CHAPTER 5

Toward an Unsettling Hauntology of Science Education

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Science education continues to be haunted by the (re)apparition of the question of where to "begin" with Indigenous ways-of-living-with-nature in the Canadian context in which I work as a white settler science educator. In this contemporary moment in Canadian science education, marked by teaching and learning in the era of Truth and Reconciliation, we are beginning to see more and more provincial curriculum moving toward the inclusion of Indigenous ways-of-living-with-nature: "we no longer have any excuse, only alibis, for turning away from this responsibility" (Derrida 1994/2006, 14). And yet, the question often materializes, conjured into being in ways that work to dispel and dismiss the full extent of this responsibility. While often informed by an intent of being in relation in a good way, this query functions as an exorcism to guard against the individual and systemic debts shaped by the ways in which science

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education is *always already* in relation to Indigeneity as a result of settler colonialism. Thus, this question often functions as a call to responsibility that masks more than it reveals: this has the unintended consequence of rendering diffuse the ability to respond to a problematic past while (re)producing it in the present. The question often belies that there is *a* proper, best, or most effective point of entry into pedagogical practice. Yet, the (re)apparition of the question as such betrays its own spectral returns: it is one that has been asked many times over, again and again, differing and deferring *an* answer, and answerability (see McKinley 2001; Spivak 1994). After Derrida (1994/2006), "everything begins before it begins" (202). Significantly, the question tells on itself: it discloses a longstanding refusal to heed the call of justice-to-come for Indigenous science (e.g., Cajete 1994; Kawagley 1995/2006). This call to honor the gifts of Indigenous ways-of-living-with-nature, and their co-constitutive ecologies, have been differentially articulated for decades by Indigenous science education scholars and allies. When pasts are passed over, but still come to constitute the here-now of contemporary practice, it is worth asking: what ghosts might science education be chasing away? As "every concept is *haunted* by its mutually constituted excluded other" (Barad 2010, 253, emphasis mine), and such is the relation between science education and Indigenous ways-of-living-with-nature (see McKinley & Aikenhead 2005), what would it mean to take as necessity the matter of ghosts, of ghostly matters?

> It is necessary to speak of the ghost, indeed to the ghost and with it, from the moment that no ethics, no politics, whether revolutionary or not, seems possible and thinkable and just that does not recognize in its principle the respect for those others who are no longer or for those others who are not yet there, presently living, whether they are already dead or not yet born. No justice… seems possible or thinkable without the principle of some responsibility, beyond all living present, within that which disjoins the living present, before the ghosts of those who are not yet born or who are already dead, be they victims of wars, political or other kinds of violence, nationalist, racist, colonialist, sexist, or other kinds of exterminations, victims of the oppressions of capitalist imperialism or any of the forms of totalitarianism. (Derrida 1994/2006, xviii)

Drawing inspiration from decolonizing theories of haunting (e.g., Supernant 2020; Tuck & Ree 2013), hauntologies of teaching and learning (e.g., Bozalek et al. 2021; Motala & Stewart 2021; Zembylas, Bozalek, &

Motala 2021; Snaza 2014), and deconstructive approaches to the spectral (e.g., Barad 2010, 2012, 2019; Derrida 1994/2006)[1] this chapter pursues an *unsettling hauntology of science education*. In a nutshell, unsettling science education is a double(d) process of, first, addressing the ways in which *settler colonialism* manifests within science education by refusing and resisting the logics and structures through which the colonial project remains ongoing; and, secondly (and more subtly), attending to the ways in which science education draws from *stratified* and *sedimented* knowledges, phenomena, histories, pedagogies, and other practices which complicate questions of making space for and responding to Indigenous ways-of-living-with-nature (Bang & Marin 2015; Bang, Warren, Roseberry, & Medin 2012). Further, hauntology is a (near-)homonym of ontology that is meant to defer and differ ontology's conventional (and often settling) "discourse on the Being of beings" (Derrida 1994/2006, 63) to embrace that which exceeds it: the spectral. Together, they invite an ahuman pedagogical practice of addressing (in both senses of the word) ghosts of settler colonial injustice past which linger and lurk in the present moment[2] of science education, not to repair the past but to (re)imagine a future justice-to-come. Herein, we are visited by three ghostly explorations: the spectrality and specters of the question of where to "begin;" ghosts of/as settler horror in science education; and hauntological inheritances(s) (or, it's ghosts all the way down).

Part 1: Spectrality and Specters of the Question of Where to "Begin"

> Haunting is the cost of subjugation. It is the price paid for violence, for genocide.... In the context of the settler colonial nation-state, the settler hero has inherited the debts of his forefathers. This is difficult, even annoying to those who just wish to go about their day.... Erasure and defacement concoct ghosts; *I don't want to haunt you, but I will*. (Tuck & Ree 2013, 643, emphasis mine)

Because we need to "begin" *some-where* and *some-time*, let's "begin"[3] with the spectrality of the question itself in the *here-now*: the ways in which it vacillates between *being* and *non-being, possibility* and *impossibility*, and perhaps an annoyance "to those who just wish to go about their day" (Tuck & Ree 2013, 643). Thinking with Ngāti Kahungunu

ki Wairarapa and Ngāi Tahu scholar and science educator Liz McKinley (2001), the (re)apparition of the question of where to "begin" has much to do with the ways in which dominance operates within science education and the ways it responds to difference: as a form of "masking power with innocence." Rather than a passive lack of knowledge, this "sanctioned ignorance" (Spivak 1999) or "know-nothing-ism" (Kuokkanen 2007) is an active positional stance and strategy of collective forgetting about oppressive structures and practices (re)produced by dominant groups in science education (see Higgins 2021). Given science education's politically and theoretically conservative nature (Lemke 2011; Milne & Scantlebury 2019), McKinley's (2001) associated mandate continues to bear heeding: "we need to challenge the mask of innocence and ask ourselves how relations of domination and subordination regulate encounters in classrooms" (76).

Where masking power with innocence speaks to the ways in which the question of beginning is ritually expulsed, it does not and cannot account for its (re)apparition. Here, to take haunting seriously is to invert the habitual and dominant structure of responsibility and agency: instead of settler colonial disciplinary spaces and individual actors taking up responsibility, haunting works to prevent the (re)assertion of an innocent or reconcilatory settler subjectivity that has assuaged its own fears and anxieties. As Unangax̂ scholar Eve Tuck and her artist colleague Christine Ree (2014) powerfully state,

> Social life, settler colonialism, and haunting are inextricably bound; each ensures there are always more ghosts to return. Haunting … is the relentless remembering and reminding that will not be appeased by settler society's assurances of innocence and reconciliation. Haunting is both acute and general; individuals are haunted, but so are societies.... Haunting doesn't hope to change people's perceptions, nor does it hope for reconciliation. Haunting lies precisely in its refusal to stop.... For ghosts, the haunting is the resolving, it is not what needs to be resolved. (642)

As the modes of taking up responsibility toward Indigenous ways-of-living-with-Nature in science education often mask power with innocence, there is far too often a move toward inclusion that does not address the settler colonial systems through which this exclusion occurred in the first place. As Spivak (1976) reminds, the language and practices we possess also possess us; thus, too simply moving beyond is "to run

the risk of forgetting the problem or believing it to be solved" (xv) by reproducing it elsewhere, albeit differently. Such possession always already "ensures there are always more ghosts to return" (Tuck & Ree 2013, 642): the project of Indigenous erasure persists in its perpetuation, whether consciously or unconsciously.

However, as Métis scholar Kisha Supernant (2020) states, haunting involves "a refusal to be forgotten, a subversion of erasure, a persistent, forced remembering" (86). Haunting *happens:* it ensures that settlers inherit the debts of those before them (Tuck & Ree 2013). This debt—marked by violent dispossession, displacement, and erasure—haunts science education. This is the case, even if or when there is a "properly spectral anteriority of the crime" (Derrida 1994/2006, 24) that often makes the locating or rendering (wholly) intelligible of an unsettling educational inheritance a task akin to speaking of and with ghosts. Such work, as Derrida (1994/2006) suggests, is the work of mourning:

> It consists always in attempting to ontologize remains, to make them present, in the first place by identifying the bodily remains and by localizing the dead (all ontologization, all semanticization – philosophical, hermeneutical, or psychoanalytical – finds itself caught up in this work of mourning but, as such, it does not yet think it; we are posing here the question of the specter, to the specter… on this near side of such thinking) (Derrida 1994/2006, 9)

This work, in part, is to work toward (but never fully achieving) a solidification of the spectral: the ways in which this beginning has already begun elsewhere, its pasts as absent presents/presence. Although, let us be clear here: in the work of mourning in/as unsettling science education, there are some inheritances whose bodily remains do not require as extensive a presencing. As Tuck and Ree (2013) remind, "haunting is both acute and general" (642). Here are three short ghostly visitations, recognizing that ghosts haunting settler colonialism innumerably proliferate. First, the appropriation of and synthetization of Indigenous traditional willow-bark-based medicine, in the name of "discovery" by the Bayer pharmaceutical company, in what we know today as aspirin (see Snively & Corsiglia 2001). Second, the ways in which Indigenous peoples have been and continue to be the *objects* of science rather than its *subjects*, such as the nutritional experiments conducted on First nations communities and

residential schools in which malnourished children were denied appropriate nutrition, as a means of controlling variables (see Mosby 2013). Third, ongoing practices of genetic extractivism rooted in an image the "vanishing Indian" such that settler scientists take samples from Indigenous peoples globally in a way that is wholly disassociated from Western modernity's complicity in the production of this image, or the multiple genocides which have come to inform it (see TallBear 2013). Importantly, for all of these ghosts, and the many others who linger and lurk, and those who are yet-to-come, "even where it is not acknowledged, even when it remains unconscious or disavowed, this debt remains at work" (Derrida 1994/2006, 115). There is not less responsibility to repair an evil even when it cannot be fully grasped as such,[4] rendered *an* event or reality: science education continues to be haunted by its ghosts.

Part 2: Ghosts of/as Settler Horror in Science Education

> Settler colonialism is the management of those who have been made killable, once and future ghosts — those that had been destroyed, but also those that are generated in every generation.… Settler horror, then, comes about as part of this management, of the anxiety, the looming but never arriving guilt, the impossibility of forgiveness, the inescapability of retribution. (Tuck & Ree 2013, 642)

Because we need to "begin" some-where and some-time, let's "begin" with Ojibwe scholar Megan Bang and Black and Choctaw scholar Ananda Marin's seminal 2015 piece on *unsettling science education* (see also Bang et al. 2012). As they state:

> Science education is a key site in which nature-culture relations are defined, enacted, brought-to-life, expanded, narrowed and legislated. The manifestations of nature-culture relations, from the very constructions of subject matter, to focal content, to the configurations of practice, engaged in science learning environments are often deeply unreflective of the most pressing scientific questions – rather they focus on "settled" phenomena as well as "settled" perspectives and relations to phenomena. (Bang and Marin 2015, 531)

Science education's ongoing relationship to Indigenous ways-of-living-with-nature is one that is complex and complicated. This relationship is often marked by Othering within, exclusion from, and problematic inclusion into science education curricula (e.g., school science) which defers and differs intended meanings and practices. When working in concert with other practices of schooling that treat Indigeneity as lesser-than, multiplicitous and entangled forms of Othering often results in forms of learning as onto-epistemic violence for Indigenous and many other learners (see McKinley 2001, 2013; McKinley & Stewart 2012). From a cultural studies perspective, school science regularly produces experiences of cultural *assimilation* and *acculturation* rather than *enculturation*. In other words, rather than a harmonious interfacing of cultures (i.e., enculturation), encounters of school science are more likely to house potential for dialectical negation that is either actualized (i.e., assimilation) or remains un-actualized through students' complex and complicated curricular navigation (i.e., acculturation). This can be, in part, attributed to the "the conventional goal" of science education as being one "of thinking, behaving, and believing like a scientist" (Aikenhead & Elliot 2010, 324). Through this unquestioned commitment, pedagogical approaches collude and coalesce around the construction and reification of the subject position of "Scientist," a position which is emblematic of the masculine, Eurocentric, and anthropocentric subject of Western modernity through modes that enact and uphold its metaphysics (e.g., representationalism, universalism, nature/culture divide). Which is to say, at the very least, there is much to be spooked about in science education.

Further, to move toward unsettling hauntologies is to engage a double(d) practice of attending to sedimented and stuck locations that continue to bear on the ways in which settler colonial logics persist and are perpetuated in ways that may register as ghostly absent presences. Although the above often goes unnamed and unmarked, it bears revisiting Tuck & Ree's (2013) conceptualization of settler colonialism as "the management of those who have been made killable, once and future ghosts" (642) and the ways in which the centering of "settled" phenomena through "settled" perspectives hauntologically matter and materialize beyond the classroom as well. Science education's (pre)dominant conceptualization of nature-culture, as possessing and possessed by society, makes palatable and possible the ongoing dispossession and devastation of Indigenous Land:

> The fundamental tenant of settler-colonial societies is the acquisition of land as property, followed by the establishment of settler lifeways as the normative benchmark from which to measure development…. The maintenance of settler normativity requires the structuration of time-space relations in ways that make the inseparable dynamics of acquisition of land, [I]ndigenous erasure, and the domination of black people appear as an inevitable, unconnected, and natural course of development rather than socio-politically engineered to support and foster white entitlement and privilege. (Bang & Marin 2015, 532)

Dispersed through and entangled with the body of science education are historicities of (settler) colonial violence: even if responsibility, in the legal-juridicial sense, cannot always be pinned to any particular individual scientist, science educator, or curriculum.[5] Nonetheless, science education is haunted: its framings of nature in which other-than-humans are unagentic, brute materiality to be extracted and exploited in the name of human exceptionalism and entitlement are not and have not been without consequence. They are part and parcel of the dispossession and destruction of Indigenous Land and deeply entangled practices of (cultural and literal) genocide of Indigenous peoples by nation-states in the sake of acquisition of Land as property.

As Tuck & Ree (2013) offer, such is the making of *settler horror*: not only in the horror inflected by settler colonialism but also the horror experienced through settler subjectivities which must be managed, "the anxiety, the looming but never arriving guilt, the impossibility of forgiveness, the inescapability of retribution" (642). In (re)thinking the question of where to "begin" with the work of Tuck & Ree, there is an invitation to consider the ways in which Indigenous ways-of-living-with-nature are included within science education as a *scéance*—more specifically—an *exorcism*: "for to conjure means *also* to exorcise: to attempt both to destroy and to disavow" (Derrida 1994/2006, 59, emphasis in original). Settler science as scéance is a double(d) move. It is an effort to conjure Indigenous ways-of-living-with-nature as ghosts of the past whose contemporaneous presencing would be too much to bear for settler science. At the same (yet out-of-joint) time, the séance is a means of putting these ghosts to rest. Importantly, "effective exorcism pretends to declare the death only in order to put to death" (Derrida 1994/2006, 59): it is at once a constative certification that the ghost is gone and yet a performative enactment of its expulsion. The work of conjuring the

ghost requires making the ghost present, ontologizing it, mourning it, to be present at the scene of its death:

> Mourning depends on us, in us, and not on the other in us. One must indeed know *when: at what instant* mourning began. One must indeed know *at what moment* death took place, really took place, and this is always the moment of a murder. (Derrida 1995, 20, emphasis in original)

Rather than an escape of the phantom effects of haunting, the collusion in murder ensures that there are always more ghosts to return: settler science education finds itself knife-in-hand, inviting its own haunting(s), yet somehow confused on this subject, wondering if such an even took place.[6] As Derrida (1994/2006) suggests, "nothing is less sure, that what one would like to see dead is indeed dead" (59). Stated otherwise, settler colonialism both organizes the repression of Indigenous hauntings as well as the ways in which the haunting is recognized as such, and simultaneously the cause of innumerable ghosts to-come: *settler horror*.

Part 3: Ghostly Inheritances(s); Or, It's Ghosts all the Way Down

> While hauntings are understood by some as one or another form of subjective human experience – the epistemological revivification of the past, a recollection through which the past makes itself subjectively present – …. hauntings… are not mere subjective rememberings of a past (assumed to be) left behind (in actuality), but rather, *hauntings are the ontological re-memberings, a dynamism of ontological indeterminacy of time-being in its materiality*. (Barad 2019, 539, emphasis in original)

Because we need to "begin" some-where and some-time, let's "begin" where time is out-of-joint: troubling times call for the troubling of time. As feminist science studies scholar Karen Barad (2010) invites, "to address the past…, to speak with ghosts, is not to entertain or reconstruct some narrative of the way it was, [but rather] to respond, to be responsible, to take responsibility for that which we inherit" (264). Once more, settler science education is called upon to learn to speak to the ghosts of pasts passed over which continue to haunt its present as this has bearing

on what science education *was, is*, and *is becoming* toward a decolonizing justice-to-come. However, as Barad (2019) suggests, to speak with ghosts, to remember (to be haunted) is more than an epistemological recollection: it is a *hauntological* act, one that is spectral, ontologically indeterminate in its space-time-mattering.[7] In turn, the work of attending to the inheritances that haunt science education is not without significance. These inheritances are *there-thens* which co-constitute the *here-now,* as well forces and flows which shape who we are and can become within science education.

Remembering the history of science, in this sense, takes on a different orientation: not only are we invited to attend to absent presences in the settler-colonial-science-education-narrative-as-usual, but also to the ways in which ontology itself is haunted by a plurality of proliferating ontologies. As Supernant (2020) states,

> Haunting implies a relational ontology, for to be haunted is to be made aware of ghosts, the other-than-human beings who resist animacy, even when Western [modern(ist)] ontologies attempt to bound them as objects, places, or specimens without agency. (86–87)

Which is to say, hauntology troubles the very possibility of ontology being a singular affair. This is of particular significance when ontology comes to stand in for epistemic realism (a "settled" view of nature) such that Western modernity becomes the meter stick by which nature should be understood or known, and a means of recentering settler colonial ways-of-being in science education (see Higgins 2019). Importantly, ontology is itself a site of settler colonial séance: "ontology opposes [hauntology] only in a movement of exorcism. Ontology is a conjuration" (Derrida 1994/2006, 202). Once more, it is worth asking what ghosts might science education be chasing away? Let's turn to a significant "origin" story of Western modern science: the birth of the laboratory.

At the center of the birth of the laboratory is the practice of being (and becoming) *modest witness*. As feminist science studies scholar Donna Haraway (1997) explains, this practice of modest witnessing is deeply entangled in the production of "objectivity" in which representational authority is established through the production of *a* scientific subjectivity which somehow loses all traces of its narrativity and historicity:

> In order for the modesty… to be visible, the man – the witness whose accounts mirror reality – must be invisible, that is, an inhabitant of the potent "unmarked category," which is constructed by the extraordinary conventions of self-invisibility…. This self-invisibility is the specifically modern, European, masculine, scientific form of the virtue of modesty. (23)

While the figuration of the modest witness and the very possibility of objectivity in the conventional sense has been under much critique, it nonetheless continues to bear as a narrative that "continues to get in the way of a more adequate, self-critical technoscience committed to situated knowledges" (Haraway 1997, 33). Science education is *always already* entangled with/in various material-discursive configurations whose (perceived) absence becomes naturalized through repetition. As feminist philosopher of science Isabelle Stengers (2001) suggests, while history does not repeat itself, it nonetheless repeats. It bears relevance and significance to learn about and from the past (as well as become-with, in the hauntological sense), even if the present is not self-same, about the ways in which the practice of modest witnessing never achieved the objectivity it sought out through de-subjectification.[8]

In Western Europe in the seventeenth century, the state required a new form of governance that was not religiously partisan as the result of many years of religious wars (i.e., the Thirty Years War). Turning from the church to science to keep the peace, those working within the laboratory as third-party observers—the practice of the day for experimental verification—were required to abstain from pronouncing or enacting religious affiliation when engaging in the act of observation (as the result could be violent). They were to witness the experiment "modestly." Worth considering here is that the modest witnesses were all white men of significant status, which may signal to beliefs about who was immodest "by nature" and therefore unable to participate in the cultural practice of science. Yet, these practices are not as simple as abstaining from taking a political stance: there is a confluence of political, economic, religious, scientific, and military practices which are entangled and enfolded into the birth of the laboratory and how we continue to understand Western modern science today. For example, the politics of Land (and how land is conceptualized) mattered from the very beginning of what we called Western modern science: many "men of science" were also land-owners. Amidst the enclosure movement, a state-sanctioned project through which the

commons were made available to businessmen for agrarian purposes, those who lived with the Land (e.g., herbalists) were denied access to the places which sustained them (and which they sustained). Note that to make their case on the onto-epistemic-spiritual grounds in which they lived with the Land was risking being branded a heretic or a witch by the Church. Yet, that which goes unspoken for in a highly politicized arena often benefits those witness modestly, albeit as an absent presence.

Importantly, considering scientific praxis as conjuration and exorcism begins to reveal hauntological inheritances that are warded away at the altar of science: significantly, those in relation to Indigenous ways-of-living-with-nature, the relation to place, its other-than- and more-than-human agency, and the politics of place that have haunted Western modern science since its very "beginning." These hauntings all matter and materialize: "one never inherits without coming to terms with… some specter, and therefore more than one spectre." (Derrida 1994/2006, 24). While the above is not an example of the direct relationship between settler colonialism and science education, it's *ghosts all the way down*: before settler colonialism, science was caught up in the dispossession of indigenous[9] peoples from land in service of proto-capitalism. As Derrida (1994/2006) states, "haunting belongs to the structure of every hegemony" (46), and some hegemonies haunt others: ghosts all the way down.

Conclusion: Unsettling Hauntology

> Decolonization necessarily involves an interruption of the settler colonial nation-state, and of settler relations to land. Decolonization must mean attending to ghosts, and arresting widespread denial of the violence done to them. (Tuck & Ree 2013, 647)

Because we need to "begin" some-where and some-time, let's "begin" by no longer asking *where do we begin to engage the question of including Indigenous knowledges or perspectives in science education*? This question, which continues to (re)appear, is a way of masking power with innocence, obscuring the ways in which Western modern science and Indigenous ways-of-living-with-nature are *always already* in relation within science education. Inclusion, as it is usually framed, becomes a site of colonial containment: Indigenous ways-of-living-with-nature are included, but

only so much as to (be able to) exorcize them in the name of assuaging settler subjectivities who cannot bear their own complicities in histories of colonial dispossession, displacement, and erasure. But to exorcize is to presence and be present at the scene of the murder. We must reckon with and learn to speak with specters of settler colonialism in science education, as it is ghosts all the way down: Western modern science has been concocting ghosts from its very beginning. For example, the scientific laboratory's entangled practices of the enclosure, witch burnings, and erasure are practices which hauntologically come to inform settler colonial pasts passed over, the present contemporary moment, and even a potentially singularizing vision of *the* future which continues to be marked by Indigenous erasure and destruction of Land. Significantly, as the future (avenir) and the to-come (à-venir) are not one and the same, the present of science education is irreducibly bound to and ethically indebted to Indigenous ways-of-living-with-nature. This potentiality that has yet-to-come, whose arrival is unforeseeable, invites "the continual reopening and *unsettling* of what might yet be, of what was, and what comes to be" (Barad 2010, 264, emphasis in original).

These three ghostly visitations are to remind that "there is no inheritance without a call to responsibility. An inheritance is always the reaffirmation of a debt" (Derrida 1994/2006, 114). For those of us in science education (and particularly white settlers, like myself), this debt is marked by injustices committed from which settler societies and individuals continue to benefit, both acutely and generally. Thus, once more, if science education continues to "focus on 'settled' phenomena as well as 'settled' perspectives and relations to phenomena" (Bang & Marin 2015, 531), which rely on and reinforce settler lifeways while simultaneously dismissing, diminishing, and denying Indigenous ways-of-living-with-nature, presence, and futurities, the question and response to "where do we begin?" will remain but a tokenistic "settler move-to-innocence" (Tuck & Yang 2012). This move serves to distract from the more unsettling demands of this work (namely, Land) and, primarily, an effort to reconceptualize and recenter the subject of dominance. Science education must learn to speak to ghosts of settler colonial injustice past which linger and lurk in the present moment. Significantly, ghosts are innumerable—"one can neither count the ghost, … count on it nor with it" (Derrida 1994/2006, 173)—these are but possible possibilities for an unsettling hauntology of science education, and there is much more work to be done.

Notes

1. This particular theoretical intersection is haunted by its own problematics. As Métis scholar Zoe Todd (2016) explicitly states "ontology" might come to be "just another word for colonialism" if the dynamics between Indigenous ways-of-knowing-in-being and post-humanisms go unmarked and unchallenged: namely the ways in which claims of "newness" often risk subsuming or suturing over ways of relating to the other-than- and more-than-human world that have been thought and practiced since time immemorial (see Bang & Marin 2015; Tuck 2010; Watts 2013; see also Higgins 2017; Zembylas 2018).

   However, and significantly, there remains some points of resonance worth critically inhabiting (even if, as Kuokkanen [2007] suggests, that many theorists of deconstruction are heavily invested in Western modernity's ontological tradition and trajectory):

   > Deconstruction is the decentralization and decolonization of European thought… Hence, deconstruction is a deconstruction of the concept, the authority, and the assumed primacy of the category of "the West." (McKinley & Aikenhead 2005, 902)

   In turn, and in learning to speak with ghosts, this work situates itself within the growing body of scholarship which attempts to productively labour these tensions (e.g., Nxumalo & Cedillo 2017; Rosiek, Snyder, & Pratt 2020; Zembylas, Bozalek, & Motala 2021).

   Furthermore, this text's multiplicitous use of footnotes takes seriously hauntological writing in that they are all traces of a main body of writing that either once was or could have been: they haunt from the margins as spectrally absent presences.
2. Significantly, for Derrida (1994/2006), "haunting is historical, to be sure, but it is not dated, it is never docilely given a date in the chain of presents, day after day, according to the instituted order of a calendar" (3). Such matters greatly in the context of settler colonialism: settler colonialism is not strictly a historical injustice located in the past but rather an ongoing event (Wolfe 1999; see also Tuck & Ree 2013; Tuck & Yang 2012). The ways in which "settler temporalities" (Rifkin 2017) produce time as a linear and unitary does not and cannot account for the ways in which pasts can be passed over for some while still very much felt by others. Further, the temporality of hauntings question the very possibility of a universal(ist) notion or enactment of time: it is always already *out-of-joint* (see Barad 2010; Derrida 1994/2006).
3. Elsewhere (Higgins 2021), I discuss in in much greater length the ways in which the relational ontologies put to work herein (e.g., Indigenous,

deconstructive post-humanisms) "caus[e] trouble for the very notion of 'from the beginning'" (Barad 2010, 245). Every "beginning" has already begun *elsewhere* and *elsewhen*: "it is not merely that the future and the past are not 'there' and never sit still, but that the present is not simply here-now" (Barad 2010, 244) This mantra of beginning some-where and some-time, repeated herein as well, serves first as a reminder that the *here-now* is entangled with a plurality of *there-thens* which are not only or strictly epistemological objects (e.g., historical or geographical facts) but are *hauntologically* co-constitutive of the here and the now. Secondly, it suggests that science education is always already within the question of Indigenous science in science education. Thirdly, it presents plurality as asset rather than liability: there is a multiplicity of productive locations from which to "begin" (re)opening the ability to respond, while recognizing that some are more productive than others.

4. Significantly, the spectral never fully belongs to the realm of knowledge (as conventionally understood). As Derrida (1994/2006) suggests,

> One does not know: not out of ignorance, but because this non-object, this non-present present, this being-there of an absent or departed one no longer belongs to knowledge. At least no longer to that which one thinks one knows by the name of knowledge. (5)

5. Nonetheless, there are moments in which it can pinned to individuals and their actions. In the earlier aforementioned ghostly visitation of nutritional experimentation, we can trace the proliferation of ghosts to two men: Dr Percy Moore, the Indian Affairs Branch Superintendent of Medical Services, and Dr Frederick Tisdall, a famous nutritionist who went on to co-develop Pablum (infant cereal) in the 1930s. That said, the localizing of the act does not act as ward against the ways in which responsibility multiply and circulate beyond the legal-juridicial sense—haunting settler science education.
6. If we also take seriously the notion that "knowledge, once it is defined, taught and used as a 'thing made', is dead" (Ellsworth 2005, 1), and the ways that science education remains largely the patching together of such sedimented and stuck knowledges, such a séance also speaks to the work of (re)animating the corpse of science (whose death continues to be refused and mourned): "exorcism conjures away the evil in ways that are also irrational, using magical, mysterious, even mystifying practices" (Derrida 1994/2006, 59).
7. In her particle physics work, Barad provides empirical evidence of hauntings through quantum field theory. As Barad (2012) suggests us in *What is the measure of nothingness?*, nothingness is itself a ghostly doing that is marked

by spectral non/being, by possibility and potentiality. This is even the case for what is classically understood as "pure" nothingness: the vacuum of space. As she states,

> From the point of view of classical physics, the vacuum has no matter and no energy. But the quantum principle of ontological indeterminacy calls the existence of such a zero-energy, zero-matter state into question, or rather, makes it into a question with no decidable answer. Not a settled matter, or rather, no matter. And if the energy of the vacuum is not determinably zero, it isn't determinably empty. (8–9)

Rather than this determinability being a question of epistemological uncertainty, it is one of ontological indeterminacy, "the indeterminacy of *being/non-being, a ghostly non/existence*" (Barad 2012, 12, emphasis in original). Even the smallest of particles vacillates between being a something and a nothing. This ghostly non/existence is co-constituted and co-constituting a plurality of other particles and particles-to-come. As she states, "even the smallest bits of matter are an enormous multitude. Each 'individual' is more up of all possible histories of virtual intra-actions with all Others. Indeterminacy is an un/doing of identity that unsettles the very foundation of non/being" (15).

8. Significantly, this de-subjectification was not without ghosts (see Higgins & Tolbert 2018). One of the most emblematic men of science whose ways-of-being-scientific continues to be used as a mould for what it means to become scientist in the contemporary moment was a spiritualist: Isaac Newton—first man of science, last man of magic (see Prirogine & Stengers 1984; Stengers 2001). As spirituality, or anything supernatural such as spirits or ghosts, often becomes a site of refusal or negation of Indigenous ways-of-living-with-nature (see Marker 2006), this past passed over haunts science education as spirituality cannot be so easily disentangled from Indigenous science (see Cajete 1994).
9. Here, the lower case is intentional to denote difference from the capitalized form which is meant to politically recognize peoples who have been and continue displaced and dispossessed through (settler) colonialism.

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