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## Thinking Post-developmental Pedagogies with Physical Activity Pedagogical Resources—Or, How Might We Entangle Pedagogies and Physiological Knowledges Differently?

Nicole Land

School of Early Childhood Studies, Ryerson University

nland@ryerson.ca

### Abstract

Thinking with a Canadian physical activity pedagogical resource, this article proposes that post-developmental early childhood education pedagogies can engage with physiological sciences beyond the instructive or instrumental relationships currently facilitated by contemporary physical activity pedagogies. To begin, I bring feminist science studies together with post-developmental pedagogies to detail how pedagogy and physiology become intertwined. I trace the tensions of weaving physiological knowledges with pedagogies, acknowledging the power-laden complexities of thinking with Euro-Western sciences in Canadian education. Finally, I work through two propositions aimed at making physiological knowledges differently entangled with the complexities of post-developmental pedagogies: (1) crafting physiological knowledges as a problem with pedagogies, while (2) deploying these physiological knowledges as pedagogical provocations that call us to engage differently with physiological knowledges.

### Keywords

Post-developmental pedagogies, physiological knowledges, feminist science studies, physical education

### Introduction

This article proposes that post-developmental early childhood education pedagogies can engage with physiological sciences in an effort to unsettle the hegemonic stability of predominant physical activity pedagogies that are underpinned by scientific epistemologies. I organize my argument in two primary movements that echo the intentions of early childhood education post-developmental pedagogies to both trace existing educational trajectories (the beginning section) and orient toward inventing speculative, situated responses to complex worlds (the concluding section) (Nxumalo, Vintimilla, and Nelson 2018; Vintimilla and Pacini-Ketchabaw 2020). I situate this paper within the context of thinking with post-developmental pedagogies (Land 2020; Land et al. 2020; Pacini-Ketchabaw, Kind, and Kocher 2016), which are pedagogies that propose relations that engage with children beyond the linear, age- and stage-based, normalizing logics of child development (Burman 2016; Moss 2016; Pacini-Ketchabaw, Nxumalo, Kocher, Elliot and Sanchez 2015) in Canadian early childhood education. I do this because early childhood education is a space where scientific knowledges entangle with pedagogical practices through various concerns, including, for example, health, nutrition, and physical activity. Further, because post-developmental pedagogies work to resist the universalizing, instrumental tendencies of developmental theories by offering situated, local, tentative responses to inherited educational structures, I focus on one physiology-informed curricular resource relevant to early childhood education in Canada. Throughout the article, my central argument is that taking physiological knowledges to account with post-developmental pedagogies entangles physiology with the ethical and political concerns of post-developmental early childhood education, thus working physiological knowledges to account with pedagogical questions, tensions, and answerabilities that complexify the epistemic structures that typically govern scientific knowledges in early childhood education. I hope that the propositions this article offers will open space for generating locally meaningful experiments in weaving pedagogies with physiologies differently in other contexts.

I begin by discussing how physiology, as a powerful Euro-Western knowledge, perpetuates colonial epistemic hierarchies and maintains neoliberal conceptions of normative, individualized “health.” Digging into how physiological sciences, practices of mainstream physical education, and early childhood education pedagogies become entangled in contemporary Euro-Western worlds, I turn to a Canadian physical activity pedagogical resource, the *Canadian 24-Hour Movement Guidelines for Children and Youth developed by the* Healthy Active Living and Obesity Group (HALO) of the Children’s Hospital of Eastern Ontario (CHEO) Research Institute, the Canadian Society for Exercise Physiology (CSEP), ParticipACTION, The Conference Board of Canada, and the Public Health Agency of Canada. While each organization provides public access to these Guidelines (hereafter referred to as “the *Guidelines*”), in this article I will refer to the version of the *Guidelines* shared on the Canadian Society for Exercise Physiology website(2016a). The *Guidelines* function as a document created for educators, professionals, and guardians that shares information on the intensity, type, and duration of physical activity recommended for children. I trace how physiology and pedagogy become intertwined in this resource and detail how these physiology-pedagogy entanglements enable specific educational practices.

In the second part of the article, I put forward one attempt at working a physiological knowledge—excess post-exercise oxygen consumption (or EPOC)—differently with early childhood education pedagogies. Briefly, excess post-exercise oxygen consumption is an exercise science theory that alleges that once a bout of exercise is complete, a human body continues to “burn” calories to restore the body to its original resting state. Following Angela Willey, a feminist science studies scholar, I formulate a partial “vision of what it might look like to politicize scientific knowledge production in a way that allows for an answerability, an accountability, beyond the realm of internal critique that science as we know it lacks” (2016, 14). I think with EPOC as one physiological knowledge that underpins the *Canadian 24-Hour Movement Guidelines for Children and Youth*. Translating Willey’s (2016) proposition into early childhood education, early childhood education pedagogies can engage, think, and ask questions *with* EPOC beyond the interpretative or instrumental frames that typically inform how pedagogies and physiology converse. I work through two propositions that bring post-developmental pedagogies and physiological knowledges together in an unfamiliar way: (1) crafting physiological knowledges as a problem with pedagogies, while (2) deploying these physiological knowledges as pedagogical provocations that might create different possibilities for engaging with physiological knowledges in early childhood education. Throughout this article, I make the necessary contractions of my work public, as I detail my situated, small intervention into how specific physiological knowledges become entangled with specific pedagogical practices in Euro-Western Canada. I want to imagine an educational practice where we (those who actively participate in pedagogies: researchers, educators, children, families) make physiology differently answerable to the multiple critiques that nourish post-developmental education while creating differently accountable practices of relating with physiological knowledges.

### Physiology and Pedagogies: CSEP’s Movement Guidelines for Children and Youth

Pedagogical resources that tout physical activity recommendations, outline physical literacy programming, and detail the necessity of educating young children in healthy nutrition habits are increasingly prevalent in Canadian early childhood education. These include the *Canadian 24-Hour Movement Guidelines for Children* *and Youth* (CSEP, 2016a), *Healthy Opportunities for Preschoolers* by Temple and Preece (2007), and *Healthy Beginnings for Preschoolers 2–5* from the Chronic Disease Prevention Alliance of Canada (n.d.). The *Guidelines* contain four core recommendations: sweat, step, sleep, and sit. Related to physical activity, the sweat guideline outlines how long children should be highly active (“an accumulation of at least 60 minutes per day of moderate to vigorous physical activity” [2]), while the step category details additional required physical activity (“several hours of a variety of structured and unstructured light physical activities” [2]). The guidelines note that children and youth should follow these recommendations “for optimal health benefits” (2). Targeted toward younger children, CSEP’s *Physical Activity Guidelines for the Early Years* (n.d.) detail physical activity recommendations for toddlers, setting the developmentally rooted groundwork for the *Guidelines’* prescriptions for moderate to vigorous physical activity by recommending “progression toward at least 60 minutes of energetic play by 5 years of age” (para. 1). The intended audience for the *Guidelines* includes educators, practitioners, and guardians. Rooted in a developmental perspective of childhood, where growth and skill development are assessed against a “healthy” or “typical” norm and are universalizable across various children’s bodies, the *Guidelines* are intended to provide a reference for early childhood curriculum and policy. While none of these documents explicitly refer to EPOC in their public-facing literature, the assertion that EPOC is desirable and happens in concert with vigorous (high energy, demanding) exercise (or play) is one of the many physiological knowledges that underpins these guidelines.

### Detailing Physiology as a Euro-Western Knowledge

Physiology—as one knowledge production apparatus of Euro-Western settler colonial epistemic hegemony (Haraway and Subramaniam 2021; Lyons et al. 2017; McKittrick 2021; Roy and Subramaniam 2016; Sanabria 2016; TallBear 2013; Willey 2016)—is the science of how a living body functions. I think with physiology in this article because it is a core knowledge that informs mainstream physical education pedagogy. As a Euro-Western knowledge system, physiology sustains a specific scheme of bodied regulation. Physiology is utilized to dictate criteria for normative and legitimate bodied subjectivity, which translates into governmental constructions of citizenship and personhood, which can be achieved through individualized predictable, quantifiable behaviors (Guthman 2013; Herndon 2005; Kendrick 2011). Physiology often matters as a tool of governance, owing to histories and present inheritances of settler colonialism that perpetuate Euro-Western beliefs about knowledge hierarchies as they create ranking systems that place (what is uncontestably understood to be) rational, objective scientific knowledges as the most contemporary, leading-edge form of knowledge. Historically, this “true” knowledge of physiology was utilized to govern bodies and subjectivities, as ethnographic methods grounded in physiological “truths” informed how Indigenous, Black, brown, Asian, disabled, queer, and lower-class bodies were classified as aberrant, unhealthy, unintelligent, and in need of intervention or control (Briggs 2003; Fausto-Sterling 2000; Haraway 1990; Harding 1994, 2016). Such a history is not over; physiology and the body heralded by mainstream science remain a mechanism of structural governance.

While an exhaustive survey of the myriad methods that physiology utilizes as a tool of centering Euro-Western knowledges and subjectivities is beyond the scope of this article, taking inspiration from many outlines of how science unfurls itself as a technique of governance (Haraway 2013; Harding 2006; LeBesco 2011; Whitt 2009), a summary would proceed as follows: physiology functions amid truth-driven ontologies by making biochemical agencies and flesh visible in strategic, quantifiable ways (for example, lean muscle mass), which are then classified as normative or pathological based on Euro-Western state-endorsed understandings of race, health, function, and disease (lean = healthy), which then translates into socially sanctioned criteria for subjecthood and bodied legitimacy (people with lean bodies are desirable citizens). These ongoing familiar, but differently lived, arrangements of knowledge, bodies, pathologization, individuation, and desirability create a recursive system, where physiology makes visible a biochemical mechanism or measure as consequential (lean muscle mass), thus sustaining the need for physiological inquiry in order to ensure the optimal normative functioning of said mechanism (we need to fully understand lean muscle mass physiologically, to ensure more people can work toward gaining lean muscle mass).

In Canada, Euro-Western epistemological traditions, physiology, and other structures that center whiteness as normative overlap to enact settler colonial oppressions targeting Indigenous and minoritized communities (Allan and Smylie 2015; Reading and Wien 2013; Smylie and Firestone 2015). This leads to a multitude of physiology-validated (and sustaining) intrusions, including interventions promoting “healthy” physical activity, which act as thinly veiled tools of reasserting settler valuations of bodied legitimacy, desirability, and citizenship (Rice 2016; Russell, 2020; Ward, Beausoliel, and Heath 2017). Physiological evaluations of “healthy” or “ideal” bodies position (male, physically able) white settler bodies as a “normative” benchmark. This supposed ideal designates non-“normal” bodies as less legitimate and less desirable, thus lending a science-based rationale to the historical and ongoing systemic oppression—murder, genocide, slavery, sterilization, relocation, erasure, program and funding disparities—faced by Indigenous Peoples, immigrants, refugees, and people of color. Physiology has been utilized to abstract ancestry to blood quantum, to rob reproductive agency based on skin color, and to maintain the validity of race-based genetic predispositions to what is perceived as moral failing or bodied weakness, such as epidemiological ethnic vulnerability to obesity, anemia, or substance use. In the particular context of thinking childhoods, physiology intersects with child development to dictate “healthy” trajectories of growth and to shape children’s relations with their bodies toward achieving an “ideal” normative body (Burrows and Wright 2007). This is why thinking with how we engage physiology in the context of Canadian early childhood education matters: physiology is a non-innocent knowledge with highly impactful lived consequences.

One site where these consequences of physiology become lived in education is in physical activity or movement curriculum. As McKay, Gore, and Kirk (2012) argue, physical education resources increasingly integrate scientific insights in an attempt to legitimize physical activity teaching as “valid” amid colonial constructions of scholarly knowledge, thus centering the Euro-Western scientific knowledge that holds great power and ubiquity. Azzarito et al. (2017) contend that physical education curriculum obscures the complexities of moving bodies by ensuring that “specific bodies and identities in relation to the health discourse are normalized, celebrated, and legitimized in pedagogical settings (i.e., school PE) through many acts of reinforcement and reiteration” (2016, 7). Particular to Canadian early childhood education, physical activity pedagogical resources, including the *Guidelines*, enact the political consequences of physiology through their reiteration of a particular, normalizing response to the question, Who can the child be? Burrows and Wright (2020), following Harwood (2009), name these classed, gendered, ableist reiterations as biopedagogies: the pedagogical contours given to (normative, developmental, non-innocent) scientific knowledges as they become enacted in the name of health in education. The *Guidelines* participate in these reiterations as they center neoliberal conceptions of children as future citizens, personal responsibility, bodied legitimacy, and quantifiable educational attainment (Dahlberg and Moss 2004), and as declarations that early childhood education pedagogies must teach children the skills they need to be healthy or pedagogies that promote fundamental movement skills and fitness are crucial for children’s healthy development become wrapped in affirmations of morality, care, and teleological learning that make them risky to contest. For example, the CSEP (2016b) accompaniment to the *Guidelines* purports that reaching the recommended sixty minutes of activity can help children “improve their health,” “maintain a healthy body weight,” “do better in school,” “feel happier,” and “have fun playing with friends” (para. 13). These professed benefits invest in dominant developmental Euro-Western narratives of childhood as a period where children gain the skills they need to become successful and valued citizens within a neoliberal state (Azzarito 2009; Rich 2011). In turn, the guidelines strategically delimit the possibilities for thinking physical activity pedagogically because pedagogies must properly teach physical activity in order to produce healthy children.

When physical education pedagogical resources are made indisputable by the assumed validity and efficacy of science-informed information, the background knowledges and practices that sustain their unquestionability are recursively bolstered. Complex material-discursive enactments (Barad 2007) of health, fitness, children, and teaching are framed as fixed, true, and common educational touchstones. The vast, lively, and deeply contestable knowledge-generating practices that underlie these pedagogies, including the physiological sciences that bolster mainstream conceptions of health and fitness, cannot easily become an accessible or worthy concern for pedagogical practice (Land and Danis 2016; Petherick and Beausoleil 2016; Rich 2011). If posed, questions of why children should participate in prescribed physical activities are answered with a gesture toward evidence-based research, coupled with an assumption that the ontological supremacy of the scientific canon negates any critical impulse.

#### Concealing How Physiology Entangles with Pedagogies

By curating the foundational features of physical activity pedagogies that can become subject to pedagogical purview, dominant physical education pedagogies ensure their educational authority and secure the dominance of settler-colonial onto-epistemological paradigms. When pedagogical resources are framed as well-founded and incontestable dictates (“optimal health benefits” can be achieved by following the *Guidelines*), debating the (physiological, ontological, ethical) principles that underpin their content becomes unnecessary. This constructed certainty, whereby it is the curriculum, recommendation, or practice and not the composition of that curricular formation that is made to be perceptible, in turn, brackets the possibilities for critically engaging these pedagogies. Foundational investigations and the scientific knowledges they produce are silently woven through the guidelines. Gestures in the form of citations are made to background studies but each study’s particular conceptualizations, assumptions, borders, outcomes, and affordances are not centered beyond their utilization as evidence toward the veracity of the *Guidelines.* While perhaps enacted in the name of (patronizing) accessibility, any overt attention to making public the epistemological mechanisms that give the *Guidelines* the gravity they are habituated to assume is not present (ex: Timmons, Naylor, and Pfeiffer 2007; Tremblay, Shephard, and Brawley 2007). In highlighting this making invisible (or, making untouchable) of the messy, imperfect, lively bioscientific knowledges that underpin many predominant physical education and movement teaching approaches, I am focusing on how physiological sciences are not put at risk, and especially not beyond the conventional tools science employs to critique itself (validity, reliability, methodology), in how pedagogical resources typically engage with physiology.

There are a multitude of very important human-centered social justice critiques that make visible how these pedagogies are complicit in race, gender, fat, ability, and socioeconomic privilege-based oppression (Azzarito, 2009; Dagkas and Hunter 2015; Flintoff, Dowling, and Fitzgerald 2015; Hylton 2015). For example, Laura Azzarito (2009) details how high school physical education pedagogies systematically perpetuate gendered and racialized constructions of ideal “fit” and “healthy” bodies. Douglas and Halas (2013) outline how post-secondary institutions center white, Euro-Western physical education researchers, which translates into a wealth of knowledge built of white, Euro-Western epistemologies, ontologies, and research biases. Analyzing physical education curriculum, Flintoff, Dowling, and Fitzgerald (2015) trace how curriculum policies conceal white privilege and Euro-Western knowledges into seemingly universalized, normative discourses of health and fitness. These are very important critiques. With my more explicit focus on complexifying physiology-pedagogy entanglements, I want to emphasize that by making only certain human-centered concerns accessible for critique, current methods for integrating physiology with pedagogies strategically conceal other contestable features of these pedagogies. This delimits the pedagogical possibilities for thinking movement, muscles, fitness, fat, and physiology critically and creatively.

What if we foreground the foundational onto-epistemological assumptions, practices, and knowledges that underpin physical activity pedagogies? The violent histories of decisions justified by science, the Euro-Western epistemological hierarchies that position science as objective or universalizable, the contemporary structures that produce and are produced by science as dominant knowledge—what happens when we commit to engaging science as a practice of both inheriting and hoping with pedagogies? Willey proposes that “when we claim sciences, instead of ‘engaging’ them, the terrain shifts from one of how un/friendly feminists are to Science to one of what a world of sciences has to offer, where so much is at stake” (2016, 146). Reading Willey’s argument with early childhood education pedagogies, to do the work of “claiming” sciences proposes that, in our pedagogical work, we might engage differently (tending to knowledge politics, ethics, consequences) with physiological knowledges, and contest science’s onto-epistemological projects, by intentionally noticing physiological knowledges as a lively pedagogical participant. I propose that refusing to let scientific assumptions hide behind physical education pedagogical resources might become a method for claiming, infiltrating, and taking to account how physiological knowledges entangle in problematic and productive ways with early childhood education pedagogies.

The *Guidelines* do not, in the form distributed to practitioners, make clear the physiology that serves as the foundation for the recommendations. While it should be noted that the *Guideline Development Report for the Canadian 24-Hour Movement Guidelines for Children and Youth* by CSEP (2016b) is mentioned once in the preamble, in the *Guideline*s points like “an accumulation of at least 60 minutes per day of moderate to vigorous physical activity” (2) are abstracted from the scientific customs that materialize their perceptibility. If the messiness behind this understanding of movement is concealed, the vulnerabilities it might hold are also made irrelevant to pedagogical concern. This allows for certain questions to become possible: Who decides what counts as energetic play? How does this assessment devalue other forms of movement? How are gender, sex, race, ability, body size, access, and other power disparities addressed or perpetuated when “moderate to vigorous” physical activity is recommended? While these questions are critical and important, the *Guidelines* make differently complex questions less accessible: What scientific practices facilitate this temporal frame of sixty minutes? What physiological conceptions make this “vigorous” intensity matter, and how do these metabolic activities become imbricated in meaning-making practices? What ways of getting to know movement are made imperceptible by the epistemic power afforded to physiology? If I do put stock in a recommendation for moderate to vigorous physical activity, how might the physiological foundations of this recommendation—and the knowledges, bodies, and consequences they engender—mesh with my pedagogical intentions?

#### Intervening with/in Physiology

Taking physiology to account with pedagogies, I confront singular, authoritative, and non-complex/complexifiable assertions of dominant physiological sciences as they matter in pedagogical resources and work to engage these knowledges beyond their claims to certainty. This article is certainly not the only project intervening with/in physiology. Feminist interventions in Euro-Western science on an ontological level take up the practices of contemporary sciences (Barad 2007; Frost 2016; Mol 2002; Roy 2007; Youdell 2017), arguing that science dis/invites critical engagements with interdisciplinary knowledges that unsettle the seemingly-unquestionable interpretative inevitability that Euro-Western sciences have come to bank on – and make bank from (Haraway 2016; Kirby 2013 McKittrick 2021; Roy 2018; Stengers 2010; Wilson 2015). There are modes of living physiologies that refuse to lend physiology or the Euro-Western ontologies it compels a single breath Stengers 2011): Métis scholar Zoe Todd (2014) examines human-fish relationships to detail how fish can be engaged within expansive relational frameworks lived by Indigenous Peoples in Arctic Canada; Banu Subramaniam (2014) writes with flowers, tracing how her practices of plant physiology intertwine with different disciplines and gendered dynamics across India and America; vaginas are a site of Kanien'keha:ka refusal with Emily Coon (2020), who thinks flesh beyond colonial gendered narratives of reproduction; and Kim TallBear (2013) theorizes genomic knowledges with Indigenous sciences and relationalities. From the biosciences come a multitude of feminist methodologies of doing science otherwise: tracing metabolisms (Landecker 2011, 2013); heart feminism (Pollock 2015); thinking fetal development as transdisciplinary relationality (Yoshizawa 2016); and imagining epigenetics as obesity entanglements (Warin et al. 2015). Physiologists craft publications that contradict what the field once took to be true, troubling the underpinnings of the field they have pledged to sustain. Feminist art interventions refigure what it is to live fleshed lives when physiology matters, as, for example, Sabrina Benaim (2017) writes poems made in the traffic of serotonin that animates her depression.

As I work to rethink how early childhood education pedagogies can engage with physiology, I can know, and this article can take up, some of these interventions in physiology. Other alternative possibilities for physiologies, flesh, and life remain necessarily imperceptible to my work. I take this unevenly perceptible critical engagement as a making-real of Willey’s plea to “recognize the importance of proliferating sciences (and not consolidating epistemic authority) to anti-imperial projects of worlding” (2016, 145). Without grandiose claims, I offer my work up to other projects that critique science from a variety of ontological, epistemological, and methodological places, with the hope of working alongside them in this massive project of unsettling colonial hegemonies of Euro-Western science.

### Post-Developmental Pedagogies and Physiological Knowledges

Following from critical reconceptualist early years scholarship that has extricated pedagogy from universalized scientific evidence-based prescription (Cannella 1997; Dahlberg, Moss, and Pence 2013; Kessler and Swadener 1992; MacNaughton 2000), post-developmental early childhood education orients toward pedagogies concerned with urgently inheriting the present complexities of contemporary worlds with children (Blaise 2013; Taguchi 2011; Rautio and Jokinen 2015; Pacini-Ketchabaw and Blaise 2021; Taylor and Pacini-Ketchabaw 2015). Post-developmental conceptualizations of childhood begin from an appreciation of how stage-based theories of development, which claim that children reach adulthood through a series of universalized developmental milestones, privilege Euro-Western ontological and epistemological systems (Burman 2016; Dahlberg and Moss 2004; MacNaughton 2003). By constructing both childhood and development as common, linear, predictable, and stable experiences, scholars concerned with creating post-developmental pedagogies argue that Euro-Western developmental theories allow for precisely targeted education practices, which service settler colonial conceptions of citizenship, individualized responsibility, and productivity (Land et al. 2020; Pacini-Ketchabaw, Nxumalo, and Rowan 2014; Pacini-Ketchabaw and Taylor 2015). Alternative understandings of childhood or education are devalued and silenced by developmental narratives (Blaise, 2014), which, in a global and settler colonial context, leads to the imposition of Euro-Western “normative” expectations of childhood upon diverse children (Blaise 2005; Cannella and Viruru 2004; Nxumalo and Adair 2019).

Post-developmental pedagogies contend that education, childhood, and development are ongoing and plural, and made through different practices, epistemologies, and ontologies (Blaise, Hamm, and Iorio 2017; Pacini-Ketchabaw, Kind, and Kocher 2016; Rautio 2013). The post-developmental theorizing that I draw upon positions education as a specifically politicized, non-anthropocentric and humanism-refusing endeavor (Iorio et al. 2017; Nxumalo 2018; Olsson 2012; Taylor 2020). In contrast to the stable human-centered conceptions of education facilitated by developmentalism, post-developmental scholars maintain that pedagogy, childhood, bodies, and learning unfold with a multitude of human, material, and more-than-human actants (Land and Todorovic, 2020; MacRae 2019; Nelson, Pacini-Ketchabaw, and Nxumalo 2018; Pacini-Ketchabaw, Kind, and Kocher 2016; Rautio 2017). Postdevelopmental scholars dissolve developmental constructions of gender (Blaise 2005), literacy (Nxumalo 2017), movement (Hackett and Rautio 2019), neurons (Taguchi 2016), everyday scientific concepts such as force (de Frietas and Palmer 2016), and individualized responsibility (Taylor 2017) into complex, entangled, intentional, always ongoing pedagogical negotiations—living knowledges (Vintimilla, Pacini-Ketchabaw, and Land 2021)—composed and responded with in situated collisions of children, adults, and place-based actants.

Physiology, and the physiological knowledges that enable developmental logics, can serve as rich sites of intervention for post-developmental pedagogies. Bringing post-developmental pedagogies’ insights toward my discussion of how physiology and pedagogies do, and might, become entangled, I argue that predominant relationships between physiology and pedagogies, such as those in the *Guidelines*, can be reconfigured. When universalized physical activity recommendations lose their utility because the developmental assumptions underpinning them are made, to borrow from Haraway (2016), unthinkable, then inherited physiological knowledges do not need to be buried under taken-for-granted curricula and sciences do not need to be ascribed the explanatory power they are accustomed to.

#### Doing Physiological Knowledges with Post-developmental Pedagogies

I experiment with two propositions for bringing physiological knowledges and pedagogies into unfamiliar, critical conversation: (1) taking physiological knowledges as a problem *with* pedagogy; while (2) generating pedagogical propositions wherein pedagogies might engage differently with physiological knowledges. I begin by detailing a physiological knowledge that participates in recommendations for physical activity intensity, excess post-exercise oxygen consumption (EPOC). I think with EPOC as a resource, selected due to its insidious presence in many physical activity guidelines, including the *Canadian 24-Hour Movement Guidelines for Children and Youth*. I do not claim that EPOC is the only or the most important physiological knowledge that participates in the *Guidelines* —it is one physiological knowledge that matters. Further, EPOC as a physiological knowledge is quite interesting to grapple with pedagogically, as it raises questions of temporality, exchange, and debt.

#### Meeting EPOC

“Oxygen debt,” “after burn,” and “raised metabolism” are some of the names EPOC colloquially introduces itself with. EPOC is a loyal product of exercise physiology and is dedicated to theories of movement that understand biochemical energy as a system of carefully regulated and bounded consumption, exchange, and production. EPOC logics, alongside many other physiological knowledges, lurk beneath recommendations for moderate to vigorous physical activity intensity. Oxygen debt needs to be earned, EPOC will tell us, by vigorous physical activity; it is the result of exercise work to exhaustion, muscled work that taxes aerobic energy systems and dips into anaerobic reserves when we feel our lungs scream (Børsheim and Bahr 2003; DeLorey, Kowalchuk, and Paterson 2003). The harder you work, the more EPOC you can earn (Crommett and Kinzey 2004; LaForgia, Withers, and Gore 2006; Yano, Yunoki, and Ogata 2003). When we work our bodies via contracting our muscles, EPOC knows that we utilize metabolic substrates at the site of muscle contraction to the point of depletion, that lactate is generated as a by-product of muscled work, and that body temperature spikes as an outcome of our effort—and, that these disturbances must be righted to maintain equilibrium, to restore homeostasis (McArdle, Katch, and Katch 2006). EPOC realizes itself as the period where these disruptions are righted, where although our body has stalled its intentional, bounded bout of vigorous physical activity, a tremendous amount of oxygen is required to re-craft muscular energy stores, to oxidize lactate, and to compensate for an increased body temperature. Here is where EPOC plays its hero card: this post-exercise oxygen deficit, this need to shuttle oxygen throughout the body to repair cells and replenish energy stores even after you finish exercising, also taxes the body—it dips into fat stores and burns calories after you have ceased purposeful physical activity (Dorado, Sanchis-Moysi, and Calbet 2004; Gaesser and Brooks 1984). And EPOC might posit, isn’t burning bonus calories an interesting wrinkle in the quest to treat obesity and promote health and fitness?

#### EPOC as a Problem *with* Pedagogy

To pose physiological knowledges as a problem with post-developmental pedagogies, I invoke a specific conception of what it is to problematize or what it means to take as a problem. *How* might I make EPOC a problem with post-developmental pedagogies? I understand that post-developmental pedagogies are always a practice, a labor, a doing (Hodgins 2014; Pacini-Ketchabaw, Kind, and Kocher 2016; Taylor 2017). Stengers, a feminist science studies scholar, emphasizes that “connections are something that must be created…this is the only way of succeeding in creating problems rather than receiving them readymade” (2008, 9). Bringing Stengers together with post-developmental pedagogies, I make—enact, deploy, do—pedagogies with/in my intentional practices of creating EPOC as a problem with post-developmental pedagogies. Importantly, I do not want to create problems for the sake of problems. I need to generate “problems that are not to be solved but problems that need a different response” (St. Pierre, Jackson, and Mazzei 2016, 105)—problems that, as Stengers stresses “give to the situation the power to make us think” (2005, 185). I need to generate knotted problems that cut across the ontological disjunctures of physiological knowledges and post-developmental pedagogies, and that reconfigure how post-developmental pedagogies can engage with physiological knowledges.

##### Pedagogical problems of response with EPOC

EPOC engenders a logic of response: the harder an agential human exercises their muscles, the greater the demand on metabolic resources within muscles, more resources are consumed and must be regenerated, and thus a greater EPOC is created. I might see this as an EPOC physiology of response, one loyal to a physiological knowledge of dose-response relationships (Altshuler 1981). EPOC as response enacts a physiological knowledge where stimuli interject in a body in a specific dose and the body then responds in a measured manner, predictably appropriate to the magnitude of the stimulus. Taking response EPOC physiological knowledges as a problem with pedagogy is to confront the ways this notion of response cuts across pedagogical practice: How is the “response” practiced by EPOC im/perceptible to the ways of being responsive we nurture with pedagogies?

Returning to the *Guidelines* to generate pedagogical problems with EPOC response logic, I need to trace the various “responses” privileged in the pedagogy this document advances. EPOC and vigorous physical activity use a teleological, positivist, and predictable logic of response that captures response as a stable pattern—the harder you work, the more EPOC you generate. EPOC, as a concept for getting to know the body, extends into the *Guidelines* through both the recommendations made (sixty minutes of vigorous activity a day for the most healthy bodied response) and the pedagogical practices that the *Guidelines* profess. I can borrow from post-developmental pedagogies that refuse a conception of curricular interactions located in linear or predictable logic (Olsson 2012; Pacini-Ketchabaw 2010) to take this straightforward assumption of responsivity as a problem of being accountable for the different modes of responding I create with pedagogy: How can I craft pedagogies that are hospitable to, practice, and can be interrupted by the methods and modes of responding that I value? How can I think with modes of responding imperceptible to dominant settler-colonial paradigms?

Post-developmental pedagogies also adopt experimental modes of responsivity, including response-ability (Haraway 2016, thinking collectively (Instone and Taylor 2016), (re)storying (Hodgins 2014), or thinking diffractively (Davies 2014). Post-developmental responsivity is not a singular bounded, stable pattern. With EPOC dose-response logic, I can generate problems of response multiplicity: if I understand that pedagogical interactions are non-linear, and therefore refute or complexify the “easy” pedagogical recommendation of prescribing activity intensity, but I do invest in EPOC as a relevant knowledge, what modes of responding do the pedagogies I participate in make possible because of the ways that these pedagogies expect cells, lungs, bodies, and children to respond (differently—or similarly)? If EPOC response-logic matters to contemporary health discourses and generating local modes of responding with children matter, how can I take up the messy spaces between answerability, invention, and dose-response relationships?

##### Pedagogical problems of transaction with EPOC

Transactional logic animates another EPOC physiology. EPOC is made visible as the exchange of oxygen for the release of stored muscular energy, as cellular metabolic substrates swap for muscular contraction and oxygen trades back to replenish muscled energy reserves (McArdle, Katch, and Katch 2006). EPOC as transaction begets a specific problem of the kinds of transactions that are made perceptible with pedagogies: How do EPOC transactions matter with pedagogical modes of exchange?

EPOC employs a transactional logic that roots children’s motion, caloric deficit, and aerobic health in a metabolic transactionality reflective of modern economic systems—and, as Rosi Braidotti (2013) and Hannah Landecker (2013) assert, anxieties—where physical activity is exchanged for measurable health and development outcomes. In the *Guidelines* and their accompaniments, this transactionality is demonstrated in statements such as “children who get 60 minutes of moderate-to-vigorous physical activity per day are stronger, more confident, and less stressed” (ParticipACTION 2017). This is an easy, straightforward transactionality that, when taken with post-developmental pedagogies that attend to how pedagogy is ongoing (Taguchi 2011), generates questions of transaction coherence: (How) can I reconcile or integrate linear conceptions of bodied metabolic transactions with an understanding of curricular exchange that is fragmented and non-linear? What is required of my pedagogy to hold different (or similar) conceptions of transactionality for different scales of exchange (educator-child, cellular)? How might I think with modes of transactionality that disrupt the assumed linearity and commodification of exchange within Euro-Western logics?

EPOC also adopts a transactionality that confronts temporality, as it locates caloric deficits in the future (vigorous physical activity *now* leads to an increase in calorie-burning *later*). I can use post-developmental pedagogies to confront this temporal imperative and attend to the multitude of temporalities that reconfigure pedagogical practice (Farquhar 2016; Myers 2016; Pacini-Ketchabaw and Kummen 2016). With post-developmental practices that cultivate an attention to the present and detail the dangers of imposing future-oriented logic upon early childhood education (Holmes and Jones 2016; Olsson 2012; Blaise, Hamm, and Iorio 2017), I can generate problems of transactional logic: When pedagogies locate children’s aerobic activity as a transaction that enables future calorie burning, what kinds of movement, bodies, and learning do these pedagogies create? How do pedagogies that are underpinned by the metabolic consumption of calories-to-come mesh with my pedagogical values? How does pedagogy do exchange(s) in early childhood education?

The “how” of making EPOC a generative problem with pedagogy is always partial and I have offered here two potential means of EPOC-problem-ing with post-developmental pedagogies. There are, I hope, a multitude of additional problems that EPOC poses with pedagogies, which might include problems of homeostasis (what does the assumption of equilibrium do with pedagogies?), agency (who makes/enacts/does EPOC?), veracity (how is EPOC contested from within physiology?), or difference (how does EPOC do difference?).

#### Generating Pedagogical Provocations to Think Differently with Physiological Knowledges

After working two EPOC physiological knowledges into problems with post-developmental pedagogies, I turn toward generating pedagogical provocations wherein pedagogies might engage differently with physiological knowledges. Post-developmental pedagogies detail how thinking pedagogically is the work of continually (re)crafting meaning and meaning-making practices (Nxumalo 2017; Rautio 2017) because of the answerabilities and accountabilities that participants in a pedagogical entanglement demand from one another (Nxumalo, Vintimilla, and Nelson 2018). Post-developmental pedagogies are situated and responsive. They actively refuse didactic application and universalization, but this refusal is one of speculating, of gesturing toward what might happen when we think with children about how to answer to our inheritances, debts, and relations in the name of living well together. This parallels Haraway (1988, 2016) and Willey’s (2016) concern with the ethical accountabilities of scientific knowledge production and echoes Stengers’s contention that “the ‘how’ is a question which exposes, which puts at risk, those who are obliged…. [and] only these people can take the risk of putting experimental change into the formulation of their obligations, because only they are exposed by the question” (2005, 192). In the context of the pedagogical work I am proposing, these feminist science studies insights mean that generating pedagogical provocations is a question of answerability because different bodies are differently accountable to different problems, provocations, and pedagogies. Post-developmental pedagogies act on these accountabilities by creating pedagogical spaces, questions, and conditions that demand that those involved in the unfolding of a pedagogy confront the tensions and imperfections that tug at the borders of that pedagogy (Early Childhood Pedagogies Collaboratory, n.d.). Provocations intentionally put ideas, knowledges, people, and practices at risk because of how these actants entangle with the pedagogies that underpin or animate a provocation. I want to craft provocations that draw physiological knowledges into differently answerable partial pedagogical entanglements; into questions that demand we think carefully about how we might engage with physiological knowledges and pedagogies in order to create different tensions and openings for re-inventing how physiologies and post-developmental pedagogies can entangle in ways that activate our pedagogical intentions, politics, and ethics.

##### Pedagogical provocations of responsivity

In taking EPOC response physiological knowledges as a problem for pedagogies, I wondered how EPOC might spawn problems of responsivity with pedagogy: How is the “response” practiced by EPOC im/perceptible to the responsivenesses of pedagogy*?* With post-developmental pedagogies, which make a habit of problematizing discourses that allow for the easy translation of one state/knowledge/practice into another in planned, bounded, and future-oriented ways, I can remind EPOC of the violences inherent in such linearity: When we understand our flesh or pedagogies as predictably responsive, what possibilities for pedagogy are made possible? This is a *provocation of wondering the responsivities that animate pedagogies*, of tracing multiple modes of co-extensive relational response and entanglement. What happens when I intentionally attend to how responding/responses happen in the education spaces I participate in? How do Euro-Western conceptions of response entangle with my pedagogical habits in both obvious and inadvertent ways? Where do physiological or EPOC notions of dose-response logic interject in my, and children’s, movements, engagements with flesh, or other methods of responding—and how might I, or do I, want to confront these methods of responding? This might work to unsettle EPOC certainties and make visible the tensions in trying to contain possible modes of response that interject in early childhood education practice.

Returning to the *Guidelines*, ParticipACTION (2016) shares a package of resources designed for educators to utilize with children as they incorporate the *Guidelines* into their daily activities). These include coloring pages, matching games, and a certificate of achievement, which intend to evoke a specific kind of pedagogical response. As a pedagogical provocation that takes up the problems that predictable pedagogical response-logics make with pedagogies, I wonder how these resources might make visible non-linear, non-human-centered methods of responding: How can these resources be engaged pedagogically while intentionally decentering the belief that these resources draw a predictable, universalizable, or controllable response from the children and other participants/materials/agencies that engage with these? How else can we *respond with* coloring pages, complexifying the responses that these resources assume? How might different material analyses, ontologies of “health,” epistemologies of education, diverse lived experiences, or constructions of childhood generate different possibilities for responding with these normative resources? Perhaps this provocation might upset the bounded, curated responsivity that these resources enact, and make predictable response-logic visible as only one potential method of responding with/in post-developmental physical activity pedagogies.

##### Pedagogical provocations of transactionality

Posing EPOC’s transactional logic as a problem with pedagogy, I asked how EPOC transactions might matter with pedagogical modes of exchange*.* Thinking with post-developmental pedagogies, I can take up the im/perceptibility of economic/metabolic transactional logic, tracing where this logic emerges in children’s everyday engagements and where it intrudes into encounters. This is *a provocation of attending to transactions*, of making visible how the specific exchange-mode of EPOC physiological knowledges might contradict post-developmental pedagogies-informed methods of exchange. EPOC articulates an ethic of exchange grounded in a specific future-oriented temporality. With post-developmental pedagogies, I can ask what might be required to frame flesh as in pursuit of a future utopic (“healthy”) state—what must be possible for EPOC and the *Guidelines* to locate physical activity amid a futurities framework? Post-developmental pedagogies oriented toward productivity (Taguchi, Palmer, and Gustafsson 2016; Pacini-Ketchabaw, Kind, and Kocher 2016) lend resources for asking what the ethical implications of centering a physiological knowledge that creates oxygen deficits to burn future calories might be: this is a *provocation of complexifying how, or if, movement matters as a transaction*. The resources for educators (ParticipACTION 2016) detail sixty “sweat” activities that educators can use to promote sweaty vigorous physical activity, including “chase a fairy,” “run from zombies,” “shoot hoops,” “sword fight a pirate,” “chase the boys,” “escape prison,” and “chase the girls.” From pedagogies that take movement as unpredictably generative (Jackson 2016; Manning 2014; Rotas 2015), I know that movement does far more than displace a body in space or fulfill recommendations for physical activity. I wonder how these suggested “sweat” activities might be engaged for the “transactions” they invite. What if I intentionally do not conceptualize these movement activities within a vigorous physical activity/EPOC frame of transaction, and instead follow how these activities generate exchange(s) that do or do not mesh with my pedagogical intentions? Perhaps this provocation might hold to account the idea of moving as propagating oxygen absences or promoting normative health, while opening space to trace how debts, surpluses, exchanges, and transactionalities are made, multiply and momentarily, with post-developmental pedagogies.

### Towards a *Why* for Doing Physiological Knowledges Differently with Pedagogies

In mainstream early childhood education in Canada, physiology often matters as physical activity guidelines, nutrition recommendations, and normative developmental dictates. This is not to say that physiology is a special site of engagement or governance or resistance in early childhood education, only that it is a force that demands to be reckoned with. I have argued that post-developmental pedagogies can work physiological knowledges toward a complex pedagogical answerability and I have explored one possible strategy for how pedagogies can confront the physiological knowledges that matter to early childhood education. My practice of crafting problems with pedagogies while deploying provocations aimed at demanding a different answerability of physiological knowledges is always partial, necessarily contestable, and vulnerable to both unsettling and re-centering the dominant forms of knowledge I work to complexify.

Echoing Stengers, I believe that we need pedagogical innovations that take up physiological knowledge(s) “as it diverges, that is, feeling its borders, experimenting with the questions which practitioners may accept as relevant, even if they are not their own questions” (2005, 184). Taking physiological knowledges to account with post-developmental pedagogies exposes physiology to the critical terrain of post-developmental early childhood education, thus working physiological knowledges to account with pedagogical concerns, innovations, and answerabilities that differ from the benchmarks that sciences are typically held to in settler-colonial education spaces. Within much larger, incredibly diverse projects of dismantling the dominance of colonial epistemologies, perhaps weaving physiological knowledges with post-developmental pedagogies might function as an imperfect and situated intervention toward unsettling dominant hierarchies of scientific knowledge while confronting some governing practices of making flesh perceptible in early childhood education.

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### Author Bio

**Nicole Land** is an assistant professor in the School of Early Childhood Studies at Ryerson University. In collaboration with educators and young children, her research works to create and sustain situated post-developmental pedagogies that take seriously children’s complex relations with fats, muscles, physiologies, and movement.