of dispossession and disconnection, some Indigenous knowledge has been lost. Even though Indigenous knowledge systems are inherently adaptive and thus resilient to change, they are nevertheless vulnerable to further knowledge losses (Fernández-Llamazares et al., 2021).

The purported universalism of Western science in concert with colonialism has led to yet another loss: By silencing all non-Western sciences (not only Indigenous science, but also African, Middle Eastern and Eastern sciences), Western science has deprived itself from understanding the world in its full complexity (e.g., Harding, 2015; Henderson, 2000b; Russon, 2008; Van Norden, 2017). The active exclusion of non-European thought and science in the quest to better understand the world has precluded Western science from finding the best possible solutions (Trisos et al., 2021). Our world is becoming ever more complex, and more complex solutions are needed; they are more likely to be found when multiple perspectives work in tandem (Tengö et al., 2017).

The Bigger Picture of Decolonizing Science

The call for decolonization—that is, the undoing of colonial domination—has always included more than merely achieving political sovereignty and equal economic opportunities. A crucial set of demands in the decolonization process is concerned with education, research, and science (e.g., Simpson, 2017; Smith, 2012). In Canada, for example, the Truth and Reconciliation Commission (TRC), after documenting the injustices experienced by thousands of Indigenous children in residential schools, released 94 calls to action alongside its six-volume final report. Scores of these calls center on teaching and learning, with more than one-third of them pertaining to postsecondary institutions (TRC, 2015). This focus on teaching and learning is not surprising, for education played (and continues to play) a powerful role in colonizing, subjugating, and assimilating Indigenous peoples. For that reason, education is also crucially important in the decolonization effort. On the eve of the release of the TRC report, Murray Sinclair, the chief of the TRC, made the following statement, which succinctly sums up education's role with regards to (de)colonization: "Education is what got us into this mess [...] but education is the key to reconciliation" (Watters, 2015, para. 17).

Decolonization is not just the morally and ethically right thing to do; it is also a legal imperative. As laid out in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), Indigenous peoples have a right to decolonization so that they can reaffirm and reclaim their sovereignty, live dignifiedly and prosperously on their native lands, and exercise self-determination with regards to their lands, culture, and beliefs as well as their political, economic, social, and spiritual systems (Simpson, 2017; UNGA, 2007). This key instrument addressing the human rights of Indigenous peoples is first and foremost a framework for action. Canada and the other three large settler-colonial states [4] of the Global North, Australia, New Zealand, and the United States of America, were the only UN members who voted against the UNDRIP when the resolution was adopted in 2007 (United Nations, n.d.). Afraid of losing access to land and resources, the Canadian government cited inconsistencies with the existing Canadian Charter of Rights and vagueness regarding the declaration's implementation as reasons for not signing on (CBC News, 2007). In 2010, the Canadian federal government endorsed UNDRIP with reservations, then in 2016 committed to fully implement it in Canadian law. In addition, the Canadian government led by Prime Minister Justin Trudeau is committed to renewed nation-to-nation, government-to-government relationships between the Canadian government and Indigenous nations in Canada (Mas, 2015). Implementation has been slow (Needham, 2022) but may be accelerated now

[4] Settler colonialism is a type of colonialism. It is an ongoing power system that aims to eliminate Indigenous societies by replacing them with a settler society.

that the UNDRIP Act has been passed (Department of Justice Canada, 2021). One of the foremost goals of implementing the UNDRIP in Canada is Indigenous peoples' exercise of the right to self-determination. While Indigenous rights and sovereignty are most often discussed in the context of law, politics, and government (Moreton-Robinson, 2006), a true post-colonizing nation-to-nation coexistence has implications for all aspects of life, including research and evidence making.

To decolonize science means first and foremost to accept that science is never value-free. It is further paramount to be aware of the fact that science has been repeatedly abused to back unscientific tenets in support of exploitation, oppression, and exclusion, such as in the example of apartheid in South Africa mentioned above. Understanding modern science—as evolved in a Eurocentric setting—as just one among may equally legitimate ways of knowing and generating new knowledge will allow for a multicultural view of science. Only when the alleged universalism of Western science is relinquished can different sciences complement and enrich each other.[5] To denote this process, I prefer to use the term "decolonizing science" rather than "decolonized science" or "decolonial science." This choice is not simply semantic persnicketiness; using the gerund of the verb "to decolonize" indicates the process, the action of the endeavor. In that sense, decolonizing science is a path, not a destination. In fact, we do not know what a decolonized science will look like in a decade or two, but we can embark on a journey now to explore what it can be.

Paradigmatic and Practical Considerations for Bridging Indigenous and Western Sciences

To unsilence Indigenous scientific inquiry and legitimize its methodologies and findings several scholars, both Indigenous and non-Indigenous, have invited Indigenous science to find its place within the Western philosophy of science. Donna Mertens and her colleagues have proposed to include Indigenous science in their transformative paradigm, as the two frameworks for scientific research share an interest in power relations and aspirations for emancipation and decolonization (Cram & Mertens, 2015, 2016; Mertens & Wilson, 2012). Several other scholars have proposed to encompass a fifth paradigm, called "Indigenous paradigm(s)," to include the breadth of non-Western perspectives with the current "big four" (Dillard, 2006) Western research paradigms (postpositivist, constructivist, transformative, and pragmatic) (e.g., Chilisa, 2020; Chilisa et al., 2017; Dillard, 2006; Romm, 2015; Wilson, 2008).

While this new paradigm may be a first pragmatic step toward greater diversity in approaches to science, it is still an attempt to shoehorn Indigenous research paradigms into the Western framework of how to think about scientific inquiry. I agree with Tuck and Yang (2012), who have argued that such an incorporation is not advised, as decolonization is not just another social justice issue but a fraught and unsettling undertaking. I understand this to mean that Western and Indigenous thought are so different when it comes to their basic beliefs that any alignment, assimilation, or convergence is not advised (Held, 2019). Instead, the bridging of Western and Indigenous sciences will (have to) open up new multiparadigmatic spaces in order to serve radical decolonization. As this novel way of doing research develops further, a new paradigm may be developed alongside.

However, the basic beliefs of Western and Indigenous approaches to research remain incompatible due to their different assumptions about the nature of reality, knowledge, and values (Held, 2019). These differences do not preclude collaboration and cross-fertilization, but they make Western and Indigenous sciences an uneasy fit with regards to a common philosophical underpinning, mainly because the axioms of Indigenous paradigms are infused with relationality. Hence, I envision the aforementioned multiparadigmatic space to be something new altogether. The tenet that one's research can only be guided by one paradigm (Denzin & Lincoln, 2008) thus no longer holds.

Notwithstanding the unsolved question of a paradigmatic home for decolonizing research, the invitation to collaborate across different worldviews stands (Chilisa, 2020; Whyte, 2013), and both Western and Indigenous scholars already engage in decolonizing research. Whether they use boundary objects[6] (e.g., maps) to bridge

[5] Maybe even the relativist position regarding sciences can and needs to be abandoned, as suggested and discussed by Lesley Green (2008), a social anthropologist from South Africa.

[6] A boundary object is a concrete or abstract object that is part of several intersecting social worlds. It is flexible to adjust to local needs while also being easily recognizable across social worlds. Thus, a boundary object can

Indigenous and Western scientific ways of knowing (e.g., Bishop et al., 2022; Kourantidou et al., 2020) or a co-learning journey such as two-eyed seeing[7] (Bartlett et al., 2012), it is paramount to respect the local Indigenous protocols (Whyte et al., 2016; Wilson, 2008). Further, the bridging work, which takes a considerable amount of time, needs to be done collaboratively and iteratively (Bishop et al., 2022). There is no standardized formula to decolonizing research; what worked for one collaboration may or may not work for another. The cocreation process itself cannot be replicated elsewhere, as the cooperation is always also rooted in the local, in the worldview of the Indigenous partners. Thus, it can be helpful to use a common practice or technology—a boundary object such as a map—from which to start the collaboration.

Regardless of what the collaboration between Western and Indigenous sciences looks like in practice, this new multiparadigmatic space must not degenerate into a free-for-all in which all sorts of knowledge systems (e.g., revelation knowledge) are vying for scientific legitimization. Western science and Indigenous sciences can engage each other because both *are* sciences—namely, proven rational and empirical ways of knowing. In the collaboration that is decolonizing science, both ways of knowing as well as the knowledge created from their interplay will have to be validated respectfully and continually (Bartlett et al., 2012; Bishop et al., 2022). However, care must be taken that this validation does not merely focus on using Indigenous findings to corroborate Western results. This was a serious issue a few decades ago when Western scientists were only interested in factual Indigenous knowledge as it pertained to the environment, thus reducing Indigenous knowledge systems to "TEK" (traditional ecological knowledge) and co-opting it into a Western framework (e.g., Briggs, 2013; McGregor, 2005; Nadasdy, 1999). Using Indigenous knowledge as a mere data set does not account for the complex and holistic context in which the knowledge was gathered, transmitted, refined, and used. Indigenous knowledge is never just factual observations, for they cannot be isolated from past observations (as knowledge is intergenerational) nor from ethics or values (as they are an inextricable part of the worldview; Houde, 2007).

Creating meaning from knowledge and/or data is always also a political act. As mentioned earlier, Indigenous peoples have largely been excluded from meaning making in the past (e.g., Chilisa, 2020; Smith, 2012; Wilson, 2008). Now, after years of advocating for greater data sovereignty, they are asserting control over the collection and use of data by and about them (Walter et al., 2021). Transferring data sovereignty to Indigenous peoples is a way to affirm their autonomy and self-determination, as data, through its interpretation and subsequent decision-making, has far-reaching implications—for instance, regarding legal definitions and policies. To decolonize science is but one step in the entire decolonization process. If research findings are to have a real impact, then decision-making needs to be decolonized, too, which affects not only resource managers and health policy makers, for instance, but the entirety of our political and economic systems (McGregor, 2005; Snively & Corsiglia, 2016). The process of decolonizing science is having further ripple effects on science education (e.g., Aikenhead & Elliott, 2010; Battiste, 2013; Boisselle, 2016; Hansson, 2018), academia (e.g., Dei, 2000, 2016; Kirkness & Barnhardt, 1991; Kuokkanen, 2007; Rodríguez, 2018), and evaluation (e.g., Chilisa et al., 2015; Cram, 2015, 2018)—it is about decolonizing expertise, i.e., who is being heard (Trisos et al., 2021).

Conclusion

Science is not something that is easily defined. The discourse about what constitutes science and knowledge is distorted by social and political power imbalances. Thus, research and science are never neutral (Smith, 2012; Trisos et al., 2021). Modern Western science is just one manifestation of the quest to generate reliable and useful knowledge. Such a multicultural view of science is necessary if the decolonization of science is to be successful. Further, it is essential to recognize the limits and the incompleteness of Western scientific knowledge, for only then does the need to engage the diversity of approaches to scientific inquiry become truly apparent (Russon, 2008). Ignoring the diversity of people, sciences, and answers jeopardizes finding the best solutions to today's ever more complex issues (Trisos et al., 2021). However, decolonizing science is neither a panacea nor an easy undertaking.

facilitate communication across intersecting social worlds (Star & Griesmer, 1989).

[7] Two-eyed seeing is a guiding principle for science research, application, and teaching first proposed by Mi'kmaw Elder Albert Marshall from Unama'ki (Cape Breton), Nova Scotia, Canada. It is a co-learning journey that interweaves Indigenous and mainstream sciences and ways of knowing to gain a more inclusive and holistic view of the world (Bartlett et al., 2012).

To decolonize science is only a part of the larger decolonization project; it is a crucially important one, though, as science and education have been complicit in colonialism. Thus, it is paramount to invite Indigenous sciences into academia, by nature a racist and colonial institution. By practising and teaching Indigenous sciences, academia has the potential to challenge the hegemony of Western science. But despite their importance, different ways of knowing are not the crux of decolonization, at least not in settler colonial states. Tuck and Yang (2012) have made it very clear that, ultimately, decolonization is—and needs to be—about the land. The unsettling undoing of the status quo must also be accompanied by healing. Only then will decolonization also lead to reconciliation and redress of past and present colonial injustices.

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