EDUCATING IN A MULTISPECIES WORLD

by

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Abstract

The widespread deterioration of our planet's life support system is a global challenge facing humanity. This dissertation is based on the premise that changing course requires fundamentally reconstructing how we think about humans and the rest of nature. If a sustainable course requires that we see ourselves as members of an ever-evolving biotic community, then we will have to abandon ways of thinking and acting that distort a sense of continuity between our species and others, replacing kinship with radical separation. Insofar as education is concerned with human learning processes while considering learning in other species as irrelevant or nonexistent, it institutionalizes and perpetuates attitudes that prevent us from reintegrating back into our web of relations. These attitudes are no longer biologically, philosophically, or ethically warranted. They do not keep up with the extent of our empirical and theoretical progress beyond thinking in terms of metaphysical dualisms. To evolve a better discipline, I claim that we must ecologize education; we must dare to imagine and enact an interspecies pedagogy. In the seven papers that follow, I draw from various philosophical, scientific and pedagogical sources to trace pathways into interspecies pedagogy and I try to overcome some of the ways my culturally-informed biases have blocked me from taking the concept seriously. The papers are diverse but they also overlap, showing the process by which I have worked to develop a theoretical alternative that erases
the line between education and biology. As such, this publication fits within the larger
"posthumanist" shift occurring variously throughout the university. My partial solutions and
explorations are admittedly situated and contextual. However, I hope that they can help those
who suffer similar blockages as I do to feel more viscerally that the world around them is
responsive, attentive, and worthy of pedagogical consideration, and that the range of human
affairs treating the biological world as but scenery set behind the great human story is as
miseducative for other species as it is for us, and in need of a swift dismantling.
Acknowledgements

My daily life is burst open by the presence of countless creatures that are difficult to acknowledge in academic writing without seeming either starry-eyed or deliberately confrontational. Nevertheless, it is simply a fact that everything from the brief encounters to the sustained relationships I've developed with nonhumans over these many years have had a profound impact on the evolution of my thoughts as presented here.

This thesis would also not have been possible without the support of many of my own species along the way. I am in particular gratitude to the following people for insights, discussions, criticisms, and support: Liz, Dick, and Morad Affifi, Guy Allen, Nora Bateson, Lauren Bialystok, Sean Blenkinsop, Eric Bredo, Luis Bruni, Sarah Cashmore, Lucie Cermakova, Kimberley Chan, John Currie, Michael Derby, Nigora Erkaeva, Leesa Fawcett, David Greenwood, Ryan Hall, Susan Hall, Peter Harries-Jones, Mark Hathaway, Jesper Hoffmeyer, Filip Jaros, Richard Kahn, Gary Knowles, Rick Kool, Pete Kosa, Sasha Manes, Sarah Martens, Rebecca Martusevicz, Joren McCormack, Jennifer O'Reilly, Antoinette Oberg, Philip Payne, Sophavanh Phommixay, Laura Piersol, Heather Read, Jean-Paul Restoule, Montana Salvoni, Jan Sapp, Sean Smith, Erin Stanley, Anh-Thi Tang, Evan Thompson, Ann Valentin, Denis Walsh, and Anthony Weston. Six families, the Kamels, the McCormacks, the Phommixays, the Reids, the Reeves, and the Sai Nyais, were crucial support throughout. Sophavanh endured the cycles of freneticism and despondency that seem to sometimes accompany my creative process, supporting and encouraging me with her calm attention and loving faith.
Finally, it is impossible to deny that the most significant event inflecting my thesis process in countless known and unknown ways was the death of both of my parents. Not only did they both die during the “doctoral candidate” stage of my program, I was also the primary caregiver for both of them. This consumed much of my time at different points along the journey, and compelled me to restrict my involvement in many “grad school” opportunities, such as research assistantships, teaching assistant positions, and even possibly instructor positions. I had to make cuts somewhere, and I decided that on the hierarchy, reading and writing would be the last things that I should limit, though there were certainly various periods when these both suffered as well. However, there is nothing apologetic in these comments. The depth of intimacy that death solicits, how it confronts one with life and its meaning in the starkest terms, and the general reorientation that one thereby undergoes, have a profound lateral impact on all of one’s activities. A certain generosity of spirit has come to shape my process in all its stages through the gifts that my parents provided me up to and including their passage out of life and time. Pain and love are both great filters, prioritizing things when there is too much noise. Many of the values (fears) that graduate student advisors implanted in me early on, about the dismal prospects of employment and the cut-throat competitiveness required to play the academic game, were really given a powerful antidote by the bone-shaking transformation that my family was given to endure, which allowed me to focus on what I really cared about. As a result, I feel like I managed to retain (most of) my integrity despite half a decade of reminders about the bleak uncertainty and PR compromises one would have to make to stay afloat in the field. I could pursue my research freely, hand in hand with “time” itself, with the beauty and the sadness that are inherently a
part of its very structure, and its constant reminder that the moments we have are there but to pass away, that the world is perhaps far more serious and far less serious than we give it credit for, and that either way, surrendering to this impermanence can give rise to a broader love of both the joy and pain it provides and a more graceful acceptance of the process.
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Introduction

Have you ever been stunned into silence by a squirrel? Fixed in place by its fixed gaze? Why should the experience of perceiving another being perceiving me be so disabling? And so wonderfully profound? Is it the impenetrable mystery of being seen -right now- by another? By an other? Or is it the dizzying loop that opens up between us as we see each other see each other? Perhaps it is that sudden awareness that the world is full of sentience, that around me are countless creatures feeling my presence while I take them for granted. Or maybe it is the burst of excitement and fear that through this experience each of us will modulate, in however consequential a way, each other’s possible future? Is it simply the suspense of not knowing what either of us is going to do next? Why did we stop in each other's tracks in the first place?

For millennia, people have pondered the fact that the world is watching itself through their eyes. That the world can organize itself into such a configuration that it can perceive itself is indeed shocking and worthy of contemplation, but that it can create meetings -meaningful encounters- between parts of itself leaves me much more dumbfounded. So many feelings are birthed through encountering another and the relationships that come out of such encounters: excitement, shyness, curiosity, play, self-consciousness, love, desire, loneliness, empathy, admiration, grief. The range of ways a human can feel multiplies through the stereoscope of encountering another, enriching experience, while the interactive potential of the universe is vastly opened up by such encounters, which were made possible by biological evolution while at the same time contributing to it.
Between the sensate biochemistries of grass blades underfoot and the embrace of a
mother and her son, lies an immense terrain filled with indeterminacy and surprise, the
biosphere lunging forward in all its evolving manifestations, produced at each moment by all
those encounters between beings perceiving and interpreting one another, and responding in
turn. Whether or not some of these beings interpret each other "as" others, and all the other
intriguing questions we may ask through linguistically mediating the experience, can have a
destructive underbelly when they pull us away and distract us from the fact that we are
entangled in the creation of the world. Favouring such a philosophical approach *a priori* is a
product of what Dewey calls "the spectator view," an approach predicated on the assumption
that knowing in its highest form involves establishing an outside perspective rather than
being a way of actively participating in the world. Perhaps the world is not, as Nietzsche
imagined it, the playing out of a musical box, absolutely necessary or determined (1974, p.
168). Perhaps it is such that whatever happens now sets the stage for what will happen next,
so that novelty emerges out of novelty even as parts organize into more or less mechanical
relations. Nor would the organism be, therefore, the mere performance of a genetically
determined tune, given that the way a gene behaves is continually adjusted in response to
how that being experiences its environment - and therefore us, as long as we are in it.

Evolution and learning, the two great creative processes on Earth, turn out to be
remarkably intertwined, each affecting the possibilities of the other. The capacity to learn
surely evolved, but learning thereafter affects evolution (and surely the evolution of learning
itself) in a number of ways. To name a few: learned behaviour can modify an organism's
environment and therefore its selection pressures; it can modify another organism's
environment and therefore that organism's selection pressures; it can modify the likelihood that the organism itself will persist and reproduce; it can alter the context and therefore expression of the organism's genetic materials; and it can also change the way in which the organism raises its young. New learned behaviour can also feed into each of these processes by altering the significance or usage of previously learned behaviour. Each of these adjustments can alter the course of evolution. Organisms have "species typical" behaviour to be sure, but they also stand open before their worlds, ready to learn, ready to change, ready to contribute to the refashioning of the crust of planet we call home. And we sit in the midst of it, able to ponder scattered fragments of these giant nesting dynamics, and feel the honour, the responsibility, and even the danger of being implicated in their outcome.

This dissertation consists of seven published papers exploring different aspects of *interspecies pedagogy*, a pedagogy committed to understanding, appreciating, and improving these relations that we sit in the midst of. Chances are you have had an experience similar to the one I had with the squirrel. And yet, if you are like me, the moment was probably cut short by a conceptual scheme that crept in and dismissed the experience. To recover the possibilities of such encounters, in the papers to follow I strive to free a number of concepts, including communication, learning, intelligence, interpretation, pedagogy, and education from their conventional uses so that they are no longer exclusive to humans and exclusionist against the remaining biosphere. The result is a theoretical exploration seeking to redefine "education" and related concepts, so that we humans may be able to interact more sensitively in all our relations. I am not claiming that these words mean exactly the same thing for a
squirrel as they do for a human. The suggestion is rather that because of the common origins, needs, and structures of all life, there is likely considerable overlap across the biosphere not currently acknowledged by our institutional boundaries. Generalizing educational concepts to embrace the biological world means neither replacing scientific knowledge with anthropomorphic naivety nor performing some sort of sociobiological reduction. Such approaches fail to restore any true sensitivity to other organisms precisely because they attempt to collapse all distinctions into either the category of the "mechanical" or the "human." Paying closer attention to emerging insights in the biological sciences, from botany to ethology, can generate a fruitful continuity between humans and the rest of life and with it the responsiveness and openness helpful for meaningful pedagogical encounter.

If biologists are increasingly discovering that organisms are not preprogrammed, by their genes, instincts, or prior experiences (as is argued in the approaches compiled by Oyama, Griffiths, and Gray (2001)) and are, to whatever degree, indeterminate and self-determining, growing through interpreting and responding to the circumstances they face, then the empirical data we gain from studying life may be influenced by how we study and engage with biological systems in the first place. The reflexive turn taken in the social sciences is required in the biological sciences as well. This pulls the biologist toward what people call “second-order" cybernetic thinking, or the attempt to understand how systems change through the participation of the observer within them. Transitioning from the “spectator view” of the subject to that of a “participant” means the progressive realization that further empirical results in one’s field of study do not merely indicate features of the organism(s) alone, or in the abstract, but specific ways that beings are growing in contexts
that may also include those interactions that occur with a human inquirer. And the conclusion of this line of thought is that if we really want to know what an organism "is," we will want to know of what it is capable, and this means studying it in a way that enables it to most richly and diversely explore its possibilities for growth. In this vein, biology becomes educational.

In addition to reframing biology as a subject to something closer to a biology of subjects (as Evernden would call it (1985)), an increased sensitivity to those furry, feathered, and verdant learners around us requires an educational shift for our human students too, with a sustained focus on developing activities in and out of the classroom, restructuring learning environments, fostering new styles of writing and speaking, and ways of paying attention, so that we can teach and learn from them meaningfully without it being mere metaphor, framed in condescending scare quotes or implausible romanticization. Since the focus in this dissertation is primarily theoretical, I have not explored such practical elements adequately in the pages that follow and hope to experiment in developing such approaches alongside students in the future. It is my opinion that all school subjects in the future will need to become increasingly attentive to our being situated in evolving, ecological communities, and will need to also develop specific educational practices to mutually engage given that we are immersed in living processes that change, that change because of us, and where we hold some responsibility for the changes that ensue. I also believe that the importance of such a shift in emphasis would reach well beyond the classroom. Technologies, risk assessments, infrastructure and building design, and resource extraction all would need to undergo
significant changes if people understood other living beings as active and responsive beings, growing and participating in the growth of those around them.

Because each paper has its own introduction and conclusion, and because I prefer to keep some surprises for the reader (a pedagogical choice, for better or worse), I will resist laying out the contents of these seven papers here. However, I will describe some general observations now that I can look back on them. As a theoretical exploration of interspecies pedagogy, a number of philosophical themes resurface continuously throughout the papers. The most common of these are my attempts to get beyond several dualisms. As mentioned, the most prominent of these is the assumption that education is something that goes on between humans, with the rest of the world’s organisms treated essentially as machines whose mindedness lies outside of any meaningful pedagogical consideration. However, there are others. I continually struggle with whether the world is deterministic and every one of my papers tries to pry open the possibility of there being, well, possibilities. The time I have spent thinking about this is surely some sort of self-medicating, ongoing attempts to pull myself out of Laplacean biases that continue to hold me down. "It is a mischievous notion that we come late into nature; that the world was finished a long time ago," said Emerson (p. 54, 2000). But in an evolutionary universe, what functions as a cause appears to be emergent rather than preordained. The hopeful suggestion that new beginnings are possible, that humans need not play out the destructive story that is coming to dominate the narrative of our species, does not mean that we should simply replace a mechanistic worldview with a premechanistic one that assumes the will or the heart or the soul is "the cause" of whatever
change that may come about. The assumption that our minds are the loci of our actions is simultaneously contributing to two hubristic attitudes: that autonomous humans have the right to willfully reorganize an otherwise mechanical world, and that we can steer away from our unsustainable course merely by "willing" it. My interpretation of interspecies pedagogy adopts an ecological perspective that sees new causal interactions as the processes and products of evolving relationships. It makes more sense to see humans and their environments as mutually co-constituting one another in some sort of feedback relation. The dualism separating cause and effect into two different ontological categories is thereby challenged by the ecological worldview that sees a cause as simply the effect of an earlier event, an effect which now shapes the context for the next round of interactions.

Interspecies pedagogy has also led me to try and blur the rigid, categorical boundaries that are commonly drawn between teacher and student, culture and nature, animal and plant, animate and inanimate, theory and practice, and form and content. It is undoubtedly because I am so concerned with the impact of dualistic thinking that I have been attracted to the ecological approaches found in pragmatism, cybernetics, systems theory, biosemiotics, and (some interpretations of) evolutionary thinking in general. What all these approaches share is a desire to do away with metaphysical dualism, but not in the way that eliminative materialists or radical cultural idealists do, where they accept the division set out by dualist thinking and proceed to identify with one side by slandering the other. Often both sides have something of value and the real work is figuring how they got torn apart conceptually (and then materially) and in what ways they can get re-stitched back together again. This means a search for continuity, a search for how seemingly diverse elements and forms emerge
homologously from common processes, highlighting the deep kinships upon which our differences are grounded. I suppose I have spent some effort on this re-stitching, though with inconsistent success.

The ecological way of seeing the ongoing mutual constitution of organism and environment could be called “interactionism” (or, as Dewey eventually called it, "transactionalism"). Interactionist thinking predates the ecological sciences, and yet is committed to the intuitions brought forth in them. Interactionism sees mind and matter, humans and nature, self and other, as dialectically related through ongoing feedback such that the role of each is constituted by the other through relationship. While it affirms that humans (and other organisms) act, actions are always also reactions to what the organism has just undergone. In this sense, interactionists might reject the idea of simply assigning "the cause" of the ecological crisis to humans, and might prefer to consider how the "cause" (and whatever solution(s) we come up with) is itself a type of ecological system distributed across organisms, ways of thinking, material structures, and social systems. Interactionist thinking, while deeply ecological, is itself rejected by many environmental educators who do not feel comfortable giving up the idea that the ecological crisis was brought about through human (and typically a subset of power-holding human) abuse. Because the interactionist argument invites the reflection that all technology, every clear cut forest, all greed and error, and the plastic in the oceans, are all ultimately the same sorts of recursive organism-environment systems as those that have created the grace of a flower or the intricate vivacity of a coral reef, environmentalists may consider it dangerous. It can be seen as a variation on the oft heard “Well, if everything that humans do is a part of nature, then our destroying it is natural
and maybe this is what is supposed to happen.” While I also find this sort of quasi-
theological resignation offensive (it is, after all, a combination of divine predestination and
original sin), I do not think that we improve our position by reclaiming a human-nature
dualism as some sort of weapon against it. This is move is counterproductive because our
ecological problems are to a great extent the consequence of believing in such ontologically
secure dualisms in the first place, or to be more specific, a product of the ecological
interactions that occur between organism and environment when the human organism acts on
the basis of such problematic premises. Rather, I believe that an interspecies pedagogy must
place our species firmly back into the natural world without assuming that this gives us carte
blanche for its rampant destruction. I suggest that it is only through realizing that our
destructive tendencies are processes and products of larger, ecological feedback systems, that
we are likely to have the humility to analyze the situation thoroughly and perhaps come up
with solutions more viable than educating people to “be the change.” Likewise, from an
interactionist perspective, a term like "the Anthropocene" perpetuates the very sort of
dualistic thinking that we need to abandon. An interactionist perspective assumes that a great
deal of our problems are rooted in the way the world ends up organized physically, socially,
and conceptually so as to (re)produce similar sort of problems over and over again. While
personal transformation may remain one goal of education, the broader and more significant
goal is to uncover ways in which people can become more able and proficient at considering
the effects of their larger structural conditions, social and otherwise, and modifying them
accordingly. This does not mean that we can or should expect to predict what all our effects
may be and act on them accordingly. Where the effects are vast and intractable, we may need
to restructure our conditions so that we are made more aware of our limitations. What pedagogical design choices would a house builder make, for example, if the goal was to invite its users into the bigger -and mysterious- set of relations of which it is a part?

I assume that new beginnings are possible. It is possible that the richest and most mutually fruitful ways of interacting with other organisms are only in the ‘seed’ stage right now, or have long disappeared from the world and are now awaiting rediscovery. This does not mean that progress, on some level or the other, has not sometimes been made. Many relationship with other species draw out possibilities for further development of those involved. And everything from “owning” a pet to feeding finches can be, some sense, a developing system, in the sense that the relationship is interactional and therefore mutually constitutive and evolutionary. A horse trainer, with decades of experience and perhaps apprenticeship from those with decades still more, will without a doubt be deeply aware of levels and nuances of interaction and of the subtle reciprocity between him or herself and the horse. The relationship is evolutionary and can become sensitive and collaborative. But this does not mean that richer ways of doing interspecies pedagogy need follow the lead set out by the horse trainer. Indeed it is possible that the trainer is optimizing a set of relationships through a long history of co-learning that has limitations set out by purposes by which the human defines the interaction. It is possible that co-establishing new premises for the relationship with the same dedication and “sweat equity” would produce entirely different ways of relating with a horse, perhaps more pedagogically “appropriate” too, depending on our evolving understanding of these terms. We can foster some methodological agnosticism and assume a pluralistic attitude is most fitting for interspecies pedagogies. Our past
successes, however impressive, may just be local optima on what complexity theorists call "a fitness landscape." While a system is converging on (without ever reaching) an "optimal" way of doing things, it is only a local peak in a larger landscape, and there may be higher peaks that are not accessible precisely because the system remains set up to converge on that local peak.

"Landscapes and trees have nothing to teach me," Socrates tells us, "only the people in the city can do that" (Plato, 1995, p. 6). And the same pedagogical fracture persists two and a half millennia later. Interspecies pedagogy, as developed here, is seen as one possible way of restoring some continuity to our understanding of human and nonhuman life, and some methodological continuity between education and the biological sciences. This does not imply that interspecies pedagogy needs to be grounded in a reconceptualization of the human-nature split, or that it is the only way of undertaking such a reconceptualization in educational theory or practice. Indeed, interspecies pedagogy could and ought to develop along many lines, with each providing a different lens into the interactions. For example, it seems likely that dialogical approaches seeking to enrich the experience of encounter as developed by Buber will be invaluable complementary explorations to the present studies (see Blenkinsop, 2005). Perhaps closely akin to this are approaches that strive to develop empathy and care in pedagogical relationships. I also see that place-based pedagogies (critical and otherwise), as well as some reframings offered by the "new materialists" and the posthumanists can also ground educative relations in a larger more-than-human community. Disability theorists, feminists, and queer theorists may also have something to offer, especially in how they consider voice, representation, and participation. That I have not
explored these approaches here should not be taken to mean that they will not be useful to me at some future time nor be useful for others. The objects of my intellectual love affairs more closely indicate the therapies for the particular challenges I have faced at various stages of my dissertation. I also acknowledge that traditional knowledge and practices of Indigenous People across the world have often enacted rich and diverse ways of engaging with nonhumans, and that some of these have been respecting other species as their teachers for as long as they can remember. It is my hope that these varied approaches can find ways to engage with one another.

On the other hand, philosophers of education, such as my thesis supervisor, Eric Bredo (1994), have been instrumental in helping identify where and why dualisms latent in education theory have been destructive and how they might be best remedied, without developing any concepts related to interspecies pedagogy. These philosophers are working at healing the fractures from the other side. It is precisely because of this unique combination of counterpoint and harmony in our orientations, that I have been able to dialogue with Eric and fruitfully generate the ways of understanding articulated here. Through a multi-pronged and bidirectional effort, I believe it possible to reconstruct education. It may not be easy. We are on a dire trajectory that seems increasingly difficult to alter. However, my faith is secure in the fact that novelty is ever-present in the world and that it is unwise to assume that the future is laid out in the same cloth as the past. May education one day become a field of practices that sustain and nourish the possibilities of life on earth, with humans as defenders of its essential freedom and stewards of its ongoing flourishing!
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CHAPTER 1: What Weston’s Spider and my Shorebirds might mean for Bateson’s Mind: Some Educational Wanderings in Interspecies Curricula.

Abstract

Education has institutionalized a process that not only perpetuates cultures but also establishes ecological communities and ultimately evolution itself. This enclosure has lessened our sensitivity to the pedagogical (eteragogical) nature of our lived relations with other people and with other living beings. By acknowledging that learning and teaching go on between species humans can regain an eteragogical sense of the interspecies curricula within which they exist. This article explores interspecies lived curricula through a selection of ideas from ecopragmatist, Anthony Weston, and cybernetician, Gregory Bateson, and through lived experiences with shorebirds of Lake Ontario. Some gulls and a tern teach the author to enrich and diversify rather than constrict the potentiality of the life beings involved. In so doing, being ecological and being educative become unified concepts.

L'éducation a institutionnalisé un processus qui n'a pas seulement réifié des cultures, mais qui a également établi des communautés écologiques et, finalement, l'évolution elle-même. Cette enceinte a diminué la sensibilité de la nature pédagogique (éteragogique) de nos relations vécues avec d'autres personnes et avec les autres êtres vivants. Si on reconnaît l'enseignement et l'apprentissage qui se passe entre toutes les espèces, les humains peuvent retrouver un sens éteragogique dans les interactions curriculaires inter-espèces au sein desquelles ils existent. Cet article méandre au sein du curricula vivant inter-espèces par l'exploration d'une sélection d'idées de l'ecopragmatist Anthony Weston, et du cybernétiqien Gregory Bateson, et à travers les expériences vécues avec des oiseaux de rivage du Lac
Ontario. Grâce à l'apprentissage de quelques mouettes et d'une sterne, l'auteur enrichisse et diversifi plutôt que resserre la potentialité des êtres vivants en cause. Ce faisant, être écologique et éducatif deviennent des concepts unifiés.

**A Gull One Morning**

I settle down on a picnic bench close by a swaying willow near the shore of Lake Ontario. The sun is only just beginning to trace its arc across the peaceful, summer waters. I close my eyes to listen more clearly to the different sounds around me. As my ears become accustomed to the soundscape, a dialogue between the gulls to my left drifts into my attention. Their beautiful, haunting calls often stir emotions that connect me to my childhood. But today, their speech unhinges from this association and takes on new meaning. I feel them acutely as voices, uttered not for my nostalgic soul, but for the demands that they themselves have to communicate. The longer I listen, the more certain it seems to me that this conversation is not merely mechanical, nor dismissible as merely instinctual, but is driven by felt need and satisfied through encounter. A gull calls out to another, affirming both the existence and importance of a being other than him or herself, and its need for relationship. Everywhere around me, beings are calling out for connection, for curiosity, for relationship.

I open my eyes. The colours are brighter and warmer and the atmosphere feels calm. On my right, a gull bobbles up, his bright white chest framed by his smooth grey wings. He cocks his head and points his eye directly at my face. I
angle my sight towards him. He jumps a few steps back. I turn my head away and glimpse out at the lake. He inches back towards me.

Some people consider gulls to be food-grubbing pests made dependent on us by our propensity to feed them. But I wonder: were I simply a “food dispenser” to him, would he so desire to approach me as I sat motionless, with my eyes closed? Wouldn’t I be more likely to feed him had I been holding a bag of bread, perhaps eating some potato chips, or at the very least, having my eyes open? Couldn’t it be that the very peculiarity of my action, its unexpectedness from the gull’s point of view of what humans usually do, is an intriguing call for him to approach me? And how does allowing or discounting this possibility impact our relationship?

**Hidden Curricula in Schools**

Many scholars have pointed to the pedagogically significant, unarticulated contextual dimension of school programming, sometimes called the “hidden curriculum” (Jackson, 1968; Snyder, 1971; Eisner, 1994). This term is often used to highlight aspects of school, textbook or teaching practices that either consciously or unwittingly serve the economic and political structures of the powerful elite. Neoliberalism may impose its contextual messages upon curriculum content (Apple, 1975; Giroux, 2001), but other racial, gendered (Margolis & Romero, 1998), and technological impositions (McLuhan, 1964) are similarly contributing to what is a multi-layered matrix of meanings. However, the hidden curriculum is not solely established by hegemonic forces because these contextual elements still need to be interpreted by those experiencing them, be it teachers, students or others (Sambell &
McDowell, 1998). The term "hidden curricula" emphasizes that there is unlikely to be a single, or even a finite and articulable set of “lessons” that can be excavated from the implicit contexts of educators’ messages.

Despite advances in understanding, revealing, and attending to social aspects of hidden curricula in classrooms (see, for example, Bowles & Gintis, 1976; Everhart, 1983; Willis, 1977), scrutiny of the relations that schools normalize with other living beings is only more recently being explored. Analyses of the hidden curriculum of human-animal relations in schools (such as discussion of animal objectification (Pedersen, 2004), dissection (Oakley 2009), or the anthropocentrism inherent in the school's almost exclusive use of computers and books (Bell, 1997)), are exciting developments in our struggle to wrestle culture from morally and ontologically naive human-centeredness. Many scholars link patterns of dominance promoting anthropocentrism to the same sources that reify racism, sexism, and classism (Kahn 2002, 2008; Selby, 1995; Russell & Bell, 2000). Humane education and ecopedagogy seek to rewrite curriculum on multiple levels, from the explicit content of lesson plans to implicit lessons learned from the cafeteria all the way to the school bus.

In the spirit of Indigenous People worldwide, scholars such as Fawcett (2000), McKay (2000), Oliver (1992), Dillard (1988), Abram (1996), Evernden (1985), Bell and Russell (2000), and countless ethologists, poets, and lovers of the world's myriad subjectivities, I will advance the concept of hidden curricula along a slightly different, yet complementary, line. As long as we consider the human/more-than-human relationship an issue to be addressed in our schools and for our students, the dualism between humans and other living beings is left intact. Education for humans still has hidden messages, one of
which surely is that education is for humans. To address the relationship between humans and other living beings completely, we must recognize that even the classroom is a learning space co-constituted by a larger field of relations. Opening to the notion that we continuously teach and learn from an audience of other living beings alters the way we interact with, see, understand and relate with them. This has important educational and ecological implications, and I hope to show how I now see they might be tied.

While humans are teaching and being taught by fellow humans, they are often being watched by non-human students who may be, ironically, paying much greater attention to them than those they intend to teach. Through his description of a classroom activity he sometimes engages in, Weston (2004) invites us to consider how a spider in a schoolroom is aware of us. He writes evocatively: my imagination whirls as I experience flashes of what it could mean to be me as observed by a spider. I feel a distinct sense that the spider’s being opens up a meaning or a previously unseen dimension into the space of the room. It is a startling experience because I have been trained to not consider it. I have scientifically or philosophically regarded the spider’s perspective as “inaccessible”, leading me to not reflect on it at all. This has led me to act as though the spider’s perspective doesn’t even exist. Nevertheless, the spider’s presence is important, and our relationship with her is educational not only for our human students, nor only for ourselves, but also for the spider herself. I must dedicate myself to exploring these dimly lit spaces and not let my epistemological frameworks lead my imagination to "retreat" (Armbruster, 1998) from the challenge. From its corner, the spider watches and interprets the space of the room along its own lines, birthing a parallel universe within which we play a part. Our very ignorance of her company is a part of
this part we play; were we conscious of the spider's presence or blithely unaware, our actions would differ, and would also be learned differently by this attentive watcher. A classroom is rarely, if ever, a uniquely human learning space, and part of de-anthropocentrizing the discipline of education is recognizing this.

Curricula Vitae

The institutionalization of education also enforces the cultural belief that education primarily or perhaps only occurs in recognized educational settings, such as a school, a training centre, or some other designated area. This separation has led modern culture to overemphasize the importance of schooling while devaluing the significance of out-of-school education. Education is more holistically integrated into traditional societies, where apprenticeship (of both skills and of attitudes) is a part of daily life (Lave & Wenger, 1991). Traditional societies reflect an awareness in practice of a cultural view that educators, following a line of thinkers after Dewey, have come to appreciate. Dewey (1916) recognized that humans learn more and teach more in their daily lives than they do in schools, and it is in these ways that cultures perpetuate themselves. The various ways living beings teach and learn from those around them through living their lives can be thought of as lived curricula or, literally, a curricula vitae. The school diverts people's attention from their curricula vitae by bifurcating experience into two domains: those where education occurs and those where it doesn't (Illich, 1971). As humans become less attuned to the educational dimension of their out-of-school lives, they hardly see that it is in these daily ways that they are responsible for

1 The term “curriculum vitae” has been used by Jardine (1998) differently, describing a curriculum that exudes “generativity, movement, liveliness, and difficulty” (p. 73) rather than actually being played out through the process of living. While his use is metaphoric, mine is literal.
reifying culture (Bowers, 1993). We then also become estranged from our interspecies educational development. Our lived curricula is co-involved with the curricula of countless humans, but it is also an educational domain co-constructed with "all our relations." Not just the shorebirds I visit, but our pets at home, the speckled touch-me-nots and chicory spattered with rain as I peddle past them, even the great willow that feels my feet press the soil with its roots burrowing underground, and the cows and chickens locked in our factories and the workers tending them, and the mysterious qalipu, whose age-old tracing across the continent is now broken and treacherous - all these beings, amongst uncounted others, are engaged in this wondrous interactive space, teaching and learning each other into a collaborated upon future. As I interpret it, a thread of Gregory Bateson’s work implies that these curricular relationships matter for the development and function of ecosystems: curricula vitae are ecological processes.

**Bateson’s Mind/Body Ecology**

Bateson (1972; 1979) challenged the predominant view that ecosystems are “biomachines” that can be understood merely as systems of material or energy exchange (Harries-Jones, 1995, p. 236). This mechanical metaphor drew from the Darwinian cultural shift that caused us to “exclude mind as an explanatory principle” (Bateson, 1979, p. 20) in evolution. Without discounting Darwinism, Bateson brought the mind back into ecosystems and evolution. Ecosystems emerge through living beings that do react purely to energy supply or energy availability (Bateson, 1972, p. 481), but who make decisions based on

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2 Bateson's "mind" is not necessarily conscious. For Bateson consciousness can, at most, operate as a part of mind, and is often a misleadingly linear arc in what is actually a circular, recursive system.
knowing, communicating, and learning. Thus ecosystems are great processes built up by exchanges of knowing, communicating, and learning.

We are capable of changing our understanding, often through taking a “bird’s eye view” of actions that we formerly engaged in without consideration. Thus living beings are capable of changing the context by which they know and learn. Life doesn’t simply learn, it also learns how to learn (and learns how to learn how to learn). Similarly, living beings don't simply teach, they also teach how to teach, with whatever contextual messages lying unaware to the learner forming hidden curricula. Bateson, borrowing from philosopher Bertrand Russell, calls these levels of learning “logical types” (Bateson, 1972, p. 279). Our decisions depend on the level of logical typing that we use to learn and interpret the situation. Based on interpretation and context, it is inherently non-mechanical. It is also ubiquitous among living beings. I have noticed that *Mimosa pudica* (sensitive plants) that grow along well-trodden paths are much less sensitive to touch than those just a few metres in from the brush of traffic. The plant does not just react to the stimulus, it also reacts to its evolving interpretation of the stimulus.

Bateson’s understanding undercuts the tendency to see mind as merely some ecological epiphenomenon, while scientists focus on reductionist explanation. Through learning we make and break habits, and re-enforce or disrupt patterns of activity and thought. Habits are not benign. Living beings physically re-make the world through habits, and it is in the world that organisms live, so “it is still habits which set the conditions for natural selection” (Bateson, 1979, p. 244). All living beings develop habits based on learning, habits which feed back into the world and in turn create the physical conditions of their future
habitat. It is this insight that led Bateson to famously declare that the “unit of selection” in evolution is “organism plus environment” (Bateson, 1972, p. 449), each linked together by "mind." Both ecosystems and evolution are co-constructed by cultural factors intermingling with biological ones, interacting recursively through the world and in time. Our developing sensitivity to how we teach and learn from other living things shapes the ecosystemic evolution that we co-construct as an interspecies community.

Through Bateson's insights, we can conceive of interspecies relations as educational affairs, and ecosystem development as the playing out of interspecies curricula. Although Bateson discovered elements of how mind/body circuits network themselves into ecosystems and was also clear as to what is toxic to them, he was always reluctant to bring about “solutions” for fear that they would set about inappropriate relations and destructive runaway feedback loops (M.C. Bateson 1972; G. Bateson, 1972, p. 440-447; Charlton, 2008). Because he was so sensitive to the recursive nature of ecological interaction, he knew that any solution could reverberate in dangerous, unanticipated ways.

**A Moment with a Tern**

I have learnt much from my interactions with the terns and gulls at the mouth of the Etobicoke Creek leading into Lake Ontario this summer. The gulls are less hesitant than the terns when humans approach, but both can eventually come to feel comfortable. I walk out onto the pier to watch them arcing above me, while terns occasionally plunge into the water for fish. The terns’ beautiful streamlined bodies, their sharp tails, wings and mouths, seem to suggest a symmetry and logic that is beyond human understanding. I am careful not to
stare at them, I worry that I may make them feel uncomfortable with an analytical gaze.

A tern is resting on the metal fence of the pier. It shifts positions continuously, unsure as to whether to fly away or to stay perched, watching me at every moment. I think he is male because he seems bigger than the two others poised beside him a few minutes ago. I read somewhere that male common terns are slightly larger than females.

I occasionally peek at him but mostly just stand there gazing out at the water, content that we both know that we are both here together. What a wonderful, overlooked feeling this is! Two beings, one larger, one smaller, one feathered, the other clothed, standing in the midmorning sun simply being aware each other. I feel him watch me. I glance back at him. He turns away. Now, his looks feel less fearful. He stands sturdily on the beam and watches me watch him.

A woman walks past us, earbuds in her ears. She pauses at the end of the pier to cast her eyes out at the softly cresting waves. The tern was a little too close to her as she marched by us and he flies off. With the space between us broken, I feel the loss of his being. The woman's presence entering our space was thunderous. A similarity opened up between me and the tern, fusing our interspecies gulf. We were connected now by our shared sense of the otherness.

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3 On reviewer commented that I may be "too mammalian" with my concern over whether or not my stare is perceived by the tern as "analytical." This may be so. However, at the time, this was the precaution and the rationale behind it. I suspect that it is as difficult to transcend my mammalian nature as it is to establish how non-mammalian beings feel about staring.
we felt from the woman. Riding my bicycle home, I see how intensely my whizzing wheels affect the birds and squirrels in their daily routine. Thanks to my visit with the tern, these interactions are heightened, and I wonder what sort of work we will have to do as a species to create new sorts of relationship that do not trigger instant apprehension.

Ecologically, it would certainly be significant. Were we careful and respectful wherever we tread, animals would be less frightened of us and would feel more comfortable or able to populate spaces that we have taken for our own. This sort of work might actually be a part of species saving: as humans expand their reach, most species run away. But there is only so far that they can run to, and all of the natural commons are splitting up and diminishing. By attending to the diverse species with time and care, we can develop understandings about our lives intersect. I have noticed that after a heavy rainfall, terns dive-bomb much less often, probably because they can’t see the fish in the water from the cloudy sediment in the river. What role does my own house play in this watershed and how is my tomato garden directly related to he who circles overhead?

Wherever we are, we can gain awareness of the interspecies curricula we are always a part of. How to do this certainly includes shutting off the bombardment of human created things that vie for our attention, such as iPods, televisions, advertisements, books, and computers. But it also requires that we simply spend more time directly involved with trying to interact with
the species around us in the most non-invasive ways possible. One way to develop perceptual ecology (Thomashow, 2002, p. 74-75) is to seek out intimacy and relationship.

The tern I stood with was clearly more interested in me than he was in the woman with the headphones. By being sensitive to him, I invited him to become more interested in me. This experience reveals the basic fact of our relatedness and invites the tern to consider our shared relationship. Its conception of what humans are, what the relationship between human and tern is, and also of what he himself is, have all shifted slightly by our meeting. To make this claim is not anthropomorphic, but it is anthropocentric to assume otherwise. And insofar as my actions and the terns actions have readjusted through this encounter, so has our ecosystem developed a new cadence of interspecies meaning.

**Weston’s Eco-Pragmatism**

The American pragmatic tradition, taken up by Weston, recognizes the systemic nature of ecosystems and the problem of recursion while providing interesting ways out of our ecological conundrum. As I explained, Bateson showed that learning relationships are ecological and ecological relationships are pedagogical (or, as I prefer, “eteragogical”).

“Being ecological” is, then, being educative in all our relations. As Dewey realized (1916), an educative experience opens up learners to further development and growth, while

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4 "Pedagogical" has etymological roots relating to leading or guiding children. “Etera” is Greek for “other” and eteragological is a term that can refer to the educational dimension we refer to as “pedagogy”, but with respect to not only children, but adults, other living beings, and also oneself.
miseducative experiences close them off, limit them and render them static. I have diverse relationships with those around me: humans, other animals, and other more-than-animal species. When I close off their potentiality, I am acting miseducatively, which is to say unecologically. Weston’s eco-pragmatic approach (1992; 1994; 1996; 2004), favours an opening up of possibilities instead of prescribing definitive solutions as an invitation for interspecies relationships not constructed upon preconceived understanding. We can use Weston’s pragmatism to live in the communicational, eteragological world that Bateson articulated. His interspecies etiquette provides an approach to entering interspecies curricula vitae responsively and enrichingly. He provides a way of linking Bateson’s ecological understanding to everyday action.

And according to Weston, we can begin right now. We do not need to be aware of the particular ways in which other species learn from us to begin learning from them. The very awareness that we are being attentively watched and that our actions are eteragical in the widest interspecies sense, is itself educational for us, as Weston (2004) demonstrated. We are led to an expanded view of our self as we feel how our size, motion, sounds, and manners may be experienced by those who watch us. For example, we can learn how attentively we must tread by considering how we are perceived and trying to feel it viscerally. Am I seen as mountainous, with the vibrations of my heavy body's every motion registered in soft legs of the spider with whom I share a floorboard? Or is the spider simply watching my lumbering presence with bemusement from above (as one anonymous reviewer suggested)? Exploring diverse conceptions of how we might be teaching other beings opens up possibilities of co-creating meaning. By recognizing that the spider's perceptual field is neither entirely hidden
nor entirely knowable, but as open as my own to discovery and connection, I can enter into
eteragogical relationships with it. Awareness of this teaches me, the spider’s curricula
becomes more complex while, at the same time, shifting the hue of my own.

Weston develops two concepts of particular value for the ecological reconstruction of
education that this paper advances. He calls a “self-validating reduction” (1996) the vicious
cyclical process whereby disvaluing something in the world contributes to the deterioration
or destruction of that thing, which consequently renders it much easier to further disvalue.
Consider a prairie that has lost some of its diverse flora and fauna, and is now seen as
impure, tainted, or degraded. Conceiving it as just a shadow of its former splendour, we are
much less likely to begin protecting it. A way out of this feedback loop is to commit to re-
imagining the ecosystem. It is clear that our current way of understanding it has funneled our
relations with it into a destructive, recursive nightmare. However, if we open up our minds to
the possibility that the prairie might still have more to offer our heads or hearts than we
know, that it is not something fixed or determined but rather a constellation of beings in a
process of growth and change, with meanings and relations and openings into the world
always a little bit hidden and enigmatic for us, then our approach to it shifts. In shifting, we
actually see new things and develop new relationships with the beings of the land and
become increasingly open to experiencing other novel things with it. Weston calls this

Sensitive educators often approach a new classroom with excitement that they will
meet all sorts of new people and that unexpected relations will develop. This attitude opens
up a classroom space where students feel comfortable in exploring themselves and each
other. Continued growth depends on the teacher’s ability to keep open this invitation so that students can feel comfortable and accepted throughout their processes of change. In interspecies relations, the situation is no different. What we can teach and learn from other species diminishes if we are not open to seeing them in unexpected and diverse ways. Weston’s “self-validating invitation” opens up the gate to experiencing eteragogical relationships with other living beings.

Though he didn’t explicitly address Bateson, Weston invites Bateson’s “mind” back into the world. Self-validation shows that appearance and reality, and mind and matter are not separable, but are interweaving processes irrevocably co-involved. Weston’s approach recognizes the recursive nature of our interactions and the dangers inherent in feedback loops that results from understanding things in limited ways. His solution is to create feedback loops that perpetuates possibility rather than certainty. Weston’s reason is similar to Bateson’s: erecting any definite principle or solution to counteract our short-sighted, anthropocentric culture is surely doomed because, despite our best intentions, any proposal is still informed by the toxic conceptual residues of our cultural context (Weston, 1992). The way out is to open up possibilities, to invite evolution and diversity back into the world, and to let the world create new relationships on its own. His eco-pragmatic approach refuses the path of “finding the solution” which caused so much fear for Bateson. The solution will evolve out of possibility and is not conditioned by the limited scope of human purpose and rationality. It is a stochastic process, like learning and like evolution as a whole. We provide the diversity, and evolution can “pluck the new from the random” (Bateson, 1979, p. 49). Humans as managers is an eteragogically sterile mode of being. We are teachers and learners
amongst a community of others. Our part in the interspecies curricula can support the regenerative capacity of our Earth.

**A New Lesson**

I come back to the pier in late September to visit the terns. There aren’t any, but I do meet one lone gull, sitting on the metal bar of the fence, not far from where I had been with the tern earlier. I admire her mottled grey and white coat and her calm posture. I approach her cautiously and stand several metres away.

“Hello, how are you?” The gull twitches her head and looks at me even more carefully than she had been.

“I don’t really know what to say to you.” I glance around to see if anybody is watching. There is a man in a mail truck looking over from the other side of the river. He probably thinks I am using a handless mobile phone.

“People probably think I am crazy trying to talk to you…” I move a little bit closer. “You know, it is so hard being a human in this time.” I think about how often I feel as though humans are “fallen” creatures, alienated from a deep magic and interconnection. My emotions while speaking as candidly as possible to this bird surprise me. I feel as though I am revealing myself, and I really hesitate to find the right words. My meaning seems to matter to me even more than it does when I casually converse with most humans. I feel vulnerable and exposed.

"But you probably have your own problems too.”
A flock of geese flies past us, close to the water, and lands on the beach close by. I gaze out over the pier. I imagine how this might appear to her. I feel a flickering possibility of the place as her home, as a winged being, and how well she must know every turn and every bend of the shoreline, the pattern of trees against the sky from different heights, and where the sun is positioned when the angry dog comes to chase her away every morning.

“Why are you here alone?” I ask. I wonder if she has been thinking the same thing about me. At that moment she flies off, up the river a few hundred metres, turns around and flies back towards me. Passing over the pier, she lands on the opposite shore than the geese had alighted, into a flock of gulls resting on the sand. They are all facing the sun, their bellies shining in the warm light. The lesson she taught me becomes clear. I am astounded. I feel ashamed and confused.

Inviting Invitation

When I asked the gull why she was alone, I altered the contextual dynamics of our relationship. It was at that moment that the gull lost interest and flew away. It was not my act of using a human language that led her to break our interaction: I was coming into the situation nakedly, earnestly trying to communicate in ways natural to my species and I believe she felt that. It was in my asking the question that I was denying our relationship. If she were indeed alone, then how was it that we were interacting? While she is unlikely to have understood the words I was speaking, my words were also accompanied by paralinguistic and kinetic messages - and it is through these messages that living beings,
including humans, gain understanding of context (Bateson, 1972). Though I am limited by my mammalian body and human symbolic ordering of the world, my curricula are not simply determined by what I intend. The gull creates interpretations. And yet, the gull taught me that if I explore our relationship honestly, she will respond similarly. Even if neither of us can articulate precisely what it is in the other being that we are responding to, we will evolve relationship.

Perhaps self-validating reduction and self-validating invitation are actually connected, as pieces of the same process occurring at different times. To engage in a relationship with another being, we must find a commonality and both creatures reduce the range of their actions to do so, making relationship depend on reduction as much as on invitation. Bateson noted that his gibbon and his dog used to play by finding a pattern which worked for both of them (1979, p. 153). But is the reduction permanent or is it breakable? Is it imposed by and broken by the human, or is it co-constructed? Humans are often the pattern imposers and the patterns breakers, but we need to become more skilled at listening to the other being to see what sort of relationship we can co-create. In other words, self-validating invitation works on a metalevel: the invitation must be the context of the context of the interaction. It must be in the "hidden curricula" of the relationship! To use Bateson’s terminology, it is an invitation on a level of a higher logical type, which allows both moments of reduction and moments of invitation in actual interaction.
CHAPTER 2: Learning plants: Semiosis between the parts and the whole.

Abstract

In this article, I explore plant semiosis with a focus on plant learning. I distinguish between the scales and levels of learning conceivable in phytosemiosis, and identify organism-scale learning as the distinguishing question for plant semiosis. Since organism-scale learning depends on organism-scale semiosis, I critically review the arguments regarding whole-plant functional cycles. I conclude that they have largely relied on Uexküllian biases that have prevented an adequate interpretation of modern plant neurobiology. Through an examination of trophic growth in plant roots, I expose the conceptual difficulties in attributing functional cycles to whole-plants. I conclude that the mapping of resource areas in the root system is a learning activity requiring higher-scale sign activity than is possible at the cellular scale, strongly suggesting the presence of organism-scale functional cycles. I do however question whether all perception-action cycles in organisms are accompanied with organism-scale semiosis.

Introduction

Phytosemiotics is granted a passing nod in biosemiotic surveys but is not often given a careful examination (though see Krampen 1981, 2001; Kull, 2000; Barlow and Lück, 2007; Witzany 2008; Deely, 2009). In particular, plant learning has not featured explicitly as a topic of concern (for an exception, Cvrčková, et al. (2009). And yet, plant behaviour and communication is currently a hot topic, and learning is a useful semiotic concept. Learning is concerned with changes in sign activity, which may occur in either the sign, its object, or its interpretant.
Sign activity ushers in novelty, but the biological world operates on multiple scales and although the scales interact, the rate of semiotic changes on each scale is unequal. This leads to interesting dynamics. For example, since species-scale learning is much slower than organism-scale learning, signs inherited from a lineage appear as a contextual markers, constant and fixed, and perhaps less directly accessible to perception than those aspects available for direct modification by the organism. Thus, we find species-scale semiosis encoding sign aspects that are not possible in organism-scale semiosis, which is why we sometimes find that organisms have symbolic signs encoded in their lineage without being capable of forming new symbolic references during ontogenetic development. A typology of learning should be formalized, though it need not take on the form of the one suggested in this paper. Clarity on this distinction may bridge the divide between scholars who insist that all life forms have complex signifying capacities (such as Stjernfelt 2007; 2012) and those who maintain that broad semiotic divisions are evident across broad phylogenies (such as vegetable-animal-human) (such as Deacon 1997; Kull 2009).

This paper proceeds by a distinction between scales of learning and levels of learning. The former follows spatial and temporal dimensions, while the latter are Batesonian logical types (1972). It is my conviction that different levels of learning are capable at different scales, but that there are invariably interactional effects such that the same learning activity at one scale may produce a different level of learning on another scale. I use this typology in order to narrow down on the notion that the most important questions regarding plant learning involve the organismic scale, because this scale would most likely reveal functional cycles in the whole plant organism -which is, arguably, the most important ontological
question in phytosemiosis. I then review some cases from the plant neurobiology literature to assess whether we can reasonably presume the existence of functional cycles from the type of learning reported.

For the purposes of this paper, I take "learning" to mean changes in signification. This can occur through a modification in at least one of the three elements of semiosis, sign-object-interpretant. If no element changes no learning has occurred. All three elements cannot change simultaneously either because this would imply semiotic discontinuity. I assume that a change in any one of these elements can only come about as an interpretant of some prior semiosis. Thus, I assume that the learning process is made possible by the fact that prior semiosis enables the organism to participate in its environment in such a way that further significations become possible. Finally, I assume that learning occurs on a given scale if and only if semiosis occurs at that scale. Signification must be somehow evident that can only be made sense of by resorting to the scale that the learning is said to occur on, and not be compositional (i.e. a mere bi-product of a lower scale semiotic exchange).

**Scales of Learning in Plants**

By scales of learning, I refer to the different spatial and temporal ranges within which learning can be studied in plants. There are at least four major scales\(^5\) in which it is conceivable that plants learn and each one gives us a different depth and understanding of changes in semiosis.

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\(^5\) We shall ignore intracellular semiotics and signal transduction in this paper as this is a component of all life and therefore not essential to understanding phytosemiosis (or zoosemiosis). Mycosemiosis may be a different case, however, owing to the different role that cells play in fungi (see Hoffmeyer 2008, p. 224-225).
On the first scale, learning occurs by parts of the plant without being regulated by the activity of the plant as a whole. In this case, there is insufficient integration for what Maturana and Varela (1987) call "second-order autopoiesis" or what Uexküll calls a "functional cycle" to develop. Although not the most intuitive scale of learning from the point of view of naive consciousness, it is probably the least controversial one when botanists refer to plant response and adaptation. The modular character of a plant in distinction to an animal is well established (though animals do have modularity as well). Localized activities happen in individual cells and are mediated in multicellular locales. For example, many studies now point to plant leaves dosing with allelopathic chemicals in locally-gauged response to insect predation. Trewavas (2003) notes that in some trees, every leaf can be seen at a slightly different stage or degree of responsivity to a stress. Because such examples suggest that each locale responds without being coordinated by centralization, Firn (2004) argues that plants should be primarily thought of as a confederacy of parts that only operate as a unit under exceptional circumstances. The prevalence of modularity lends weight to skepticism that plants have any unified perception-action cycles and therefore no Umwelten.

Nevertheless, the centralization hypothesis is growing in influence and in evidence. Plant neurobiologists have detailed descriptions of how plants utilize chemical and electrical signalling to centralize and coordinate sensory activity, movement, and tropisms (Trewavas 2003; 2004; 2005; 2009; Karban, 2008; Brenner et al., 2006). Trewavas (2003) claims that globally mediated and regulated learning integrates signals from multiple body parts,

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6 It may be that, in some cases, there are actually two scales here: the single cell scale and the organ scale. However, they shall be treated as a single ontological type for the purpose of this paper.
combined with prior knowledge encoded in the phenotypic variation present in the different stages of the plant's growth. There is also growing evidence to support Darwin's (1880) controversial suggestion that centralization is localized in the plant's root systems, which has lent stronger legitimacy to whole-plant conceptions (Baluška et al. 2004; 2009a; Masi et al. 2009). Because learning, perception, and experience are thought to emerge through the structure of the whole in animals, the question of plant body unity is particularly interesting and will form the basis of this essay.

Plant communities may also learn. "Signalling cascades" (Heil & Walters 2009) mediated through root signalling or through the release of volatile organic compounds (Baluška & Mancuso 2009b), gives rise to what I consider to be local or regional phytodialects of behaviour. Such learned behaviour can be passed to a plant's progeny as well (Mazer & Gorchov 1996; Rossiter 1996). Though it is unclear how long such phenotypic communication and inheritance persists, this scale indicates the possibility of proto-enculturation, the transmission and perpetuation of learned behaviour through hereditary pathways that are neither genetic nor epigenetic. The term "enculturation" is justified because the formal structure of the semiosis is the same as it is in human and animal cultures. In all cases, phylogenetic changes are circulated and re-circulated through pathways available as the result of phenotypic plasticity, creating enduring temporal patterns without being attached to causally efficacious genomic changes. That the particular sign types differ in humans cultures to include arts, morals and religion, and are transmitted through processes such as language and imitation, is not relevant. The extent and ecological significance of this
interactivity and its similarity and differences to cultural behaviour in animals is a great, unexamined field of inquiry.

The fourth scale includes species scale, phylogenetic changes. Through natural selection, a species "learns" certain adaptive behaviours, makes novel semiotic distinctions and behavioural interpretants, as when a plant species co-evolves a flower morphology in tempo with the needs of a fellow co-evolving pollinator. Learning takes on a very different sense here as it is no longer associated with anything experiential or phenomenal. Phylogenetically evolved signs may be experienced in a species Umwelt, but the learning is unique in that it may be selected for and therefore not experienced. However, it should be noted that the ontogenetic and phylogenetic effects of different scales of learning are complex. When plants learn, they change their behaviour, which in turn shapes their environments. The changing environments modify the selection pressures on the plants in turn (Bateson 1979; Odling-Smee, Laland, & Feldman 2003). This sort of circular interaction between phenotype and genotype has seen some revival in renewed discussions by post-neo-Darwinist biologists (for overviews, see Weber & Depew 2003; Jablonka & Lamb 2006; Oyama, 2000; Griffiths & Gray (1994)).

Note that Witzany's taxonomy of "levels of biocommunication in plants" (2008; 2012) (interpretation of abiotic influences, transorganismic communication, interorganismic communication, and intraorganismic communication (2012, p. 2)) are all instances of cellular/modular semiosis. There is a crucial difference between plant semiosis having effects on organismic or ecological scales plant-plant semiosis occurring on such scales. When considering the organism-scale, for example, the critical question is whether the unity of the
organism is a necessary and sufficient condition for novel organism-scale sign activity. I would tend to agree that plants do not communicate with each other on the organism-scale, which suggests that communication and learning do not operate isomorphically, though this should be investigated further.

**Levels of Learning**

Besides scales of learning, there are also levels of learning, corresponding to the logical typing of the semiosis (Bateson, 1972). Learning levels is a concept that Bateson draws on from set theory. The idea emerges from the fact that organisms can become responsive to patterns, but then recursively responsive to patterns within those patterns. Bateson identified likely levels of learnings as L0 through to L3.

Different levels of learning may theoretically exist at any scale. When discussing plant learning, then, it is necessary to distinguish what conceptual space is being considered with a general rubric. In fact, when talking about any semiotic activity, such specifications should also be of value. For the purposes of this paper, I shall confine my discussion to the level of the organism proper, as indicated by the cells marked with an "x" in the table below (Figure I).

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If a plant is capable of learning at an organismic scale, regardless of the learning level, the plant can be said to possess a functional cycle at the organism scale. Many examples illustrating plant adaptation and plasticity suggest higher levels of learning than learning 0, but do not adequately differentiate the scale. For example, plants are capable of producing novel and more efficient responses to droughts, salt, chemicals, frost, heat and water (Trewawas, 2003), but differences in what adaptation would look like from L1 and L2 are not considered.

Like any typology, there are of course problems with this one. For instance, it does not communicate intuitively to the user that there are often relationships between scales and levels, such that the same phenomena can function on different logical levels at different scales. In fact, in some sense, the different scales are different logical levels of one another, as higher scales make formal constraints on the learning process at lower scales. This is related to the problem of "punctuation" as discussed by Bateson. Be that as it may, it does not discount the fact that changes of logical typing also exist within each of these scales. The typology serves its purpose of differentiating plant learning in a way that forces precision on
a discussion that has often otherwise lacked it. For example, when Cvrčková, et al. (2009) insist that learning requires "true" memory (which they define as stored information that is actively accessed rather than haphazardly imprinted), they insist that organism-scale memory and learning is the only real level, whereas the other levels are "metaphoric." I would prefer to ask, in the cases of imprinted information, what level of learning is occurring at each scale. If imprinting is a simple response, perhaps in these cases, we have L0 at the organismic scale, but L1 at the cellular and/or cultural/ecological scales. For a similar reason, differentiating levels and scales may assist in explaining how different sign aspects appear on in different ways in organisms, perhaps opening the way to combine Stjernfelt's (2007; 2012) "degenerative" (if I may call it that) biosemiotics with approaches favouring phylogenetic threshold zones (Deacon 1997; Kull 2009).

**The Argument over Functional Cycles in Whole Plants**

Of course, it is natural that Cvrčková, et al. (2009) would like to make this distinction. As strongly individuated vertebrates, we have an especially strong interest in organism-scale semiosis. Since we identify our ability to have lived experience with our organism-scale experience, we also tend to look for evidence of lived experience in other creatures through their organism-scale perceptual faculties, information processing, and motor activities. With such a bias, I also consider plant organism unity as a fundamental ontological question for phytosemiosis.

This question has been approached in the literature through discussions of "functional cycles", where an organism's perception and action is recursively connected, integrating purpose, function and meaning through ever-reconstituting semiosis. Jakob von Uexküll took
for granted that functional cycles were experiences subjectively by an organism in the form of *Umwelten*. Since they are more easily inferable from physiology than *Umwelten*, they have formed the basis of much argumentation for organism *Umwelten*. Whether or not functional cycles are sufficient for *Umwelten* is a separate discussion (see below).

If plants can be said to learn as individuals and not merely as aggregates of parts, we would expect observable centralization of both sensory information and corresponding responsive activity. In other words, we would expect global functional cycles to emerge beyond specific locales such as cells or organs. Protosemiotician Jakob von Uexküll stated that plants do not have functional cycles, and Krampen (1981), who wrote the most often cited article on the subject, followed him in this assessment, reiterating many of his arguments, from claims that plants lack receptors or effectors, to the assertion that plants are structurally incapable of functional cycles because they are built as "casing" or "dwelling-shell" (*Wohnhülle*) (2010, p. 146-150), i.e. a "living layer of cells" (147) around an abiotic core. Krampen connects Uexküllian semiotics with Peircean terminology, developing an early tripartite concept of threshold zones. Unlike later versions (such as Kull, 2009), Krampen associates plants with indexical semiosis and animals with the additional capacity for iconic semiosis, owing to the latter's capacity to form "images of objects".

There are many problems with both Uexküll and Krampen's characterization, which I will not repeat here but will refer the reader to Kull (2000), who has gone through Krampen's article point by point. I would, however, like to add several additional points to Kull's discussion. If we want to examine whether or not plants have functional cycles, I insist that Uexküll and Krampen both start from the wrong assumptions. As we will see in the next
section, I regard the possibility of organism-scale learning and hence functional cycles in plants as highly likely but remain doubtful as to whether this necessarily implies organism-scale experience unless accompanies with evidence of organism-scale signs.

First of all, the claim that plants lack receptors or effectors (and for Krampen, that we call them "sensors" and "regulators" instead, in keeping with a cybernetic vocabulary that originated with the study of machines) is both arbitrary and mistaken. It assumes a difference and then reifies it through making a terminological distinction. Krampen does not use compelling biological evidence to make the distinction and it is unclear what such evidence would even look like. Further, this argument would seem to apply to plants at any level, including the cellular one, however most biosemioticians (including Uexküll) maintain that unicellular organisms do have functional cycles. In this case, he would have to show what is substantially different between a plant cell and a protist in this respect.

Second, the notion that plants are a "casing" or a "living layer of cells" seems unnecessarily arborocentric. There are obviously many instances in the plant kingdom of species that do not conform to the case or shell metaphor. Regardless, it is far from clear that those species that do have a casing architecture (at least in their trunk) are a priori denied functional cycles on this account. Communication and integration could feasibly operate either from within the casing itself (through auxin, other plant hormones, or through various neurotransmitters and ions (Baluška, 2004)), or laterally through the air and soil (as we find, with increasing evidence (Orians, 2005; Heil and Ton, 2008; Baluška, et al., 2009). The fact that intercellular communication seems to be electrically mediated, with plant celling have action potentials (with the highest activity in the root apex) (Masi et al., 2009; Baluška,
2010), and even "adhesion domains" homologous to neural synapses (Baluška, Volkmann and Menzel, 2005) strongly suggests we should remain skeptical of denying functional cycles on the basis of the weight we place on anthropomorphically-valued structural differences.

Third, Krampen maintains that plant systems are unable to fit together afferent and efferent signals to form the signifiers required to constitute "objects" in experience, and that this is a part of his general argument against functional cycles in plants. It is uncertain to me that object constitution is a necessary property of functional cycles, but this bias, again, seems rooted in his Uexküllian foundation. There are many stimuli that people react to that have semiotic significance but that do not appear as objects. It seems to indicate a distinct ocular-bias in his approach (in the abstract, he comments on a functional cycle needing to represent the "image" of objects (257, also 270), which recalls Jonas (1966), and has been critiqued by Sheets-Johnstone's (1999) approach emphasizing the primacy of movement over object constitution. Iconicity is less image-ruled than Krampen would have it. If a plant recognizes jasmonic acid as part of the same category of signification as methyl jasmonate itself, then this satisfies the requirements that the sign have aspects of iconicity, where a sign stands for something else on the basis of some similarity. This bears the same semiotic structure as an E. coli cell receptive to sugar but fooled by an artificial sweetener (Stjernfelt, 2007). It is not indexicality because the chemical relative is in no way a necessary indicator of actual methyl jasmonate. Plants can also differentiate between roots that are their own and those that belong to plants, even to the point of differentiating their own roots from roots of vegetatively propagated clones that once came from them (Callaway, 2002; de Kroon, 2007; Callaway & Marshall, 2007; Dudley & File, 2007). Their competitiveness in foraging is
correlated with the degree to which the other root is related to them (Gruntman & Novoplansky, 2004. This cannot be understood as purely indexical signification either because the self/other distinction is itself iconic (T. v. Uexküll, 1986, p. 211).

I shall not take sides in the debate as to whether or not plants semiosis is essentially indexical or iconic. I agree that a more complex picture of semiosis will emerge, recognizing that what aspect of a sign comes out depends on the level and scale it is being looked at, and the question of phylogenetic differences should always specify scale chosen for analysis prior to distinguishing threshold zones. Stjernfelt (2007; 2012) argues that complex Peircean sign aspects are distributed across the biological world in ways that do not fit neatly according to icon, index and symbol hypothesized phylogenetic threshold zones (such as Krampen 1981; Deacon 1997; Kull 2009). For Stjernfelt (2012) all the classes of signs are already in even the most primitive bacterial behavior because they are implicit in metabolism itself, and what differentiates complex from simple behavior is the capacity for the organism to explicitly articulate individual sign types from out of this originary unity, so as to increase plasticity. This occurs through "segmentation, articulation, autonomization, adaptation to further purposes, ... [and through] loosening semiotic structure still more from its causal basis" (p. 47). He likens this process of differentiation and distinction making to the emergence of semiotic freedom (Hoffmeyer, 1992). For Stjernfelt (and according to him, for Peirce) an argument is the basic fully-developed sign, and the question is how less-developed, degenerate sign aspects are made prominent in the semiosis and how such degenerate sign aspects assist the organism (Stjernfelt, 2007, p. 25). Thus, Krampen's borrowing of Marxian
"subtraction" (Favareau 2010, p. 265) is not an adequate method by which to realize other species' semiotic capacities.

When Stjernfelt (2007) speaks of "hypostatic abstraction" he is referring to the capacity to form higher-level signs (via L2 and L3 level semiotic changes) within the organismic-scale. Hypostatic abstraction is already present in plants, but it is embedded and develops on the species scale. For example, "jasmonate-ness" occurs as evidenced by the fact that classification of various jasmonate derivates is possible, but it is not possible within the learning level of semiosis for which the organism itself is responsible for.

**An examination of root growth**

Phenomenologist Hans Jonas (1966) attempted to connect temporality to spatiality through emotions, and can therefore provide a useful entry point into questions regarding plant semiosis and learning. He naturalized emotion by insisting that it provides a causal role in soliciting an animal towards (or away from) phenomena that is present to it at a distance. As space is established and a distance opens between what a creature needs and where it is located, there emerges the need to e-mote, literally to compel the creature into movement. A Peircean biosemiotician might prefer to say that the animal experiences some iconic sinsign (referring to a general class of problems denoted by a legisign7) to which its subsequent action is an emotional interpretant. The experience of that which e-motes provides the incentive for an organism to pursue that which it needs but is not directly accessing. If there

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7 The capacity for a particular instance of some plant hormone or neurotransmitter to act as an iconic sinsign e-moting the plant into an activity occurs on a different scale than the capacity of the plant to form a class of situations for which the iconic sinsign is but a replica. The class is a legisign, and it may be an evolutionarily inherited sign type that is not itself available to change during the course of somatic development.
is some external object disclosed such that the organism acts with reference to it, Jonas suggests that this behaviour is therefore a clue into the phenomenal world of that being. It must be responding to something immediate that is internal to it but which is tied to the external, distant object. Plants have flushes of hormones, secondary metabolites and even neurotransmitters analogous to those in animals (Baluška & Mancuso 2009a), all of which direct or redirect the plant's activity, sometimes for spatially or temporally distant goals. Do they e-mote the plant into action? And if so, on what level or scale is this activity occurring?

Trophic growth in plants presents a subtle though commonplace sort of plant movement. Because many tropic movements in plants arise through responses to qualities contiguous on a gradient scale in the environment, it is often argued that any movement or growth towards a resource is better than none and therefore acting towards something and acquiring more of it are one and the same thing, requiring neither perception of a distance (nor, therefore some iconic sinsign) for solicitation. There simply would be no need to e-mote if the benefit is directly entwined in the action. A distance in space and in time need only be disclosed when no benefits at all are incurred until the organism has reached its goal. If we can show an instance where a plant's trophic growth acts toward anticipated objects such that no benefit occurs for some duration between the point that it begins acting and the point that it reaches its object, then the plant will have to fit Jonas' e-motion (and therefore distance) criterion. Keep in mind, however, what we would need to look for in reference to our discussion of plant learning. Suppose we do find internally generated sinsigns driving behaviour towards potential things. From the organism scale, there could be no changes in objects, signs or interpretants, and hence no learning, even if this turns out to be a veritable
functional cycle. For learning, there must be some observable change in sign activity and semioticians must be able to decide on what scale it is occurring.

It is a common misconception that plants are autotrophic and animals are heterotrophic. This misconception is propagated by biologists themselves who discriminate between the two terms primarily on whether or not a given species is able to fix atmospheric carbon. However, if we consider both terms more etymologically, the identification of plants as autotrophic and animals as heterotrophic becomes unjustifiable. Plants do photosynthesize ATP and gain carbon directly from the air, but their nutrient needs are met through precarious soil foraging. By contrast, humans can be said to be autotrophic in certain senses (their access to oxygen and vitamin D is secured through a contiguous adjacency to the resources) while other nutrient needs are met through foraging their environments. In animal motility, an animal moves by using energy from broken down carbohydrates. In plant trophism, a plant moves (i.e. grows) by selecting where to put inflowing carbon. In both cases, a surplus of carbon-based molecules frees the organism to choose from a complex manifold of interacting variables that would not be open to it had it no stored energy.

However, whether certain plant chemicals act as iconic sinsigns compelling plants into trophic activity does not necessarily imply the existence of organism-scale semiotic activity. Certain perceptual information is received, produces the sinsigns as an interpretant, which then becomes a sign for other cells, which in turn act so as to push trophic activity forward. This can easily be explained by cellular functional circles. There are similar

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8 To coordinate the movement of sugars, plants use action potentials along long tubules interspaced with chemically mediated signalling across plasmodesmata, in a system that formally converges with animal neurotransmission (Baluška, Volkmann & Menzel 2005)
ambiguities with Kull's (2000) double-slit experiment (with a bow to Thomas Young and Claus Jonsson). If we put a plant in a black box, with two holes in the top, through one of which is shone light at a wavelength unusable for photosynthesis, that plant certainly moves towards the hole with the light, but this does not illustrate the need for whole-organism functional cycles as an explanation either. On the contrary, this can easily be explained by the fact that the wavelength is interpreted as a sign by all of the cells that the light hits, triggering all of them into movement towards that hole in the box. Of course, we have a case of iconic sinsigns again, but the semiotic activity may be confined to the cellular scale and intercellular semethic interactions. Such activity within the plant is a feedforward process just like resource foraging in animals. It is precisely internally significant signs that function as a surrogate stimuli when distal goals are required. But this may only mean that Kull's "biological need" (2000, p. 339) is confined to the plant cell.

Is there anything that makes plant foraging a better candidate for organism-scale functional cycles and the possibility of organism-scale learning? Having no resource directly gained through the activity, allocating resources to grow roots in certain areas and not others requires e-moting by iconic sinsigns (which, again are instantiations of legisigns, or there would be no generalizability as to the interpretants they generate). This is particularly true when the translocation of resources is not a passive process in plants, such as in "active transport," which works against chemical gradients and therefore requires energy input (see, for example, Servaites, Schrader & Jung 1979). However, the nature of the plant foraging suggests a semiotic activity beyond what is required for mere e-moting. In foraging for nutrients, a plant never spreads its roots out uniformly in all directions. Instead, the roots in
the more nutrient-rich soil patches spread out more than the ones in the relatively barren areas. To accomplish this, the various roots' micro-environments need to be compared so that carbon resources can be best distributed. What is considered "nutrient dense" is relative to the particular context of a given plant so that nutrient-poor soil in one plant's environment may be interpreted as rich in a very infertile location. Now, here's the point: a sign is as big as it needs to be. If we see integrated whole-plant behaviour that shows that the various regions of the plant root system are being compared to one another and energy resources from other parts of the body translocated accordingly, it is reasonable to assume that an organism-scale mapping is occurring. The mapping is itself a sign activity, but one that functions on a higher scale than the modular scale for the simple reason that it is integrating information to rate multiple modular locales. In essence: whole-plant spatial behaviour that implies a global map also implies a global sign. If the organism is responsible for creating a sign that can only be interpreted by the whole-organism, then we have compelling evidence of a global functional cycle. Of course, the map is not "visual," but it is certainly spatial. That the mapping is continually changing as a result of the very trophic decisions that the plant makes while using it indicates that mapping is also a continuous learning process, occurring at least on the cellular and organismic level. What levels of learning are possible at each scale could be revealed through further plant research.

**Conclusion/Discussion**

There are rather complex sensorimotor activities that occur in humans that do not seem to clearly disclose an Umwelt. When sleeping, people can receive perceptual signals and respond to them in coordinated ways, sometimes including vocal responses, without
being aware that they have done so. Are plants like sleeping animals? Of course, many plants experience nyctinasty, difference in plant growth (Nozue & Maloof, 2006), a reduction in nutrient translocation and assimilation (Lillo, 2008), stomatal closure (in non-CAM plants), as well as nighttime shifts in genomic activity (Schaffer et al., 2001). Though these studies indicate deep physiological differences that are undoubtedly accompanied by semiotic differences, they cannot provide evidence that the plant's daytime semiosis discloses a more vivid Umwelt than its nighttime activity. Nevertheless, studies that show that plant learning at the organism-scale depends on sign activity (such as mapping) that is itself at the organism-scale, are a more compelling reason to assume some sort of organism-scale experience. To really find out whether or not plants sleep, it is necessary to examine changes in organism-scale semiotic activity.

I will this paper with four remarks. First, "functional cycles" are difficult to find in organisms that veer strongly from the paradigmatic cases. Second, there appear to be cases, even in humans, that satisfy Uexküll's criteria for functional cycles but that do not have tangible Umwelt experientiality. Both of these points, taken together, imply that the term functional cycle is unclear and should be fleshed out. The way it is often defined may be a necessary but not sufficient condition for constituting phenomenal experience. Third, it seems that a stronger claim for organism-scale experience is the requirement that there are functional cycles organize perceptual and/or effector signs as single organism-scale signs, such as a maps, that cannot be conceivably "read" at the modular scale. Fourth, the typology of learning types along scales and levels can allow for a more precise discussion as to what sort of semiotic processes are active and changing and which ones are providing more static,
contextual, and formal constraints. This is important for any discussion of semiotic classification along phylogenetic lineages, but is also likely useful for integrating richer Peircean semiotics into our understanding of biological systems.
CHAPTER 3: Generativity in Biology

Abstract

The behaviour of an organism, according to Merleau-Ponty, lays out a milieu through which significant phenomena of varying degrees of optimality elicit adjustment. This leads to the dialectical co-emergence of milieu and aptitude that is both the product and the condition of life. What is present as a norm soliciting optimization is species-specific, but also depends on the needs of the organism and its prior experience. Although a rich entry point into biological phenomenology, Merleau-Ponty's work does not adequately describe milieu-aptitude development in interactions between organisms, but it can be assisted through employing Husserl's three levels of analysis identified by Steinbock, extending all three modes into the biological world. In particular, generative analyses can address inter-organismal behavioural structures slighted in Merleau-Ponty's work. Generative phenomenology is concerned with the cultural, historical, and intersubjective constitution of human experience, and is generally thought to be solely of value in examining the structure of human phenomenality. However, the possibility of human generativity presupposes structures produced widely in the biological world. Ecological, embryogenic, and evolutionary development already depend on protocultural and historical processes creating and created through intercorporeal interaction. After developing the concept of biological generativity through a consideration of plant ecology, mammalian embryology, and insect mimicry, I conclude with implications for humans, who are can participate in biological generativity not merely phenomenally, but phenomenologically.

Introduction
Early in his career, Merleau-Ponty (1963) provided an important analysis of behaviour in biological organisms. For Merleau-Ponty, organisms maintain their form by constituting milieus that elicit preferred behaviour. “Preferred behaviours” re-establish preferred relations with what appears as significant in the milieu. Thompson explains that “organisms shape the physicochemical environment into a milieu (an Umwelt). A milieu, from the standpoint of what is present and real at the physicochemical level, is virtual, something needing to be actualized, and actualized moreover at another level, the level of vital norms and meaning (2007, p. 74). A milieu is transcendental in a twofold sense: it is not merely the a priori conditions for the possibility of experience in an epistemological sense. It is also the a priori conditions for the possibility of the form of the organism. The forms of life depend on a structure of behaviour that casts a web of signification and valence onto the world, a milieu dynamically constructing and constructed by the motor and perceptual possibilities of the organism.

For Merleau-Ponty, the general structure of behaviour is such that the milieu and the aptitudes of the organism are two poles of a single phenomenon (1963, p. 161). General situations emerge with general aptitudes. Both the organism's sensory and motor worlds are connected "in a chain of reciprocal determinations" (p. 50). As such, the "organism itself poses the conditions of its own equilibrium" (p. 150) maintaining a "vital" and not a "physical equilibrium" (p. 147).

The structure of behaviour is "expressed by certain constants of conduct, of sensible and motor thresholds, of affectivity, of temperature, of blood pressure," etc. (p. 148). Although the expression is species-specific, behavior is not strictly a series of repeating
patterns that permits comprehensive cataloguing. The system is open. The actual world out of
which the milieu-organism dialectic takes shape impinges constantly on behaviour. Although
the manner in which such perturbations appear in the milieu is established by the structure of
behavior, novelty continually demands recalibration. As such, even in the simplest
organisms, the organism's activities and the milieu it discloses are continuously readjusted.
An organism and its milieu co-constitute one another, setting boundaries for what experience
is possible, while experience plays a role in shifting those boundaries.

**Static, Genetic, and Generative Milieus**

Merleau-Ponty provides a bridge between phenomenology and biology, but his
structure of behaviour is limited to non-social and, in that sense, acontextual descriptions of
the emergence of biological signification. We can extend our understanding of the
phenomenality of life through the three interconnected levels of analysis that Steinbock

Husserl called his first form of analysis "static phenomenology," and through it he
explored the unchanging structures of experience, such as the structure of intentionality. At
this level of analysis, a living being appears to have a set of ways of disclosing its milieu
fixed in accordance with the limitations of the organism. A living being has vital norms
instituted in virtual relations, but they are seen as adjusting behaviour without themselves
being adjustable. Much of Uexküll's work (1926; 2010) can be seen as attempting to forge
static analyses of organism's milieus based on species-specific sensorimotor possibilities.
Genetic\(^9\) description goes beyond this because it is fundamentally concerned with the way an organism's milieu is actualized spatiotemporally. The dynamic co-constitution of a changing organism in a changing milieu cannot be described by simply delineating the invariant structures of experience. It must be re-seen as "a process of becoming in which [an organism's] present experiences point back to previous ones, having become sedimented as habitualities and predisposing [it] to other typical future acquisitions" (Steinbock, 1995, p. 57-58). By entertaining this level of description in our consideration of other species, we can go beyond understanding them as having fixed milieus and acknowledge that, in contrast to Heidegger's claim, all living beings are "world-forming" (1995). Merleau-Ponty's (1963) analysis of amovable forms in the *Structure of Behavior* is an attempt to extend genetic analysis to the animal world, where the structure of an organism's behaviour is permits temporal evolution via the dynamic relationship between a milieu pole and an aptitude pole. A living being is oriented to the virtual, but there is a development and changeability as to what is virtual and how the virtual elicits responses over time.

However, the genetic level of analysis is not sufficient to consider the behaviour of even the most basic creatures. The norms that a living being attunes to can also be affected by the norms of other living beings with whom it interacts. Living things are "sensing and sensible at every moment" (Merleau-Ponty, 2003, p. 273); they continuously interact and intertwine through intercorporeal contact. In so doing, novel spatiotemporal dynamics occur that extend well beyond the organism and yet feed back to impress upon the organism's subsequent disclosure of its milieu. Generative phenomenology is said to be concerned with

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\(^9\) The use of this term in this paper is phenomenological and does not refer to the field of genetics in the life sciences.
the cultural, historical, and intersubjective constitution of human experience, but these terms have biological analogs that play an actualizing role in the structuring of almost every organism's milieu. It makes sense to talk of intercorporeal, sense-making beings in terms of generativity even if they themselves are not able to conceive of it in these terms. In proposing this analysis, my purpose is not to level out or diminish the particularity of the phenomenality of human experience, but to situate it biologically. Likewise, although Steinbock identifies the co-emergence of homeworld and alienworld as the core phenomena in generative phenomenology, and stresses how the experience of birth and death are manifested generatively, the absence of these or any other particular dialectic in other species does not indicate a lack of generative constitution of non-human milieus.

Cultural, Historical, and Intersubjective Constitution of the Organism's Milieu

Lest the move to conceive biology generatively be seen as brazen anthropomorphism, let me address the issue head-on in this section. The concepts "cultural," "historical," and "intersubjective" should be considered broadly enough that their role as biological preconditions for human culture be evident. These terms can help reveal what biological structures and relationships need to already by in place in some formal way within the biosphere for the possibility of what is uniquely human to emerge. All three terms have precursors in the biological world, where they are as interconnected and as indissoluble as they are in the human world. Steps toward generativity were made long before the human arrival on the planet, although it is certain that fundamental "différences of integration" (Merleau-Ponty, p. 133) make possible different formal possibilities in what is realized across different species.
Intersubjectivity is required for both culture and history, so it will be addressed first. Intersubjectivity can be thought of as the form of behaviour that occurs when an organism is "structurally open to the other in advance of any actual encounter" (Thompson, 2007, p. 383). Trevarthen (1979) made an important conceptual distinction in analyzing the emergence of intersubjectivity in infants. By differentiating between "primary" intersubjectivity and "secondary intersubjectivity", he was able to encompass the infants' perceptual responsiveness to others, which had otherwise been poorly represented by notions that intersubjectivity necessarily involves an awareness of other subjects as subjects in one's experience. Instead, primary intersubjectivity was a more embodied concept, appearing as a heightened responsiveness, attention, and capacity to co-regulate with other humans. The other human infiltrates the infant's experience unlike any inanimate object without appearing as an ego or a subject, and is a structural precondition for any behaviour that might lead to "secondary" intersubjectivity. Co-regulation of visual and vocal patterns, gestures, and body movements all suggest a fundamental structural openness of the infant to his or her caregivers.

As will be shown, the affinity and discriminate capacity to respond to specific others is widespread across the biological world. For now, readers should consider flocks of starling flying in the evening sky, choruses of grasshoppers at dusk, or a pack of wolves coordinating their hunt, as particularly vivid examples of what should be labelled "primary intersubjectivity" in the animal kingdom. Primary intersubjectivity is important because it creates orders of signification (and therefore forms of complexity) not possible in inanimate-inanimate or animate-inanimate interactions. There is surely a gradient of awareness from
systems such as adult humans, where secondary intersubjectivity is well-developed to creatures (such as, perhaps, quorum-sensing bacteria) who have no sense at all of other sense-making beings *as such*. Regardless, in all cases the disclosure of a milieu is constituted non-solipsistically because the other is already affirmed through the interactive role it plays in co-constituting behaviour. We do not need a recognition of the existence of others in the actualization of experience in order for others to have a role in this actualization. But we do need that role to exist in order to become aware of it.

Primary intersubjectivity, especially in its forms most remote from the human experience, could be called "intercorporeality." Some might prefer to reserve the term "intersubjectivity" for organisms that are subjects in a narrower sense. This is fine, as long as it is recognized that the interacting bodies are not merely bodies in a physiological sense, but poles in an organism-milieu pole that has some degree of openness to the world and, in particular, to certain other bodies in that world. I prefer the word "subjectivity" because it evokes more effectively the intentional structure of the organism and will continue to use such terms here.

Through various forms of feedback in large communicative networks, primary intersubjectivity can also give rise to a process of proto-enculturation. This is not an anthropomorphic blotting of human categories onto the rest of the biological world. It is an excavation of the patterns of interactivity that are already in place such that reflexive, symbolically-mediated semiosis and other human activities emerge in cultural systems without saltatory discontinuity. If something like culture can be said to exist in other organisms, we must not look for aspects particular to (certain elements of) human culture.
This is an injustice both to other species and to the range of phenomena present in human experience. Humans in a population learn from each other such that they co-constitute certain patterns of behaviour that provide the context for future interactions in the world. A human milieu is, from the beginning, shaped by parameters set by learning, experience, and communication with other humans. Human cultures propagate via multimodal semiotic communication pathways, and not merely by symbolic and linguistic transmission, all of which depend on an intertwining and intergenerational transactional network that need not be transmitting messages of any particular sign type. It is this behavioural structure that is already present and constitutively significant across the living world.

As primary intersubjectivity blossoms into vaster networks of co-regulating organisms, a temporal dimension exceeding an individual lifespan also obtains. Historicity is therefore already present across a multitude of temporal and spatial scales in the biological world. Husserl said that historical time spans generations, and so culture distinguishes humans from other species because an animal (for example) "merely repeats its specific environing-world with the peculiar typicality of its particular species" (Steinbock, 1995, p. 198). However, this argument seems to adopt the prominent Uexküllian biases of continental thought at the time. Uexküll argued that the experiential world of an organism is strictly determined by the type of perception and action cycles that its bodily constitution makes possible. He failed to make explicit how perception-action cycles open the organism to novelty. Whatever "learning" was possible was, in a sense, merely fulfilling the prescribed developmental outcome of perception and action. Biosemioticians and philosophers of biology following this avenue are likewise committing themselves to "static" analyses. Doing
so risks passing over much of the richness, but also the indeterminacy, of the phenomena. Darwin is often attributed with providing logic that rendered biology a historical science. However, biology can now to be seen as historical in a stronger, phenomenological sense: the milieu of a particular organism is disclosed in such a way that it indeed reflects the "nature of the times."

**Biological Generativity on Three Scales**

Biological generativity, the core structural precondition for any human generativity, is present across a vast range of biological phenomena. Here I will review three different scales (ecological, embryological, and evolutionary generativity) to examine in what ways the phenomena considered must be understood as grounded in more complex structures of behaviour than are admitted in merely static or genetic analyses.

1. **Ecological generativity.**

   The relationship between an organism and what it discloses as norms requiring optimization can be viewed statically, genetically, and generatively by considering common plant behaviour. The plant\(^10\) discloses virtual properties in the world as meaningful and acts

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\(^{10}\) Uexküll doubted that plants have *Umwelten*. He wrote that plants do not have perceptual or effector organs, therefore no carriers of meaning, and hence do not have functional cycles (2010, p. 146). Instead of meaning circulating as an organism perceives a world, acts on it, and re-perceives the changed world, plants produce meaning solely by the selection of stimuli from the outer environment on their "dwelling shells" (*Wohnhülle*). However, the conception of a plant as having fixed responses and hence fixed meanings without internal coordination or synthesis has been outdated in light of contemporary studies on plant learning and behaviour (Trewavas, 2003; 2009; Affifi, 2013). Kalevi Kull (2000) argues that plants must now be seen as also having a functional cycle with meaning cycling evolving through the iterations of the plant constituting its milieu. The more important question regarding plants is how and where milieu-constitution arises and to what extent the plant's functional cycles can be thought of as whole-organism activities or merely modular and localized. In any case, the presence of functional cycles, movement, memory, categorization, and learning in plants suggests that Uexküll's (and Jonas') intuitions regarding plants
towards them in ways that only make sense on the formal level of their lives. Consider a root seeking out and exploiting an area in the soil where there is a high concentration of soluble phosphorous. The attraction is not chemical, gravitational or magnetic. The trophism can only be explained by the fact that the plant has a phosphorous level that requires optimizing. Its form discloses a milieu that presents such signification. The phosphorous' attractiveness is explicable only with reference to the virtual value it has in how it is "seen" by the plant.

If we consider the plant's disclosure of phosphorous in its milieu and posit the structures necessary for this to occur, we are maintaining a "static" perspective. However, since the plant changes its responses over time, its milieu also actualized genetically. For example, in foraging for rare nutrients, root morphology changes when a plant comes across a soil patch with a high nutrient density (Hutchings & John, 2004). In the latter case, denser, more lateralized branching occurs. The milieu is no longer disclosed as a place in which the plant has to seek widely for needed nutriment. The milieu has a new structure that corresponds to what the plant discloses as significant given the norms that now need optimizing. The physiognomy of its behaviour is exhibited in the phenotypically plastic roots and the particular trajectory that they have forwarded.

The plants' behaviour can be further illuminated using a generative analysis because the way it unfolds its milieu is affected by its history of interactions with other plants and other species. For example, many plant species develop symbiotic relationships with mycorrhizal fungi who forage for difficult nutrients in exchange for sugars provided from the reflected his own lack of study into them and that many of the phenomenological insights that he carried over into the animal world can in fact now be considered in plants (and/or in parts of plants).
plant. Both the fungi and the plant learn from each other and the subsequent behaviour of each is informed by the evolving way each appear to the other in each's respective milieus. For the plant, the desirability of phosphorous can be radically altered by its ease of availability and the plant can put energy into new limiting resources (according to Liebig's law of the Minimum (Paris, 1992)). Some plants do not associate with mycorrhiza as well as others, and the behaviour of both the plant and the fungi will depend on this. The milieu of the plant depends on its ecological situatedness, but in turn affects the community around it through the plant behaviour it solicits.

Husserl's "genetic turn" involves a description of how habits emerge through the abnormal becoming normal within the individual (Steinbock, 2003, p. 293). In a generative context, normalizing occurs in the interactive domain of intersubjective interaction. From a generative perspective, organisms are now seen as affected by and contributing to the establishment of norms outside of themselves: we can "generate beyond [ourselves] a new 'concrete teleological sense' and thus a new normality and a new telos" (p. 293, emphasis in original). A plant's behaviour affects its community and to its descendants in the phenomena of "signalling cascades", which can produce localized norms of behaviour that are triggered and retriggered amongst plant communities through varied forms of signalling. In this way, the behavioural repertoire manifested through phenotypic modifications spreads, and is reentrant back into the evolving milieu of the plant. This sort of phytoculture can have significant implications for the composition of the ecological community, as when signals that communicate the need to produce toxic allelochemicals are spread across plants in response to herbivory (Karban, 2008). For example, plant produced allelochemicals can
increase the susceptibility of insects to infection and disease while in turn diminishing the effectiveness of entomopathogens in killing their hosts (Cory & Hoover, 2006). Signalling cascades within plant communities can potentially make these interactions population wide, significantly altering the structure and dynamics of ecological systems. Much more research is required in plant population ecology to assess the ecological relevance and extent of this behaviour.

As Steinbock notes, static phenomenology need not be the starting point for all investigation, passing through a series of "leading clues" (Leitfaden) beyond itself into the genetic and eventually the generative dimensions. Rather, all three dimensions are continuously present and are better understood on a spectrum from the static, which is abstract, to the concrete, which is generative. This inverts Husserl's original perspective that the static was the most concrete and therefore the obvious starting point. By contrast, Steinbock (and Husserl in his later years) realized that to isolate the specific from what it is embedded in is to decontextualize it, which is an abstraction. But the abstraction (just like the perception-laden physicochemical abstraction for Merleau-Ponty) never fully rids itself of the formative constitutivity of the concrete dimension from which the abstraction became possible.

In ecological terms, we can understand that the individual and the ecosystem do reciprocally determine one another and that this process is generative, while at the same time recognizing that the reciprocity is asymmetrical. Hence, just as the organism and its parts co-constitute one another autopoietically, but there is ontological primacy in the organism for the possibility of the exchange to occur at all (Thompson, 2007, p. 79), the generative
capacity of ecological communities is what grounds the possibility of the individual (and therefore static and genetic modalities). According to Steinbock, when we go from the generative context back to the individual, we go back to the individual as situated in an essential "cultural and historical tradition" (2003, p. 316). Genetic and static lenses can be reapplied, but with an awareness of their larger hermeneutic nesting.

When a plant changes its behaviour as a result of a signalling cascade brought on by surrounding plants in its community, its subsequent disclosing of a milieu is colored by signals received from other plants. For example, plants often communicate news of predator attacks through volatile organic compounds (VOCs) to other plants. While the other plants may not directly experience the presence of the attacking insect, their sensory behaviour and internal signalling systems are modified by the news. Behavioral changes are the physiognomic indication of interior changes of experience. In the case of their following suit in releasing VOCs, there is an identity between the internal state, its physiognomic expression, and its expressive capacity to other living beings. There is a structural equivalent of a "face" in a plant's release of, say methyl jasmonate or some other common communicative compound. Botanical sciences can therefore provide important leading clues for phenomenological studies into plants and the range of possible explorations of continuity amongst the living.

That dialects of behaviour evolve in animal species has been quite well-documented, in the songs of birds and whales, and in the use of tools in primates. I refer the reader to Avital and Jablonka's (2000) *Animal Traditions* to explore the realm of living expression and how widespread phenotypic inheritance is within nonhuman animal communities.
Finally, we can expect that the establishment of stable sets of relations between organisms, such as occur during the construction and continuance of ecological niches (Laland, Odling-Smee & Feldman, 2003) will give rise to "normal" geohistorical communities, where interactions are based on familiarity and shared expectation. In keeping with Husserl's discussion of the larger cultural constitution of the homeworld, there is a biological correlative that is similarly dependent on regulation and differentiation that occurs over larger spans than the individual organism's life. A niche is a milieu that is constituted through the interaction of multiple, milieu-constituting living beings. To use a Husserlian expression, the organism "appropriates (übernahme) sense" (Steinbock, 1995, p. 61) that stems from the world of form that its ecological community actualizes.

2. Embryogenic generativity.

An embryo is made up of individual cells that maintain increasingly specific relationships with one another as development progresses. Initially, we can only speak of cellular milieus. Though Merleau-Ponty was not explicit about this, he did say "we must allow for an Umwelt at the level of the organ" (2003, p. 167). Uexküll, however, is bolder on this account: "every living cell is a machine operator [possessing] its own particular (specific) perceptive signs and impulses" (2010, p. 47). Before there is strong integration, the primary sensory, motor, and cognitive activity within the embryo is occurring in the individual cells themselves and development is quite decentralized. Gradually "behaviour develops across the whole of the body ... [and] the parts of the organism acquire an existence ... in the very order in which they are invaded by the total pattern" (Merleau-Ponty 2003, p. 145). The multicellular unity of the cells comes to form what Maturana and Varela
have called a "second order autopoietic system" (Thompson, 2007, p. 105). At this point, there is a higher-order centralization that accumulates sensorimotor percepts and cognitive information from the individual cells and synthesizes whole-body information from it. However, it is not a linear system, but a recursive one. While the varied sensorimotor percepts are combined, the interpretive meaning in the whole-body directs the bodies' parts into the world to further the meaning construction of the whole. Individual cells and organs are enlisted to serve the whole-body in its constituting a milieu. This does not mean that the individual cells no longer have percepts, functional cycles, or milieus. It is simply that the milieus that they realize are within a larger body, which means that its sensorimotor possibilities are funneled (and utilized) by its situatedness.

In terms of embryogenesis, there are two related problems, each which can be re-examined through a consideration of generativity. The first concerns the possibility of the emergence of intercellular organization in dividing cells. The second is the seeming fittedness of the whole to future environments. In the first case, the individual cells are being organized spatiotemporally and the question remains how this is possible. In the second case, the emerging organism is found to be structured for an anticipated spatiotemporal relationship without it being clear how such future-directedness can be a part of a co-emergence theory. I will approach the second concern in the next section in my discussion of mimicry but will explore the first concern now.

Consider the fertilized mammalian egg cell. During initial embryonic cell division, known as cleavage, cells are undifferentiated and have the potential to become any future kind of cell. At this point, they are known as having totipotentiality. However, totipotentiality
is quickly lost. Different cells switch off different genes, eventually giving rise to specific cell types, such as liver cells or white blood cells or brain cells. How is this differentiation achieved? Embryologists maintain that there are at least two factors essential to creating differentiation. The first is the polarity of the mammalian egg cell. The second is the duplicating cells' ability to organize in relation to this polarity, cued by both cell–cell contacts and cell–extracellular protoplasm contacts (Drubin & Nelson, 1996). For example, mammalian cell differentiation often occurs through communication between cells using transforming growth factor $\beta$, which is used by cells for signalling to nearby cells.

Intercellular dynamics quickly proceed "in 'cascades' of sequential inductions and 'networks' of multiple influences (Oyama, 2000, p. 146; Raff & Kaufman, 1983). As the various cells organize themselves in relation to virtual norms (such as signals) and develop, both the norms and the polarized form becomes further established and particularized by the very activity of the cells.

By considering the cell in isolation, we are remaining in static and genetic analytical modes. Many of the chemicals used to mediate intercellular communication are already being used intracrinally and autocrinally, so from a cell-centric perspective what is called signalling can usually be understood as an activity of an autopoietic cell's functional cycling. As the cell acts and responds to its milieu, there is a dynamic co-emergence between its own bodily development and the external conditions to which it can respond. Although the meaning of the relationality of intercellular behaviour is lost, even through static and genetic descriptions knowledge emerges that is inaccessible to cell biology that does not consider unicellular milieus as a part of the actualization of cell behaviour.
However, the loss of totipotentiality during early embryological development is actually a leading clue for recognition of historically constituted milieus throughout the interaction of embryonic cells, both between themselves and with their mother's body. Whatever the individual cells' receptors and effectors are capable of realizing is dependent on the development of their own internal constitution, but their own internality is itself realized through the larger "geohistorical" situatedness that the cell finds itself. While the scale and time span seem small from our perspective, cell differentiation is a vast, multi-generational activity accumulating phenotypic changes through regulating modifications in DNA activity. "Normal" and "abnormal" (and hence perception and signalling) become established through intercellular activity and cell-cytoplasmic activity. These are embryo-cultural effects.

Endogenous cellular interactions can provide important insights into the ubiquity of generative phenomena. Perception occurs in cells and the relationship between the static, genetic and generative levels may explain some aspects of embryogenesis that are comprehensible neither through a strictly reductionist nor a whole-body approach to biological explanation. Multicellular bodies and ecosystems are not differentiated from one another according to radically different types of organization but by the extent of integration in their organization. Humans are both submerged within an embedded contextuality that they affect and which affects them and emerge from the embeddedness of others (their intra-organic companions) whose phenomenal worlds humans affect through living. In any case, the degree of integration is very consequential for the type of learning and co-emergence that can occur.

11 There are also intermediates between human and ecosystem in terms of organizational tightness, such as plants, quorum-sensing bacteria and slime molds.
3. Evolutionary Generativity.

Husserl points out that the emergence of a new species, such as a wolf, creates new "teleological circumstances" that become normal and stable (Steinbock, 2003, p. 294). New species have novel behaviour brought forth by the relational milieu that the species emerged in, but in turn, enable certain types of interactions. Just as the specification of an embryonic liver cell, instigated through relationship, contributes to further intercellular dynamics, the evolution of a species is also in a co-emerging dynamic with multiple species regulating one another. In both cases, the style of the interactions is contingent upon the perceptual possibilities of the various beings disclosing one another in each other's milieus.

However, there are novel problems that emerge in evolutionary generativity. Consider the green katydid. We start by examining the shape and texture of the insect's body. It is green and smooth, and has a partitioning pattern on its wings and body that immediately recalls the veins of a leaf. And yet, unlike the cell within the embryo or even the plant foraging for phosphorous, these characteristics do not appear as expressive of the katydid's direct interactions in its milieu. The traits seems fixed, not physiognomic, and as something handed to the insect. The individual katydid did not develop greenness or pseudo-venation to deal with a concrete lived situation so the traits seems to transcend the katydid's milieu-aptitude structuralization. Merleau-Ponty and Uexküll both called such phenomena "magical", by which they did not mean anything supernatural. They refer to the feat where things fit together in a way that does not arise through dynamic co-emergence. The green insect is magical because it emerged into the world organized in such a way that it would easily find camouflage in a certain habitat. By observing the katydid, intercorporeal
entwining becomes clearer. Its colour and texture do not broadcast its milieu; rather, these formal features reveal the milieus of others. We encounter, in particular, information about the visual field of certain birds, insects, and amphibians. In so doing, the katydid indirectly makes known its species concern for evading death.

The possibility of mimicry, markings, camouflage, displays and rituals, as "innate" biologically evolved characteristics, points to a mutual "contamination" (Merleau-Ponty, 2003, p. 186) of two different subjectivities' milieus. The phenomenal world of one species or organism can imprint formal possibilities onto another, directing the future range of interactions possible for an organism before it has even begun interacting in the world. Because one organism's appearance is based on the sensory capacities of another, ultimately "what exists are not separated animals, but an interanimality" (p. 189), and so the outer body, as Portmann noted, appears as a "work of art," in contrast to the inner body, which appears like a "machine" (p. 187). The outer form, suffused with meaning for those around it, is a "semantic ensemble" (p. 187), and insofar as meaning emerges in this virtual world of form, there is already the kernel of symbolic development. Merleau-Ponty refers to "innate symbols" (p. 195), such as the crest of the cock (p. 187). These organs of display are "semantic organs" that "act through the meaning that they acquire during milieu-specific interpretations" (Kleisner, 2008, p. 207). Merleau-Ponty writes that "le corps est tout entier manière d'exprimer" (1995, p. 244), but an important detail is miscommunicated in Vallier's

12 When describing Logos ("in the sense of language"), Merleau-Ponty explains that "there is a Logos of the natural esthetic world, on which the Logos of language relies." (2003, p. 212). Meaning is established in the bodies of interacting living things long before life has found a new way to develop meaning in the diacritics of human symbol systems, and all the essential structures of the former normativity remain in the latter.
English translation. It is not that the body is entirely "a manner of expression" (2003, p. 187, emphasis added), rather the body is entirely manner of expression. It is not an object but a mode, it is not a noun but a grammatical relation.

The symbolic bodies' features provoke meanings dependent on, and in turn maintaining relationships. In so doing, they bring forth virtual norms. That the form bodies take are negotiated by those who make meaning from them points to the intersubjective constitution of normativity. While the geohistorical scale is vast, the evolutionary development of morphology has all the characteristics of a generative activity: the experience of the individual in its milieu is constituted by, but in turn re-constitutes, a virtual dimension of norms that has been instituted through the development of intersubjective activity. While the norm seems innate from the perspective of the individual, it is subject to development and remains normative through the continued interactions that depend on it. Through a history of interactions, life brings the world of form into deeper and richer ontological significance.

Through the generativity of biological evolution, the transcendentalist's world of surfaces and nature's incessant dynamics are not merely interwoven but unitary. Phenomenology, the description of phenomenal experience as it appears, finds itself in contact with the Being it sought to bracket out in static analysis.

**Generative Phenomenology and the Human Experience**

I have suggested that all living beings have milieus that are invariably actualized through the intersections with others offered by phenomenal intercorporeity. Although preliminary, I have tried to show this generativity in ecological, embryological and evolutionary development. The science of life benefits from a generative orientation because
form, in each case, is explained by inter-organismic structures of signification. However, conducting generative analyses on biological systems has another important implication for humans. By simultaneously acknowledging the milieu-constituting nature of all life and the indeterminate protocultural nature of such constitution, humans are solicited to consider other organisms as beings not merely effected, but affected by our manner of interaction with them. In other words, conducting generative analyses on other organisms has a generative effect on human phenomenality, by vastly extending the range of organisms considered relevant in contributing to cultural and historical development. Intersubjectivity, culture, and historicity are not insulated human experiences, but the very processes and products shaping ecologies on all levels. The unfolding milieus of other organisms are now seen as interbleeding with our own: diverse species are not isolated from one another and we fashion cultural and historical trajectories through our interactions.

As beings capable not merely capable of having phenomenality, but of conducting phenomenology, we bring aspects of the constitutive structure of the biosphere into consciousness. Doing so sets us into new relations with respect to the biological world. Although "phenomenological reflection is abnormal in relation to [the natural attitude], ... it institutes a new normality and a new teleology that brings it to expression in creative ways" (Steinbock, 2003, p. 295). This means that the phenomenologist “must take a position with respect to the way sense is constituted … she must be engaged in how sense should, ought to or must take shape” because the constitution of sense “concerns the future orientation of sense, which is to say, the generation of new historical meaning structures” (Steinbock, 1998, p. 189-190, 196; quoted in Smyth, 2007, p. 199, emphasis in original). The movement
back to static and genetic engagement has an ethical weight that comes with knowing that, although the structure of experience funnels particular trajectories for milieu constitution, experience is also changeable because it has been constituted culturally and historically. Thus, static phenomenology, prior to being revisited after a generative turn, is not simply suffused with a potentially misleading transcendental idealism, as critics of (early) Husserl noted. Knowledge gained through static analyses deceptively assumes ethical neutrality. In this sense, static phenomenological reduction follows the amorality of other types of reduction. Biological reduction, for example, in describing living beings as the product of genetic codes, disregards the biological meaning inherent in formal relations between organisms. But it is on this formal -albeit virtual- level that everything except physicochemistry occurs!

One possible invitation is to reconceive Husserl's notion of "homeworld" (Heimwelt). To move beyond the spatiotemporal world of the concrete ego into the geohistorical world through which phenomenal experience is made sense, Husserl describes two concepts that exist through intersubjectivity and intergenerationality: homeworld and alienworld (Fremdwelt). Our homeworld is the world that is constituted normatively around patterns optimized by those around us. "Home-companions" co-constitute our "home," and by extension, that which is not our home. "Members of an alienworld are liminally co-constitutors of [the] homeworld" (Steinbock, 2003, p. 298) too - by the boundary that they enforce from the outside. Husserl notes that animals can be home-companions, and we can further develop a description of the extent of the nonhuman presence in the constitution of the phenomenal experience of home. Throughout most of history and throughout most of the
Earth even today, plants and animals that co-inhabit bioregions with humans have been considered members of the human home to the extent that humans depend on them, interact with them, are familiar with their seasonal cycles, movements and styles, growing habits, and environmental preferences. Living in rural Southeast Asia, I have noticed that the same word, *baan*, means both home and village in Lao and Thai languages. A *baan* is the focal orienting concept in rural life, and it includes not only houses, but farm animals, cropland, community forests, and local water supplies. Meanwhile, modern, city-dwelling humans learn what their home-companions are through technology-mediated generativity. Television sets and other forms of media render photogenic fauna members of an emerging global home, while the "alien" is pushed outside of the earth's atmosphere. In both cases, human milieus are enriched through the presence of other species. As Steinbock notes, "an eagle, through its extraordinary sight, a dog through its ability to smell ... teach us something of 'our' world that we never knew before" (2003, p. 312). However, even shared perceptions teaches us something. That we can identify katydid camouflage reveals that the aesthetic world is more-than-anthropomorphic and that appearance as we see it is substantiated in other species' experiences. The phenomenal is validated, and the transcendentalist solipsism punctured, by both the katydid and its foes, such as the antwrens and mantids.

As indicated, our milieus now include the fact that we are implicated in the realization of the milieus of other species directly and indirectly through our activities. Conservation biology has yet to consider deeply initiatives from such a phenomenological perspective, but some ecophi...
possibility of a lived dimension in interspecies encounters and thereby becomes sensitive to the dynamics of intersubjectivity. Insofar as generative phenomenology "is concerned ... with identifying essential, a priori structures that bear on the re-constitution of homeworlds and alienworlds over the generations" (Steinbock, 2003, p. 298, emphasis in original), phenomenology must pay attention not merely to language, as this is limited to certain aspects of human generativity only, but also to the gestural, pheromonal, paralinguistic, and other ways that the varied members of our home interact and communicate.
CHAPTER 4: The Interspecies Educator's Cybernetic World

Abstract

The purpose of this paper is to interconnect pedagogy and biology via second-order cybernetics. Biology can better deal with intersubjectivity within and between species by incorporating approaches and theory from education inquiry. Conversely, educators can de-anthropocentize their discipline by entering into learning relationships with other species. By rallying around the concept of "eduction", second-order cybernetics plays a role in both syntheses. De-anthropocentizing education could have practical value in creating ecologically relevant education for children and in developing more integrated environmental impact assessments. Finding convergence between the study of life and forms of practitioner inquiry in education research, and connecting these to the environmental movement. Second-order cybernetics recognizes the active role a knower plays in the systems it knows, breaks down a long standing theory-practice division, and ushers in a concern with consequences. When consequences involve living, learning systems, this concern translates into educational and pedagogical questions, approaches, and experiments. Contemporary semiotic biology reveals that all living beings maintain themselves through learning (and being learned from) so pedagogy should extend into interspecies relationships. The concept of "eduction" can help draw the bridge between a cybernetic theory of knowledge and interspecies pedagogy. If biologists become educators and educators become biologists, both the life sciences and education theory and practice can make important headway in overcoming the human-nature dichotomy and precipitate a healthier, more sustainable epistemology. This has
possible implications for educators and conservationists, some of which are briefly sketched here.

**Connecting Cybernetics to Education**

Although feedback, recursion, and a temporal/historical dimension already set first-order cybernetics apart from linear approaches to science, first-order cybernetics was epistemologically naive as it was based on the premise that perception and knowing do not participate in what is experienced. By contrast, second-order cybernetics, birthed in 1968 along with the American Society for Cybernetics, and pioneered by Bateson (1972; 1979), von Foerster (2003), Maturana and Varela (1992), and (many) others, can be thought of as a further development that includes the observer in the system that it is trying to observe. Through this epistemological turn, cybernetics shifted from a physicalist ontology to one more open to the constructive role of experience in the continued maintenance of the organism, making lived experience not epiphenomenal but a causally effective process.

The assumption that the act of knowing was passive did not hold within the new epistemology. Coming to know something changes the knower and the known, and changes the relationship between them. A second-order cybernetician would point out that even *this very recognition* of feedback *itself* feeds back into the relationship. And so, with the knowing enterprise intimately connected with effects in the real world, cybernetics also came to increasingly connect theory and practice. Researchers would have to take responsibility for what their knowing and their knowledge constructs do, as

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13 Cybernetics has played a role in various fields, including family therapy, management, and ecology. Although these practical sciences conform to von Foerster's definition of second-order cybernetics as "cybernetics of observing systems" (2003), they are not necessarily explicitly "cybernetics of observing observing systems," that element of the second-order shift I consider of greatest consequence.
they recirculate through the world, for better or for worse. Linear models of systems
unaffected by participant interaction are only explanatorily sufficient in limit cases, so the
premises underlying much of the success of modern science cannot provide a prototype
for cultivating responsible human activities. Thus, we are beckoned to put ourselves into
the loop, and address explicitly the unfolding political, social, environmental, and
intrapersonal effects of our knowledge projects. And through sustained attention to
patterns and possibilities of our activities, a cybernetic science of responsibility emerges.
Cybernetics, taken in this direction, converges with pragmatic approaches developed
earlier in 19th and 20th Century America. Dewey (1916), for example, stressed that
knowing was not concerned with an external, passive reality but with the relationship
between our activities and their consequences. He urged an active and experimental
approach to pedagogy, ethics, and politics, where actions were constantly subject to
revision as experimental results were evaluated.

Not all cyberneticians felt comfortable with approaches that relied so heavily on
consciousness to formulate and steer our practical affairs. Bateson, for example, saw
purpose-driven solutions as inherently misguided, and instead sought aesthetic
approaches that place conscious purpose humbly within a larger, more-than-conscious
field of interaction (Bateson and Bateson, 1987). Nevertheless, the spirit of Dewey's
experimentalism can easily incorporate emotional, aesthetic, and embodied modes of
knowing. Indeed, no practitioner works without them. Educators are pragmatic, second-
order cyberneticians by necessity, but most of their cybernetic knowledge is procedural,
tacit, and embodied. They are concerned with changes that occur in their students'
development, which are in turn created, modified, or maintained by how each person
interprets the other. Engaging in such an indeterminate and evolving system relies on an exploratory openness and receptivity, though educators are rarely self-consciously cybernetic modelers. They are also seldom concerned with the unchanging, perspective-independent world underlying a classroom situation. To some extent, the capacity to be a good educator is in knowing when to avoid models that abstract and generalize from concrete experience such that uniqueness is swept aside. When models muddy uniqueness, the educator's receptivity to nuance is undercut, leading to constraints on growth for the student. Perhaps this is why many pragmatist philosophers were concerned with education and why many educators are attracted to pragmatic philosophers. As the complexity of cybernetic systems becomes clearer, as the observer-dependence of cybernetic systems become more apparent, and as the sensitive relationship between observation, interpretation, and consequence becomes undeniable, a pragmatic outlook on any research program will be pushed to the fore. Educational questions emerge. It is from within this emerging nexus that I turn to biology.

**Connecting the Biological World to Education**

There are multiple, causally-entwined "inheritance systems" amongst living beings, including genetic and epigenetic pathways, and behavioral and sociocultural learning (Jablonka and Lamb, 2006), so the complexity and interconnection in ecosystems is no mere epiphenomenal bi-products of causal chains originating solely at the genetic level. In this paper I highlight the role that learning plays as an agent in the formation of ecological communities (and ultimately evolution itself). All living beings live through learning, and so long as they interact with others, through *being learned from*. This occurs within species and between species. To be certain, many organisms do
not realize that they learn from others and are probably still less aware that they teach others. Nevertheless, learning and teaching orchestrate the living dynamic of the Earth, birthing both novel behaviors and perpetuating established ones. We can engage biological systems relationally from an educator's perspective, which is to say cybernetically, as pragmatists concerned with learning outcomes.

It is useful to consider what this perspective offers in contrast to those from which it emerged. Phenotypical inheritance has re-appeared in neo-Lamarkian frameworks that incorporate recursion into understanding life, such as the Baldwin effect (Weber and Depew, 2003), Peircean biosemiosis (Hoffmeyer, 2008), niche construction (Odling-Smee, Laland, and Feldman, 2003), Maturana and Varela's "structural coupling" (1992), von Foerster's "eigenbehaviour" (2003), and Bateson's emphasis on the communicative, creatural logic of the biosphere (for an overview of Bateson's distinction between pleroma and creatura, see Bateson (1979)). I owe my initial entry into these issues to the latter, and address it here. Bateson articulated that life's behaviour -but also its physiology- is better understood as the process and product of communicational relations between living beings, so we have to take communicational relations seriously. Life, like everything else, is bounded by laws of energy and matter exchange, but it works on its own energy stores and so can respond to distinctions relevant to it, sidestepping thermodynamic conditions to disclose and live within an informational world of valence and meaning. Further, one creature's distinctions change its behaviour and can, in turn, "make a difference" for other creatures that respond to it based on a similar flexibility provided by their own energy stores.
Bateson focused on communicational relations, but communication language does not foreground the instability and freshness present in how the one communicated to interprets the communicator. Nor does it intuitively lead us to take responsibility for the outcomes of communicational processes. If we consider these relationships educationally instead, the changeability and indeterminacy of biosemiosis is given more emphasis, as is our responsibility as actors within this entangled system. Focusing on communication leads to identifying patterns and regularities; focusing on education throws the researcher directly into the unfinished loop. The education researcher is enlivened to the unfinished character of the dynamic and to his or her involvement in it. This shift in focus may better serve Bateson's later preoccupations with how humans should act in a cybernetic world.

But is it relevant to talk of "teaching" if other species do not know that they are teaching?

**The Human Animal in the Interspecies Curriculum**

Allow me to now paint an overly simplistic picture of curriculum theory to highlight where I think this discussion comes in. At one time, education theorists and philosophers thought that what educators taught was a pre-planned curriculum that had been designed for instruction of other human beings inside a classroom (Tyler, 1949; etc.). Some realized that what was actually taught included not merely what they intended to teach, but all sorts of other things, coming out through the ways they talked, the clothes they wore, the architecture of the classroom, and so on (Eisner, 1994; Snyder, 1971). An unintended, hidden curriculum became the mischievous meta-context that sometimes complemented but often interfered with what educators were trying to teach. Education theory was blurring the content/context distinction and becoming explicitly
second-order. Meanwhile, it became obvious to others that after the teacher left the classroom, and walked to the bus-stop or to the car, it was pedagogically relevant which one they went to. If they went to the bus, they would be teaching a different pattern of "normal behaviour" for their culture than if they went to a car. Curriculum theory was opening its doors to the outside world.

Education is moving outwards, and this level of consideration is still incomplete (Affifi, 2011). As the educator walks to the bus, we also find that he or she is teaching the crow perching on the pine above the walking path. If the educator’s manner is oblivious to the company of the crow, the crow will learn different things about its world than it would if that human was treading carefully and attuned to its presence.

This might seem trivial. Does it matter that the crow flies away or stays on the perch? Yes, it does. The crow is not a billiard ball in a Newtonian universe. Whatever it does could, in turn, teach other crows, other species, humans, and itself (because education is also moving inwards) something about the relationship between humans and crows. Consider this example: at the Sai Nyai Eco-School, a school I have been getting off the ground in Laos, sparrows avoid humans. They will rarely be seen within twenty meters of Homo sapiens. This is because people in the area are often equipped with slingshots, will project stones at them, and, when successful, bring the birds home to make some delicious Lao food. However, when I cross the Thai border and go to Ubon Ratchathani, I often eat at a vegetarian restaurant where the same species of sparrow will peck rice grains out of the patrons' hands. This difference is surely stabilized not only through patterns of human-sparrow interaction, but through sparrow-sparrow interaction. Other sparrows see how sparrows act in the presence of humans and normalize those
patterns of activity. My point is not that we should cultivate relationships that are "warm and fuzzy" in all contexts with other species. Perhaps the wary sparrows at the school are teaching each other a better lesson. Assessing this requires multiple spatial and temporal scales and considerations of who benefits and how through the various curricular outcomes that could emerge. In the face of such complexity, any assessment is tentative and is itself experimental. However, as implicit second-order cyberneticians, educators are aware that the very act of considering what is a better lesson opens up a space -an attentiveness- with consequent relational shifts for those involved. These shifts usually provide flexibility in the dynamics between the teacher and the student, and enable less unidirectional forms of co-regulation. It is the beginning of the possibility of a pedagogical relationship.

Nor are these interspecies relations to be considered solely in the animal kingdom (Affifi, 2013). Plant biologists, for example, are uncovering many ways that plants respond to, learn, and communicate with their surroundings. Science can help us see the effects of our actions on those with very different lived experiences from us, extending the capacity of our pedagogical consideration (Affifi, 2014). From an educational point of view, science is useful in opening up possibilities inaccessible to our established perceptual or conceptual filters, but should be approached cautiously because of its parallel tendency to close off our imaginations to alternatives.

Eduction in the Interspecies Curriculum

Humans are capable of realizing that they are teachers and learners, not merely in interaction with other humans but also with other species. We are also capable of realizing that our actions can be considered explicitly as such, opening deep pedagogical
questions and possibilities. From a cybernetic perspective, we are not *sometimes* teachers and *sometimes* learners. Rather we are always both: our actions are always also the reactions of those we encounter. We can make either distinction for heuristic reasons, but the value of such distinctions is to be assessed pedagogically in terms of what relationships and possibilities of growth are created through them, for us, and for others, in our evolving encounter.

We are also invariably "teacher educators" and "student teachers." Those we teach, teach others, in an unbounded chain, diffusing like a stone's ripple in a calm lake. And yet, we are also always a response to another's teaching, and in that way, just the first ripple of another stone, that spreads out through those we subsequently encounter. As in any complex system, there will be factors that dampen the possibilities of such spread, but this does not change the essential structure of the experience nor discount the occasional establishment or spread of novelty through such pathways. It is within this experiential space that possibilities of both structure and change emerge.

This process of coming to know through relationships between learners can be called "eduction." Eduction, rooted in the word "educe", conveys that knowing is "drawn out" or "led out" in the other through relationship. Inferential modes of coming to know, deduction, induction, and abduction can occur within learning relationships, yet are primed by larger contextual factors that evolve through eduction. What I will induce about you (or with you) will depend on the range of inductive possibilities offered by our evolving manner of eduction. I am not suggesting that eduction is totalizing in its reach. It surely depends on inferential acts to modify or sustain itself. Nevertheless, it sets the context of knowledge-production that schools our evolving relationships. Eduction shares
its etymology with "education," emphasizing the fact that coming to know is not
solipsistic, but something that occurs between learners, and is part of the unfurling,
epistemologizing of life. It also positions the human learner in a role of responsibility and
care: what patterns emerge through eduction are co-constructed through their very own
activities.

Eduction is a refining of previous cybernetic insights. Recall the
"characterological traits" (or Learning II) that Bateson (1972) described as products of
relationship: dependency, aggression, and so on. In interacting with other living beings,
we find ourselves in relationships that educe character traits in the other and in us. These
are the contexts that become established and govern subsequent knowledge co-
constitution. In developmental systems theory, eduction recalls what Fogel describes as
coregulation of consensual frames (1993). Eduction is also in eigenbehaviour (von
Foerster, 2003), in which equilibrium in the behaviour of two participants is achieved
through mutual, recursive co-constitution (p. 267). In the interspecies curriculum, humans
develop specific ways of understanding themselves and human-other relationships, and
patterns of self-validating behaviour emerge.

By denying mindedness in the biological world, we generate eductive
relationships with other organisms that are akin to plants growing without vital nutrients.
We treat other living beings as we do inanimate objects, and assume that they cannot
participate in the context setting of the evolving eduction. The resulting knowledge is
chlorotic and stunted. The eduction proceeds by bolstering the sense that other living
beings are but the mechanical backdrop to the rich drama on the human stage. In turn,
this context curbs our openness to co-establishing eduction, further deadening our receptivity to the possibilities inherent in the unfolding dynamics.

Eduction occurs between multiple learner/teachers, so traits fix quickly because there are two sets of eyes normalizing the relationship instead of just one. When we interact with another living being and that being has learnt to act in a way that is consonant with our interpretation of what it is, then our behaviour -and theirs- is being re-produced from two different, re-enforcing directions. As Bateson would say, the results are multiplicative not additive. This presents unique pedagogical challenges. However, for the same reason, it can also sometimes be easier to get out of established gridlocks than is the case when a positive feedback dynamic is established between an organism and something inanimate, such as happens a cigarette addiction. If we can change our behaviour, our changed behaviour will be re-interpreted sooner or later by the other being, which will propel the rise of new directions, patterns of action, and re-conceptualization. Such participatory un-lodging is not readily apparent in most interactions with the non-living world.

Implications

I offer one recommendation and two implications for educational practice. The recommendation first: educators can do what they do best even better by explicitly engaging in cybernetic thinking. Very few educators label themselves "cyberneticians." While they dwell professionally in eductive recursion (i.e. when teaching, they are learning from a learner learning from them), the capacity to produce cybernetic models is not for them of high practical value. Recursions are usually happening too fast and on too many simultaneous and interacting levels, rendering most models misleading. Instead, the
educator often accesses and acts on emotional responses to the situation, which function as embodied statistical computations of complex lived interactions. This does not mean that explicit cybernetic thinking is useless to an educator. Educators do think and do model. When they do, like all of us they tend to fall into lineal traps of one kind or another, some of which they learnt in teacher's college, but most of which they internalized far earlier. For this reason, in educational contexts cybernetic thinking may be of greatest utility in a negative sense: rather than providing models that we can apply to lived situations, cybernetic thinking should be recruited to detonate captivating patterns of thought that reduce interactive complexity to something linear (or, what is almost as dangerous, something simplistically recursive). Familiarizing oneself with cybernetic thought assists in understanding the circular nature of experience but does not and cannot comprehensively represent the entire experience. Practitioners can enter into the unfinished loop with less baggage when they employ cybernetic theory to scrape away what severs or distorts the educing relationship, bringing them into the living charge and potentiality of the direct encounter.

As educators de-anthropocentrize their thinking, classroom experiences will prove critical in developing ways of understanding and engaging in interspecies relationships. The average educator does not realize that the biological world is semiotic, is communicative, and is learning from them (even right now), having been heavily funneled by the anthropocentric constraints of the discipline. It is therefore essential that, as the biologist spreads out to embrace what is offered from the experience of educators, the educator likewise treads into the intersubjective world offered by subject-oriented and semiotic approaches to biology. After breaking down the barrier between pedagogy in the
classroom and interactions with other species outside it, educators can venture into interspecies interactions with care and experience, drawing from their rich work with children.

This should have important consequences for the environmental movement. Environmental scientists currently monitor the physical and chemical effects of human activity manifested in pollution, land-use changes, and the like, and record population-scale biotic effects, such as trends in biodiversity distributions and migrations. The options available to us in developing ecological societies are directly mediated by what we understand our ecological effects to be. If we limit our understanding to what environmental scientists are currently monitoring, we will continue to miss underlying causes and effects of destructive human behaviour. Environmental impact assessments loyally follow the Cartesian assumptions about mindedness in nature, missing orders of interactivity.

Educators will be able to help us develop an understanding of our pedagogical effects on the organisms in our bioregion. Whether or not it makes sense to label these effects as a new sort of pollution (such as "semiotic pollution", for example) I will leave unresolved. The term "pollution" may not adequately account for the co-regulation present in eduction, reifying the very dichotomy that needs to be overcome. However, such a discrimination between ecologically pathological patterns of eduction and those that promote vitality and re-generation may be useful for more pedagogical relationships. In any case, it is necessary to cultivate and hone our perceptual capacity to observe and experience existing relational trajectories as they unfold and to be better equipped to engage in whatever lies in the unforeseeable future. Because (good) educators are ever-
participating in eductive relationships, they bring a unique sensitivity needed to compel human attention into the subtle realms of semiotic unfolding in their bioregions. We could become conversationist conservationists.

A second practical implication is that breaking down the classroom walls (and perhaps this is literally in part what is needed) will recast classroom curricula at the root-level. A teacher sensitizing to interspecies relationships will conduct school subjects in ways scarcely imaginable today. Biology would probably face the first significant shifts, as the Cartesian assumptions underlying its rigid fixation on anatomy and physiology would surely lose out as the ontological premises of the discipline. However, both the humanities and social sciences would eventually re-orient to make room for the history of eductions between humans and those other beings around them, and for the co-constructed futures that potentially lie ahead. An integrated demolition of the human-nature dichotomy should be a part of any approach to environmental education dedicated to dethroning the pernicious assumptions that continuously invite us to commit error and folly.

One blind reviewer asked me to include a section on the implications of the ideas developed in this paper for policy. I confess that I am unable to satisfy my reviewer's demand. Teachers should certainly be given enough freedom to re-vision their subjects as needed, so any further push towards standardizing existing curricula would be hazardous. However, I am much more hesitant to make a positive claim as to what curricular or policy level changes are needed. It is not clear to me whether new ways of thinking should "trickle-up", or whether it is more profitable to make the changes at the school level.

14 I take these two terms in the broadest sense: they are the dominant methodological approaches to studying life at every scale, from genetics to ecology.
board and curriculum level. At such an embryonic stage, I am tempted to advocate that we need to sow and nurture our capacity in eduction before we begin implementing policy changes. Not doing so risks propagating one-sided and non-relational solutions that this paper seeks precisely to avoid. Although I have put forward a framework to re-conceive human relationships with other species, I must admit I am still hopelessly insensitive in my interspecies eductions. With the incredible weight and momentum of history, we have decades, perhaps centuries, of unlearning ahead of us.
CHAPTER 5: Biological Pedagogy as Concern for Semiotic Growth

Abstract

Deweyan pedagogy seeks to promote growth, characterized as an increased sensitivity, responsiveness, and ability to participate in an environment. Growth, Dewey says, is fostered by the development of habits that enable further habit formation. Unfortunately, humans have their own habitual ways of encountering other species, which often do not support growth. In this article, I briefly review some common conceptions of learning and the process of habit-formation to scope out the landscape of a more responsible and responsive approach to taking growth seriously. What emerges is a reflexive biosemiotics that has humans explicitly concerned with the in situ emergence of new signification in themselves and in other organisms. This requires we take a pedagogical stance in our attitudes and practices towards other species, which we can enrich with insights derived from re-interpreting traditional empirical studies. By freeing the habit-forming process from confining stereotype, a biological pedagogy can enable a more fluid and creative biosphere, unencumbered to explore unfolding possibilities in semiotic space.

Introduction: Locating Biological Pedagogy within Biosemiotics

Biosemiotics studies, in part, the processes and consequences of habit-making via sign activities in living beings, which occur on multiple biological scales from ontogenic development to phylogenic evolution. Jesper Hoffmeyer (2008a, pp. 189, 191; 2008b; also more recently, 2010, pp. 190-191) has argued that the main task is to uncover the semiotic logic universal across the various means and mechanisms through which life comes to signify. He is not alone (see Stjernfelt 2012, p. 49). What is important, presumably, is that all biotic processes bear semiotic homologies because the structure of
signification is scale independent. That the rooster's crow signifies something of "genetic" origin for the hen while the farmer grabbing his pail of feed signifies something else through "learning" is, in some sense, irrelevant. Both are semiotic phenomena that create, enable, and nurture distinction making and the differentiation of meaning by constructing signs, objects, and interpretants. Further, in both cases, the hen acts in certain ways based on these significations and the world subsequently changes by incorporating her actions into it (as happens, for example, in niche construction (Odling-Smee et al., 2003)). Eventually, her actions can come to have significance too for someone or something - in any case, her semiotic activity has invited this possibility. In so doing, mutual interlockings of habit emerge, in what Hoffmeyer calls semethic interaction (2008a, p. 189). There is, then, a semiotic core seeding the emergence of biological systems from cells to ecologies.

By saying that it is "irrelevant" where semiosis is taking place, Hoffmeyer was deliberately overstating the point to underscore the pervasiveness of semiotic phenomena and the explanatory breadth of biosemiotic concepts. There may indeed be broad structural similarities underlying the biosphere's diverse significations, and it is important to underscore this point. Nevertheless, we should articulate the differences between the phylogenetic and ontogenetic semiosis, because we are implicated differently in each of them. Semiotic evolution matters because it has consequences, for us and others, in the biosphere. One's semiotic effects on a semioregion are just as real as one's material

15 Hoffmeyer writes: "Whenever a regular behavior or habit of an individual or species is interpreted as a sign by some other individuals (conspecific or alter-specific) and is reacted upon through the release of yet other regular behaviors or habits, we have a case of semethic interaction" (p. 15, 2008b)

16 Kotov and Kull (2011) describe a Lotman-inspired semiosphere as the "set of relations comprising everything living" (p. 191) on the planet. However, just as "biosphere" often unnecessarily draws us away from our active participation in and effect on the world,
effects (such as pollution) on a bioregion. Many of these consequences are in the midst of developing and our involvement in them raises different challenges at each scale.

Protection of ecosystems is crucial to prevent semiotic stagnation or erosion: it is in the vast and evolving networks of species that novel semethic interactions have the richest opportunities to emerge and flourish. However, there are also situations in which humans interact with other creatures firsthand and can have immediate impacts on ontogenic semiotic development. Such direct encounters form the basis of this article. Maran describes a "unit of meaning" (2006) formed through the mutual acts of interpretation of a human and another organism, highlighting the need for a dialogical approach to semiotics (Petrilli & Ponzio, 2005). A dialogical approach, broadly construed, is helpful for coping perceptively and vigilantly with our semiotic impacts. Whether casually or as a researcher, and however wittingly, we are directly implicated in unfolding semiosis whenever we are in shared spaces with other living beings. In these cases the very models used to interpret other species, be they semiotic theories or not, have semiotic consequences. Models are not simply neutral and disembodied abstractions but guides of activity and therefore vehicles spurring particular chains of interpretants. Biosemioticians should be concerned not merely with habits that have formed, but also with habits that are forming and with habits that could form. My position is that this shift opens up a pedagogical dimension of biosemiotics that is not only coherent with, but is in fact required by, a semiotic interpretation of life. Educative approaches to interspecies

"semiosphere" bears the same risks as a global, abstract category. Since the purpose of biological pedagogy includes increasing the capacity of humans to respond with semiotic sensitivity to their interspecies relations, a regional term is preferable. Of course, any semioregion is connected by some semiotic transaction to some other, ultimately unifying as a semiosphere. But it would trivialize our embeddedness and responsibility to equalize semiotic relations in this way. Finally, semioregion should not be thought of in terms of geographical proximity but in terms of semiotic interactivity.
relations can stimulate the attentivity needed to engage with unfolding semiosis responsibly and responsively.

An *educative* approach? For educators, no less for semioticians and biologists, this may seem like a forced move. People associate education with the delivery of curricula to children (or, at least, to *humans*) in schools. However, whether or not an approach is educative is quite independent of any conception of pre-set content outcomes, let alone established learning institutions. From a Deweyan perspective, an educator is someone above all concerned with setting *educative* contexts that open up experience to further richness, possibilities, and distinctions. In this sense, teachers employed to *deliver* curricula engage in activities often at odds with "being educative" as they inadvertently "engender callousness" (1938, p. 25) or "produce lack of sensitivity or ... responsiveness" (pp. 25-26) in their students. *Educators*, by contrast, take a collaborative approach.

Consider a naturally gifted educator talking or playing with a child spontaneously *outside* of a classroom. The dynamic between them has a direction that is hardly dictated by the educator. It is instead evolving through the relationship itself, and in specific, through what each person draws out (or *educes*) in the other. To be sure, the relationship is asymmetrical. The educator is also engaged on a meta-level, with a sense of responsibility that comes from being aware that there are resulting learning effects. Such educators, in this vital, non-institutionalized sense, are semiotic *savants par excellence*: their business is to glean the varied signs, in their ebbs and changes, on all levels, from tentative glances to bubbly utterances, and to constantly evaluate what is happening with a pragmatic eye toward future outcomes (i.e. interpretants). This latter aspect separates them from others gifted in artful semiosis, such as improvisers of all kinds, because the
educator's focus is not merely to create something beautiful or fun through collaboration. The concern is with how the other (and oneself) become, not just in the midst of the process, but as a result of the process as well. From within this tack, I offer the term **biological pedagogy**. If pedagogy is the studied artistry of being educative with humans, biological pedagogy (or biogogy, perhaps?) is a similar concern and craft towards any living being.

Like an educator who throws herself directly into the semiotic loop with her students, oriented towards unfolding consequences, humans should be able to develop pedagogical relationships with other species. Being an educator, in this context, means acting towards others, regardless of their DNA or phenotype, pedagogically. This does not mean that learning is not "mutual" in any semethic interaction. Semiotic recursion expects this. We are all teachers and learners. What being an educator means is that the educator is aware of the underdetermined nature of the interaction, is watching for cracks and openings and opportunities for growth, and is imaginatively engaged with what may happen and how. It is this meta-level asymmetry that gives the educator its name.

Unfortunately, we are encumbered by various constructs and theories that prevent us from taking biological pedagogy seriously. Nativism, behaviorism, and naive anthropomorphism, three dominant "everyday" approaches to explaining other species (a claim that I will not defend here), all constrain our capacity to engage pedagogically with other species. As will be made clear, biological pedagogy suggests that we take a pedagogical interpretation of Dennett's "intentional stance" in our disposition to other

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17 Other approaches, such as cognitive ethology (Allen & Bekoff, 1997) will not be discussed for two reasons: they have not captured the public imagination as much as the three approaches identified, and their primary aim is to provide descriptions and explanations of biological phenomena (and are therefore subject to many of the concerns raised in this paper).
organisms. The implications of biosemiotic theory signal that we get into such a pedagogical space, where we can be specifically concerned with ontogenetic habit formation, consequent semethic interactions, and our roles in it.

**Growth as a pedagogical principle**

Educators are constantly evaluating their semiotic interactions with others, concerned with the habit-making process and its results. *Habit* is a crucial, but paradoxical concept for Dewey (1923), because habits provide the entry point for new experiences but also the possibility of constraining or preventing novelty. Dewey explains that the "very operation of learning sets a limit to itself, and makes subsequent learning more difficult" because "habit-forming wears grooves" (1925, p. 280). However, he qualifies that this refers only to "non-communicating habit" because "communication not only increases the number and variety of habits, but tends to link them subtly together" (p. 280-281). Dewey also notes that while a given habit de-sensitizes the organism, the multiplication of habits and the expanding power to form habits "means increased susceptibility, sensitiveness, [and] responsiveness" (p. 281). Dewey's logocentric notion of communication barred other species from the process, but we now know that there are forms of signification between species that birth novel semethic interaction. Connecting these ideas together, the interspecies educator's challenge, then, is to communicate in order to enrich habit-forming capacities.

*Growth* is a Deweyan concept that has had utmost influence in education theory and practice (Garrison 1997; Kohl 1984; Noddings 1998; Hansen 2006; though for some critiques, see Hardie 1962; Hirst and Peters 1970; Nyberg 1975; Bowers 1993). For Dewey, growth occurs when possibilities open up for an organism, thereby "enhancing its
ability to participate in its environment” (Gouinlock 1972, p. 238). It is the process of developing habits that allow the organism to interact more spiritedly, responsively, and openly to arising circumstances. By contrast, a lack of growth limits possibilities of encounter, as the organism relies on preformed habits that stultify, ossify, and close it off to novelty. In other words, growth is predicated on habits that enable future habit-forming, whereas the restriction of growth occurs when existing habits monopolize the operational domain (see, for example, Dewey 1916, pp. 44-48). We can see that Dewey has a semiotic concern: he wants to promote semiosis that enables the development, amendment, and creation of new sign activity, not semiosis that crystallizes meaning into a law-like trench. A biological pedagogy so conceived would have these same educative goals with respect to both human and interspecies relationships.

Learning theories and biological pedagogy

Unfortunately, the most common ways in which we perceive and interact with other organisms are stereotyped and therefore growth-suppressing. In this section, I shall review how several main strands of learning theory contribute to different semiotic courses and show how, despite their strong differences, they are all fail to promote any sort of compelling pedagogy. I will present three extreme positions (nativism, behaviorism, and naive anthropomorphism) that have greatly influenced how people understand and encounter other species. There are common chimera versions too (for example, people tend to view their wide-eyed puppy as "trainable" but the soaring hawk above them as "instinct-driven") but these hybrids lack coherency or integration. Experts in diverse fields ranging from psychology to ethology may have more subtle articulations of animal minds that, looked on closely, are still some complex admixture of these
dominant ways of thinking. As a result, they may be no better off as interspecies educators (and may, in fact, be disadvantaged because they have devoted so much to their frameworks). Each position numbs the human capacity to engage pedagogically. As will be shown in a later section, to strip off these limiting frames we need to adopt a 'pedagogical stance' and bring an imaginative concern with semiotic growth into our varied relationships.

Nativism and behaviourism close off possibilities for biological pedagogy from opposite sides. Consider an ethologist, with a one-sided reading of Lorenz, compiling a comprehensive ethogram of some species of forest rodent. The ethologist may accept that a forest rodent has internal mental states and perhaps even acknowledge semiosis (though it would likely resemble a broken record more than anything else), but is closed off to the rodent's learning and change. Of course, the ethologist here is concerned with a generalizable species-level description and not with individual variation or development, but "instinct" has had profound power over the imagination of the general public. Such an ethologist may be a "straw man" for my argument but it is just this wooden characterization that has such a broad influence. I frequently hear people explain animal behaviour with the term instinct, which, far from being an explanatory concept, functions more effectively as an invitation to stop thinking about (let alone, engaging with) the animal altogether.

Imagine if a teacher approaches his or her students as though their behaviour is fixed (by whatever means). It is easy to see that she is not going to get very far. For example, suppose a young boy is constantly acting up in school. The teacher shrugs and says: "boys will be boys", or, perhaps: "well, he is at that age." The sensitivity and
participation of the teacher can easily be petrified by such conceptual frameworks. The teacher fails to engage, and the framework becomes self-validating. Growth, for either of them, becomes scarcely conceivable.

On the other hand, while modern forms of behaviourism, such as behavioral analysis, have gained in nuance, the tradition still generally views learning as an associationist process that can be adequately explained and theorized from the outside.18 Many people who do not accept that animals (or plants) are simply pre-programmed machines conceive of them behaviouristically. The behaviourist intuition has also had a strong impact on our everyday attitudes towards other species. If Felix pees on the carpet, the question is how to train him (through rewards or punishments) so that he associates the carpet with something negative or the litter-box with a treat. When handling wilder learners, people often resort to the same methods, employing behaviourist strategies to repel the raccoon harvesting from their garbage pails, or to attract finches to their bird feeders. Unfortunately, while acknowledging learning, the behaviourist approach replaces the fixity of mindless innate mechanism with mindless conditioning, which has its own pedagogical limitations. While it gains the phenomena of change, it loses experience or semiosis. This amounts to throwing out the baby with the bathwater.

Behaviourism acknowledges learning, but has an impoverished sense of what it means. Suppose the teacher insists that, through reward or punishment, the student could be steered into better behavior. The behaviourist approach can be employed by directly conditioning the boy, but it could also take the form of working with his parents (with the

18 While rightly maligned by subject-centered biologists, if humans paid better attention to behaviour, they would still develop deeper relationships and sensitivity towards other species than is the case with "everyday" nativism. Behaviorism can dislodge our habit of thinking of other species in terms of "built-in mechanisms" that leads many people to ignore the subtle shades of differentiation and change in the biotic world around them.
understanding that his parents, if themselves conditioned, could condition the boy more effectively than a teacher could). In any case, the learning model is rooted in an epistemology that asserts that learning occurs when the adjacency of reinforcement stimuli becomes induced. Such a model, by its nature, tends towards fixed outcomes and control, because the only agency that matters is that of the conditioner. Learning and change are put in the foreground but growth seems further away than ever before.

I suspect that most behaviourists (including Skinner) did, in their weaker moments, find themselves "attributing" [sic] mental states to their pigeons and rats, and that, in doing so, developed empathy, care and a deeper responsiveness towards them (for an interesting perspective on Skinner's "conflict" with consciousness, see Baars (2003)). However, these ways of knowing and relating were likely chopped off as soon as the behaviourists became aware of them: such "projections" had no place in their empirical methodology. Behaviorists thereby developed habits that restrict their own growth along with the growth of their animals. What they trained themselves to chop away is not simply a misattributed human mental state, but the beginning of a richer action, reaction, semethic interaction, and eventually, a relationship. By refusing to allow the interaction with their study animals to go beyond observer-observed status, and by refusing to imagine the other species' possible experiences, perceptions, or mental states, they were restricting themselves access to the seeds of a potentially vast dimension of semethic interactions. This capacity to imagine, which will be explored explicitly in the next section, played an important role in all human activities in societies directly interdependent with their ecologies: evidence from myths, stories, practices, and beliefs indicate that everything from hunting to being hunted depended on it.
A third approach, which I am calling "naive anthropomorphism" is also stultifying for the possibilities of educative semiotic interaction. I contrast naive anthropomorphism with the alleged "anthropomorphism" of many stories, beliefs, and practices developed by many indigenous cultures that have maintained continuous, intergenerational observation and interaction with their ecological communities. Naive anthropomorphism assumes a strong identity between the human mind and that of other species, but does not observe or relate deeply enough with them to re-adjust the conception. As an explanatory program, naive anthropomorphism limits and distorts modeling, and has been justly denounced. From an educational point of view, it fails on a different account. Naive anthropomorphism has as its classroom analogue a teacher who is unable to conceive that her students perceive the world differently than she. As a result, the teacher is not receptive to differences. This is also growth-suppressing. Like behaviorism and nativism, naive anthropomorphism is imaginatively dead.

If all three approaches fail to develop growth, what then, is an educative move?

**The pedagogical stance**

Dennett's famous and controversial "intentional stance" (1989) has drawn respect and ire across the disciplines, from cognitive science to evolutionary biology. For Dennett, we should ascribe intentionality (in the form of purposes, goals, rationality, beliefs, etc.) to certain phenomena such as living beings and some machines because it leads us to predict and describe their behaviour more easily. It serves a methodological role in an explanatory program. Insofar as Dennett is more concerned with what using the stance does than whether or not it is "true," his strategy bears a resemblance to the pedagogical approach that I have been developing in the preceding paragraphs. There is a
pragmatic spirit to it. However, Dennett's project, as he repeatedly acknowledges, is an explanatory one. He maintains that adopting the intentional stance will get us into a position where we can see clearly where the stance works and where it breaks down (see Burghardt (1991) for a parallel exploration of this line of thinking in cognitive ethology). Ultimately, it is merely quasi-adopted for a future "truth" that it hopes to coax out of the phenomenon. As far as I can tell, he never discusses whether or not his application of the intentional stance for explanatory purposes has an effect on the intentionality of the beings requiring explanation.

Hoffmeyer (2008a, p. 94) provided a transcendental argument against the conclusions Dennett draws in applying the intentional stance. Pedagogically, Dennett can be amended (or extended) differently, which I believe is also a part of the biosemiotic program. The problem, from an educator's point of view, is that regardless of whether or not ascribing intentionality for methodological reasons leads to better explanations, what we really need to consider is what leads to better relations. Truth, for Dennett, still ends up a matter of correspondence and not of co-responding. Consider: what is the status of Dennett's "stance"? Is intentionality a position that he explicitly and deliberately adopts, as the definition of the word usually implies? Or is it, rather, a position that he is deliberately not adopting by forever casting an "as if" ascription onto it? For the educator, commitment to the ascription matters, and so Dennett's approach to the concept of a "stance" seems misguided. Dennett's devaluation is clearly a self-validating (to use Weston's (1996) terminology): if we do not believe that crouching down to invite a wounded robin to hop over for help could work, we would never call her authentically enough to elicit an authentic response. All we would have access to was her "as if"
response to our "as if" approach. No small wonder then that the space between Dennett's "as if" intentionality (provided by the design work of natural selection) and human intentionality (which he sometimes casts as "higher order" intentionality) is so large and vacuous. Though Dennett ultimately sees all intentionality as the result of a mechanical, algorithmic process, he manages to confine language, thinking, emotions, and freedom to a uniquely human domain to which he attaches weighty ethical import. As a result, despite Darwinian arguments in favor of continuity, his own application of the intentional stance continually reifies a human/other dualism that delimits other species prior to any actual interaction. It prevents growth.

In contrast, an educator approaches his or her students as intentional beings. It is not an "as if" ascription employed to pan an algorithmic description of "mindedness" out of the students, as Dennett's application of the intentional stance would have it. But it is an intentional stance because it does not require the burden of proof prior to use. The educator takes a stand against solipsism. The quality and direction of the semiotic recursions possible between the teacher and the student is very much dependent on the extent to which the educator takes the student's intentionality seriously. The educator is a semiotic practitioner, ever poised between the past and the future, concerned with the habit-making process itself, and not with the static establishment of a final interpretant or description. Explanation is not the end. An "as if" stance for explanatory purposes should be subservient to the semiotic unfolding that the educator is directly immersed in. We can call this a pedagogical intentional stance, or for the sake of incrementally more graceful language, simply a pedagogical stance.
If biosemiotics limits itself to categorizing organism activity using Peircean (or any other) concepts, it remains within a descriptive and explanatory modality. I myself have attempted such a study (Affifi, 2013). The problem is that such a modality is ill-suited to take into account two important semiotic points: semiosis is still ongoing, and it is affected by the very act of studying it. To put it differently, any explanans of a semiotic system itself fixes the habit-forming process, altering the explanandum. If we take biosemiotics seriously it is therefore important to be reflexive because semiosis is alive around us. To do so, we must cultivate a belief in the semiotic capacity and freedom of other species as much as we can. We should be directly concerned with removing the blinders we have all inherited on conceiving mindedness in nature. As educators, we must resist the vestiges of Cartesian doubt, such as we find even among some biosemioticians, who, instead of approaching another species with sufficient agnosticism to allow for growth, allocate the minimum amount of mindedness necessary and demand that the species prove that there is more to come. However, we should be equally skeptical of any reckless blanketing of anthropomorphic mental states onto other species that also deaden our sensitivity to difference.

The pedagogical stance is not fixed: the semiotic process it enables between a human and another being will immanently alter its presumptions, shifting our imagination of the conceivable possibilities for experience. Perhaps the entry point that can provide the highest level of openness is to universalize the Umwelt concept (von Uexküll, 2010) while continuously questioning our assumptions about what the Umwelt experience entails. Is it possible to encounter another organism with the assumption that other beings, of all types, have experience, but that none of them have experience like humans
do? This is admittedly a koan, it becomes paradoxical the more we think about it (...well then, is it, or is it not, "really" "experience"?), but that does not matter. Its purpose is to open up a relationship where we can become more sensitized to learning, change, and habit formation that occur as a result of our encounter. The educator lives in a world where understanding another's perspective is always an immanent possibility, a beckoning and a calling, but where no understanding that is actually arrived at is permanently adequate. As an orientation towards future knowledge, the educator has an optimism and faith in possibilities, but oriented towards existing knowledge, the educator has suspicions that the frameworks established may already be confining semiotic activity and hence growth. This is true for interactions with humans as much as it is for other species.

Consider, one more time, the teacher with the misbehaving boy. If the teacher in the classroom lets herself imagine what it is like to be the misbehaving boy, the tenor, mood, and possibilities of interaction between them shifts. The teacher is obviously not a devotee to the method of Cartesian doubt, requiring proof that the student is feeling what he appears to be is feeling before committing to relating to him in certain ways. The teacher neither assumes that the boy is a mirror of herself nor does she, as Dennett advocates, apply "the assumption" that the boy has feelings as some sort of Turing Test. Instead, the teacher is charged with the vitality of an intersubjective relationship, and with the opportunity of meeting a unique and developing being. The teacher creates a pedagogical space, led by the conviction that understanding the boy is possible, and by inviting the boy to exist in the space without being channeled by the teacher's prior convictions of what he is presumed to be. Possibilities are imagined based on available
information, explored, and acted on (consciously or otherwise) in various ways. The possibilities may be wrong, but they do not clutch the teacher's spirit with the tenacity of a "truth". Rather, the yearning to try to experience the child's world continually refuels the process, enabling the recursion needed for calibration between the teacher's imagination and he to whom she is trying to relate. The interspecies educator could encounter other species in a similar vein: it is unnecessarily constraining to draw the lines in the sand before the relationship begins. The educator should use any resources available to enable conditions of growth.

A "pedagogical stance" is not something that we try out once (or even a few times) and then abandon once whatever mindedness (or lack thereof) of the organism under question comes into view. It is not a strategy to establish a static description or to capture explanandum. What happens, though, when the pedagogical stance (like the intentional stance) breaks down? How can we not avoid making conclusions about the mindedness of creatures with whom we have tried to enter into semiotic interaction? There are several reasons why other organisms might fail (or apparently fail) to have intentionality or to be capable of developing novel semiotic interactions. The organism under question may need more time, either because it is unaccustomed to growth in semethic interaction with humans or because the rate at which habits form is simply slower for it. On the other hand, it may well be that the organism has acknowledged us in some way but that its reaction remain imperceptible owing to our own inexperience in such interspecies explorations. Alternatively, it may simply be that we have not yet offered a gestural invitation sufficiently attuned to the semiotic context of the animal. Further, there may be times when a respectful silence will draw creatures closer to the
interspecies educator, perhaps because some organisms may prefer to initiate the interaction. And finally, there may be (and likely will be) a vast number of cases where the other organism may simply not want to engage with us on any other level, but this should not justify negligence in our pedagogical commitment. Maintaining a pedagogical stance towards the many hundreds of creatures around us does not (and should not) imply the goal of developing "warm and fuzzy" relationships with all of them, as if our conception of a "successful" interaction should be universalized. In all these cases of apparent "failure", we should not conclude that the problem lies in the organism's inability to live up to our preconceived notion of intentionality. Rather, a failure should be seen as an opportunity for increased attention and for new pedagogical approaches. This, again, is well-established as a successful educator's manner in the classroom.

My own experience shows that the pedagogical stance is not just another concept to be thrown into the ever-growing cauldron of academic jargon. I have experienced three distinct phases in my relationship with my 17-year old cat, Black. For the first number of years, when I was a Cartesian and thought that animals were somehow ultimately "just" machines, I was not interested in him enough to have my theory proven otherwise. After exploring and questioning my assumptions, I slowly came to experience him as a subject in the world, but I was still biased by a peculiar notion that because he was "a domesticated species," his subjectivity was contaminated by humans and not worth deeply pursuing. What a horrible devaluation! I became more attuned to his needs and feelings but I only rarely truly cared. It was only when I really managed to disrobe myself of all these intellectual pretenses and encounter Black as a legitimate other, attempting to live and learn and communicate with me (so long as I was open enough to the challenge)
that our relationship could really develop. Over the past few years, we have co-
constructing new semethic interactions, and new ones on top of those, as we pay
increasing attention to each other. His old age has been less of an impediment to the
process than my prejudices. For this to get underway, I had to believe that growth for
both of us was possible.

The "pedagogical stance" is not an approach that I am inventing, but I am trying to
make it explicit. I see it come up, however implicitly, in interspecies educators far more
adept than I. For example, a chain of ethologists, starting with the loving abundance of
Jane Goodall and culminating with the brave work of Barbara Smuts (2001; 2006), shows
that at least some small quarters of modern human semiosis are finally initiating the
challenge. Typically, those attempting to know *individuals* within a species are far more
likely to make significant headway than those attempting to make population-level
descriptions, and I would argue that it is only through a deep, personal acquaintance with
diverse individuals within a species that one may be in any position to make rigorous
species wide generalizations. We know how limiting stereotypes can be in human
encounters and should be wary of it in all our relations.

**The role of science in uncovering new pedagogical horizons**

To supplement direct, dyadic encounters, educator should continue to follow up
on and employ scientific research into the biological world. This claim may seem
incongruous with the position taken in the preceding paragraphs. It is true that biological
research has, for the most part, grounded itself in a naive spectator epistemology to gain
access to apparently "mindless" patterns in the universe. It is also true, as just mentioned,
that the habitual drive to make generalizable statements can put the scientist at a
disadvantage when encountering other semiotic beings. Nevertheless, scientific findings can also be suggestive and invite further interpretation and exploration in more pedagogical directions. More specifically, scientific insights can expand the educator's imagination of where, when, and how other species form and break habits, facilitating a more serious and committed pedagogical stance.

Consider the imaginal space opened up through realizing that bats use echolocation. The discovery itself was made and verified through standard empirical research methods, but it made those who contemplated it much more creative in considering the possibilities of the bats' lived experience. Of course, as Nagel (1974) concluded, we will never be able to experience what it is like to be another living being. But in a sense this is the wrong question, one that builds a wall from the outset. That he was compelled to write the paper at all demonstrates the power of science for opening up phenomenological musings of other species' subjectivities. In semiotic interactions, it is much more important how two things "become together" (Haraway 2008) than how each thing "is." Being aware of a bat's sonar world solicits a different embodied experience for the spelunker exploring the cave, shifting perception and action, and prompting a fresh course for possible interaction. Dennett cut himself (and the biosphere) short by degrading the "intentional stance" to mere explanation, and by insisting that explanation precede and be foundational to ways of acting towards others.

Insights gained from science can feedback into our direct experience of other species. Plant signalling and behaviour research might reveal some formal ways that, say, *Arabidopsis* may be disclosing, feeling, and learning from the world that it lives in

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19 Such thinking could serve equally well to keep someone solipsistically detached from even their closest family and friends.
(remember: the pedagogical stance asks you to minimize the "scare quotes" that you want to add to these words), and this scientifically-gained perspective arouses our embodied perceptual interactions with the plant world. The way we see and touch and watch a plant shifts. We gain a measure of patience and openness towards the vegetative [sic] world around us. Science can break apart our own habitual ways of imagining other species, assisting in our own growth, which is always the co-condition for our engaging with their habit-forming processes and growth. This is why science can help us take our pedagogical stance seriously, especially when it opens up semiotic activities in species phylogenetically distant to our own.

The role of science proposed for biological pedagogy is, then, the inverse complement to Abram's (1996) ecological formulation of the phenomenological credo "back to the things themselves." Instead of the merely re-instating the position of the direct perceptual world given by the senses (and long forlorn by the abstract, disenchanting world revealed by the sciences), we acknowledge a possible (though always to be carefully considered) use for biological probing and exploration of unforeseen worlds. To some extent, Abram acknowledges this. He has, for example, written a paper that explicitly attends to the perceptual possibilities opened up by a scientific theory (1985). However, the overall tenor of his work, especially in his later writing, tends to discount insights gained from science. Certainly, he is right in his call for caution. It is clear that misleading metaphors, misplaced concreteness, and poor ecological validity can confuse the scientist in both animal and plant studies. The direct point of contact, intimacy, and depth of feeling will always be richest in our sensory experience, but we can learn humility and imagine vivid possibility in the face of beings distant from us by sometimes taking a detour into their
experience through tools that can disclose their worlds for our situated and habituated minds.  

**The broader context: Growth and the adjacent possible**

Dewey bases his concept of growth on what he calls "the principle of continuity of experience", which means "that every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after" (1938, p. 35). Growth only occurs if we have one foot in the past, through which we establish our context, but also the capacity to use this to reach what is particular, yet still unrealized, about the situation. This continuity of experience ensures that semiotic development conforms to the account Hoffmeyer presented of Kauffman's notion of an "adjacent possible" (Hoffmeyer 2004). Kauffman's theory of adjacent possible, as a non-ergodic hypothesis, works well with the Peircean notion of the evolution of the cosmos from possibility into habit. He writes: "the biosphere, and the universe as a whole, may well be kinetically trapped into an ever more astonishingly small region of the entire space of the possible that might have been reached" (quoted in Hoffmeyer 2004, p. 86-87). However, it is precisely this narrowing of possibilities that drives complexification. The adjacent possible "precludes its ever reaching a state that depends on statistical likelihood" (p. 86). For Hoffmeyer, the adjacent possible is achieved through semiosis. As a new distinction is recognized, a new habit is formed, a habit which itself can now come to signify something to somebody. Semiosis directs the complexification of the

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20 Nevertheless, it is also certain that once we take seriously our call to engage with other species as educators, we will not continue to conduct science the way we have been. I don't imagine that much of the manipulations of the experimental method will make much sense when embarking in pedagogical-minded experimentation. This is the topic of another paper.
world by funnelling possibilities that remain merely inherent in a world of pure efficient causation.

At first blush, this might seem to oppose Dewey. After all, Kauffman's point is that the sphere of possibilities is progressively narrowing. If we look at the unfolding of the universe in terms of where it could have gone had it not canalized down *this* particular path, then we can certainly imagine that there are endless forms and relationships that are now absolutely impossible. However, as certain paths canalize, semiotic possibilities *increase*. The evolution of life has seen a progressive differentiation of meaning making. The nature of semiosis assures that new possibilities of semiotic interaction are always adjacently possible. As a vertical path conceived historically, it is just one path out of many possible ones and it appears as canalization. But from within this path, the horizontal expansion of possibilities drives and is driven by semiosis. This is also described as what Hoffmeyer calls a tendency towards "semiotic freedom" in biological evolution.

Hoffmeyer (at least here) was penning a broad sketch of the world and did not articulate how this relates specifically to micro-scale semiosis such as organismal learning. But this is the level that would most concern Dewey, teachers, and interspecies educators as the practical entry point into all other orders of change. I believe that Hoffmeyer would agree that the semiosis orchestrating ontogenetic learning is itself also always moving into the adjacent possible. After all, as pointed out, part of Hoffmeyer's project is to emphasize the universal and underlying structure of semiotic activity in all its dimensions, from phenotypic plasticity to genomic evolution. In this case, the number of possibilities 'viewed from above' appears to narrow because life takes on, and
sediments, a particular trajectory. However, at each step, new possibilities of growth are
provided in the manner in which history and habit provide a context to meet new
experiences. An organism is born in a world which contains a vast range of possible
meanings, interpretations, and semiotic developments. Hoffmeyer calls this an "Umwelt
landscape" (2001), echoing Waddington's epigenetic landscape. The goal of the Deweyan
educator concerned with semiotic growth is to enable the unhinging of stalled habits, so
as to usher in not only new habits, but also the progressive development of habit. This
process is akin to being concerned with the horizontal expansion of possibilities.

**Discussion**

Habits that encourage future habit-making facilitate the organism's exploration (or
development) of its *Umwelt* landscape. Human actions can either reduce or enable habit-
making in other species. Processes such as ecological degradation have broad and violent
semiotic impacts and need to be addressed immediately. We are indeed facing an
"ontological crisis" (Tønnessen, 2003). But the focus of this paper is on developing a
biological pedagogy for our direct encounters with other species. The argument
forwarded is that we should encourage novel habit-making. The question arises: why is
this necessarily good? Assuming it is possible to unlock the behaviour of other organisms
(and there will be skeptics who will want to maintain nativist presumptions here),
wouldn't this risk unhinging the relative periods of stability upon which ecologies come
to depend? Why should such a growth be inherently valued, either in humans or in other
species? Indeed, Bowers (1993) launches just such an attack on Dewey. He points out
that tradition is necessary for a culture to maintain stability with its bioregion. The
directionless Western culture is pathological, he says, and we are hardly liberating other
cultures by enabling their "emancipation" from the habits of their traditions. Tipping our hat to him, we may ask: why would we want to spin other species off their orbits too?

The exploration of an Umwelt landscape is a major driving force behind evolution (through the sort of Baldwin-inspired argument provided by Hoffmeyer (2001)). Just as Bowers failed to properly acknowledge that indigenous cultures also continuously change and depend on knowledge creation as a part of their co-evolution with their bioregions, organisms also rely on semiotic differentiations and subsumptions to re-establish working relationships in their bioregions. Because novelty is ever-present in such complex dynamical systems, it is only the fixity of habit that prevents stability.

Still, the question does not go away quite so easily: given that semiosis is the creative propeller, why speed it up? Is not the rate of change an important ecological and evolutionary factor? Yes, it certainly is, but the increased capacity to form future habits does not prevent an organism from living habitually. In concrete terms, when we encounter some other species, we have the opportunity of unhinging the fixity of our interpretive response to its presence (and vice versa). We can shift the dialogue. But this never means the simple loss of the old habit. We do not forget how to ride a bicycle if we learn how to drive a car. Of course, if our encounter with a wild turkey causes him to lose its fear of humans, it would be at risk if it organized its interpretation of a hunter according to this new semiotic enframing. Yet we do not replace fear with curiosity or docility. The capacity for fear is still there, and if the turkey survives the encounter with the hunter, it will have an increased opportunity to differentiate between conditions requiring fear and those requiring curiosity towards humans. The trouble with Western culture is not that it is flying-off without an orbit because it develops too many habits.
The problem is that the new habits have a currency that invalidate the older ones, buttressed by an epistemological bias that has limited tolerance or appreciation for pluralism. The progression is not a horizontal enrichment and expansion of possibilities but a constant overcoming and replacement of one totalizing frame with another.

While this cultural trajectory is taking place, it is impossible to ignore that the direction tends towards a worldview that increasingly insists on an anthropocentric value system taking centre-stage against a supposedly biomechanical backdrop. Through years of such training, Western humans (and increasingly those on any continent) are particularly blind to the semiotic unfolding in the biological worlds around them. This blindness has led to our incapacity to develop new habits with respect to our interactions within them. In this way, we have become more narrowly constrained in the quality and diversity of our relationships with other species than ever before, be it hunter-gather or later agrarian societies. As our Umwelt loses its "carriers of meaning" (von Uexküll 2010) in the natural world, it has probably led to a corresponding fixity in other species' habits towards us. Most creatures may expect and have evolutionary tendencies towards developing more complex semiotic interactions than those commonplace with humans in today's industrial cultures. This is obvious when we watch how much more attentively a bird or a squirrel pays attention to a human walking by than a human pays attention to them. The animal is waiting for meaning, but the sign it gets is constrained by the human's disregard. If this is the case, biological pedagogy can be thought of as the deliberate restoration of a prior semiotic interactivity, supplemented in our modern world by scientific advances that open new horizons for us to imagine other creature's worlds. On the other hand, as we continue to wipe out other species, we are reducing actual and
possible semetic interactions between them and thereby reducing their capacity for
growth as well. This implies that pedagogical practice must extend beyond the dyadic
self-other encounter and explicitly include the protection of biological diversity.

The subjectivity of the biological world, or even the possibility of its subjectivity,
brings with it a need for care and responsiveness. A learning subject, living in a
mysterious world that we can only ever get provisional clues into, is not simply an
'interesting' feature of the universe. It is not lying in wait for the proper categorization.
The way we study it, the way we talk about it, and the way we act towards it are all
possibly being interpreted and learnt in some way. Because the biological world is
relational and dialogical, we are immanently teachers and students in biological
communities, and what lessons arise are open semiotic possibilities, dialectically
dependent on how we pursue such questions. The "unbounded" (Petrilli and Ponzio,
2005) nature of semiosis calls for reflexivity, a concern with consequences, and a
transition out of an explanation-based approach to biosemiotics. We need to develop
more educative habits as scientists, as people, and as biotic members of ecological
communities. In this paper, I have suggested some pathways into this through a Dewey-
inspired imaginative attention to growth and habit within relationships. There may be
other more fruitful concepts to pursue and I look forward to the discussion.
CHAPTER 6: Drawing Analogies in Environmental Education

Abstract

Reconsidering the origin, process and outcomes of analogy making suggests practices for environmental educators who strive to disengage humans from the isolating illusions of their dichotomizing frameworks. Analogies can be viewed as outcomes of developmental processes within which human subjectivity is but an element, such that our sense of self is threaded back into its constitutive contexts, drawing it into possible affinity with kinship practices of the world's diverse cultures. The article suggests that analogies create and perpetuate not only ideas and identities but relationships, and that what we surround ourselves with becomes the basis for engaging in and forming further relationships. Educators are therefore invited to consider practices (and here I explore just one) that repopulate our analogical repertoire such that we can have more organic and vitalizing interactions with all our relations.

Introduction

Those who suffer an illusory sense of dislocation need practices that can reintegrate their sense of identity back into the world. Until the stories we live are consonant with our larger ecologies, we will continue to elaborate structures grounded in error; order disordering what are otherwise generally integrative systems. Environmental educators have the task of imagining pedagogies to heal this dislocation, notably among them those that sanction the infamous Cartesian dualisms. Success depends on finding convincing alternative frameworks and effective de-dichotomizing practices for others, and to be sure, for ourselves.
Oppositional thinking establishes ontological clefts in our metaphysics and therefore our perception by overemphasizing differences in phenomena while understating similarities. Antipodal fracture facilitates certain types of political relationships and technologies, but only by separating humans from the very possibility of contributing to the more general cohering tendency that underlies the emergence of differentiation and meaning in the cosmos. And now, on the tail-end of modernism, science itself is revealing that indigenous people the world over were right all along to cultivate practices that resist alienation. The relatively tight integration of "internal" parts constituting the "self" is mistakenly given a separate ontological status from the relations that the self is less tightly integrated into, whose constitutive role in the individuation process is attenuated or ignored entirely. Multilevel interactional approaches to biology, from the behaviorist accounts in developmental systems theory (Oyama, 1985; Oyama, Griffiths and Gray, 2001) to the phenomenological approaches of enactivst cognitive science (Varela, Thompson, & Rosch, 1993) can help build a theoretical bridge out of the pitfalls of modernity.

Environmental educators can reshape experiential learning to include practices that assist students in disengaging from dualism. The metaphysical grounds justifying its dissolution are now known but the enactment of patterns that sustain alternatives are harder to come by. This paper attempts to forge such a pedagogy through an exploration of analogy consonant with nondualistic threads of postcartesian biological theory. Thought is often conceived as the product of humans (brains or bodies) or the cultures they reside in. As hermetic isolationism captivates, knowledge seekers obsess with ridding "nature" of any trait deemed constitutive of "culture" or "self", mandating their
frenzied asepticism methodologically as a call to evade anthropomorphism. I view this as a tragic error. Through discussing the process of analogy formation, considered the root of mental activity (Lakoff & Johnson, 1999; Hofstadter & Sander, 2013), I hope to invite the reader into a consideration of practices that redraw the human identity. The point is not to replace duality with mystical unification. Dualism emerged as a feasible metaphysical explanation because developmental interactions coalesced a being sufficiently individuated that its identity became an existential question. This cannot be simply transcended, and thankfully so, for the same process also provides the possibility of encounters, relationships, the capacity to learn, love, care for, and grow. We do not need to choose between deep ecology and ecofeminism (Plumwood, 1991) if we are careful about how differentiation emerges and in turn reconstitutes the world it emerges from. The paper's plot line explores three broad themes: a discussion of analogies inviting kinship rather than opposition; a consideration of how disorder and reintegration are possible in a nondualistic metaphysic; and a call for habits that draw the human mind back into networks of more-than-human processes. Although I end the paper with an example of a concrete activity for pedagogy, the entire paper is intended to be practical. Thought and action are indissociable; to focus on one we must focus on the other.

**Totemizing Experience**

From *Rodnidze* in Poland to *Mitupo* of Zimbabwe, for millennia people have nurtured practices that sustain identification with other beings, be it types of animals, other organisms, or larger entities such as mountains or streams. The term for these varied kinships has become *totem*, derived from *Nindoodem*, or "my clan" in Anishinabe (Bohaker, 2011, p. 94). There are significant differences in the mythologies and rituals
represented under this term (Descola, 2013), and Anishinabe people may not agree with the generalization made by (mostly) white, Western anthropologists. To avoid misappropriating the original sense and context, I use the word *Doodem* to refer to those practices particular to Anishinabe people and *totem* to refer to the constellation of less specified practices that deliver kinship with the world. This distinction is consistent with some First Nations people who use the spelling *Doodem* to refer to their own practices (such as LaDuke, 1999; Miller, 2010; Treuer, 2010).

From a historical perspective, the spreading conceptualization that de-animates the rest of the world while hyper-animating a solitary "sapient" subcomponent of it, is a brief experiment in the evolution of thought, one not proven ontologically or epistemologically tenable, let alone ecologically feasible. That totemic rituals are vital to diverse, long-lasting cultures indicates that developing care and kinship with nonhumans is fundamental to human experience. From a postcartesian perspective, such practices acknowledge, on the one hand, our ontological co-constitution with those around us, and on the other, the role that the individuation processes which brought us forth play in making this possible. And yet, totemic practices are not often taken seriously as an approach to environmental education, in part for some clear limitations (lack of teachers with deep totemic learning or commitment, fear of misappropriating indigenous wisdom, fear of being "New Agey", lack of time, a culture that does not encourage the practice, etc.). If we want to seal the nature-culture rupture by inviting other beings into our experience, as teachers and as learners in their own right (it is, after all *environmental education*) (Author, 2011), we should consider practices of kinship anew. As Weston points out (personal correspondence, citing Abram (2010)), totemism can gradually
provide a "stereoscopic" perspective on reality. Our lived experience takes on attributes of the totemic species' world. In this sense, ancestral kinships toward animals, plants and other beings, are multi-generational apprenticeships wherein humans find their sense and grounding in the world in ways of life provided by, and nurtured through relationships with their totems.

Thinking about totems risks disrespecting those who birthed the practices. I am tempted to avoid the word, to jump directly into interspecies relationships or interspecies pedagogy and the place of analogy making in these processes. However, I feel it is important to acknowledge that the styles of thinking and engaging offered here share a fidelity and perhaps a constitutional genesis with practices evolved and evolving in the earth's richer cultures. Nevertheless, people who share my mixed up placelessness and clanlessness need tools befitting their historically contingent struggle that they may rejoin others in finding a home in the grander firmament. As an educator, it is these people I am trying to reach. I do not suppose that the western, postcartesian understanding of kinship explored in the pages to follow, should be universalized nor replace the senses evoked by other midwives to its practices. In fact, for people steeped in cultures with totemic practices, my thinking will seem quite superficial. Nevertheless, I hope to stand in ontological solidarity with people of the world who take affinity with the more-than-human world seriously. What I pledge is to address the precarious place between the secularized, urbanized and disenchanted, and the inauguration of an embracing participation with all our relations. The West is gasping its first breaths after a long stretch of reductionism and humanism, accentuated through the methodological and ontological consequences of the great Cartesian split, and ways of knowing, thinking, and
acting have changed. We need practices that can bind us (from here) into those connective tissues from which many indigenous worlds drew sustenance and identity. Like the Transition Towns popping up across the continent, we need Transition Ideas to initiate the long reunion that is our mission for centuries to come. Saturated in the promises and perils of our culture, we cannot hope to implement The Solution, but we can perhaps position ourselves in a more regenerative direction with farsighted humility and grace. In this context, I see any work as totemic so far as it nurtures relationships between humans and other beings so as to constitute our thought and action patterns. It is this capacity to learn from, respect, and grow through the organic world around us that educators must cultivate, whether this come out in our science, our art, or our direct and daily relations.

A misplaced condemnation of anthropomorphism in western cultural narratives has made the notion of kinship with other beings seem incredulous. However, I maintain that anthropomorphism is an incoherent concept. Eschewing it follows a logical scheme stemming from the influential Kantian critique (2007) that claims that knowing is possible only because it consists of statements about regularities in the world as it appears pre-constructed by our sensory and conceptual faculties. Kant grounded the possibility of scientific knowledge through a distinctly Cartesian approach: he created another isolating dichotomy. By making an absolute distinction between what we can know (experience constructed) and how things are (the world itself, which we can say nothing about), the world around us simply reflected back whatever human dimensions we put into it in order to be able to experience it in the first place. The nonhuman world was quarantined into
oblivion, catalyzing two centuries of defiant, yet anguished humanism (most phenomenologists, social constructionists, and poststructuralists reiterate his fracture).

Conceiving knowledge as constructed in this way made the jump to anti-anthropomorphism easy. The alleged identification with another animal (or whatever else) could be quickly reduced to being "just" a property of our modeling system, not the thing [sic] itself. Entraining repeatedly to this objection, critiques of anthropomorphism distance us from possible points of supra-human contact and blind us to the fact that every idea, every feeling, every goal, and every memory is melodically and morphologically animated by more-than-human presences. In fact, self and other are tangled up such that we can never talk about one without the other already present as a precondition for its differentiation. Alterity (the "more-than-you") abounds, but it is not Derrida's (2002) absolute and un-engage-able otherness that creates chasms in our phenomenal experience. It is always just within our reach, the nonself that we are ready to receive, that can flow into us, and combine with us as we grow. A thread of re-integration, promising a new order of causal bridging between the universe's individuating entities, emerges in the system's evolution. As we will see, our sense of affinity ties us to other beings and infect our thinking thereby, but these affinities also open us up to being led by their differences, guided into novel parts of ourselves. Alterity is not a permanent existential fact, some categorically alien presence splitting our experience apart. It is that signpost within experience that shows us who we can meet and how we can grow. We grow into our alterity without encapsulating it, it becomes a part of us, of who we are, while always providing the horizon for new novelty.

A World of Overflowing Kinships
Taking seriously a totemic apprenticeship to another species quickly gets one's empathy and imagination entangled in a multitude of other, perhaps unexpected, species. If one's totem is a wolf, one may soon have various herbivores as totems too, because these are surely in some sense already totems for the wolf, who synchronizes, lives, and breathes her world with a stereoscopic vision of what it is like for those whom she tracks. What is the co-evolution of a predator-prey relationship but the multigenerational apprenticeship of one group of animals towards another? This too is an arbitrary stopping place because to come to know the deer or the rabbit, one must also know how they perceive their worlds, which are in turn shaped by a sensitization to species that matter for them. The wolf must know how the grasses grow. Our wolf-relationship may claim primacy or depth in our lives but it is itself threaded to the rest of its ecosystem by its own totemic relations.

There are other reasons to be flexible. Suppose I acknowledge my affinity with the lupine world and end up in an ecosystem that has no wolves (or wild dogs of any kind -or maybe no alpha predators at all). I can certainly still perceive the ecosystem with my wolfish training and undoubtedly attune myself sensitively to my surroundings by doing so. But there may be other teachers in this new context, ones that have been coordinating styles of acting and perceiving coherent with that ecosystem (or, rather, styles that contribute towards the coherence of that ecosystem). Our lives are increasingly transient and ecosystems more dynamic, so we may need several means of learning and developing as our contexts change. If we live in urban worlds and make frequent trips to the forests, the species in each community are sufficiently different that we could perhaps have different teachers to fall in love with for each.
It may be suggested that apprenticeship is not a frivolous thing: one cannot learn to be a plumber and a carpenter and a farmer and a sculptor and a midwife. Learning the trade of the wolf is an occupation, not as a pastime, and mastery a continuous process spanning thousands of hours. Further, it is a multigenerational occupation establishing the co-evolution of lineages in an ecological community. I have no objection to the spirit of such concerns. It may well be that groups of people living in tight communion with members of a specific bioregion come to rely on and enrich ecologically beneficial longstanding kinships. What I suggest is that the same spirit of openness that enables people to engage in such sustained partnerships can also facilitate shorter-term relationships. Multispecies totems exist in some cultures, such as the Wiradjuri, who have both clan totems and personal totems (Rose, James & Watson, 2003). City dwellers, detached from ecological communities (even many ecologists tend to consider ecosystems as third-person, mechanical systems), need pedagogical strategies that bring them in contact with the intersubjectivity, indeterminacy and lived presence of their actual encounters. Having a more amorphous conception of interspecies kinship or apprenticeship can enable this.

It may also seem that my proposal only recognizes totems insofar as they help us establish better relations within ecological communities, that I am concerned with the performance of an epistemological orientation, and that I am thereby reducing totemism to its pragmatic value. Indigenous groups, the criticism would go, often insist on totems for ontological reasons: the clan really has this identity with wolves, and the fact that the relationship has ecological values is an effect of the relationship not a rationale for it. I agree. But pluralizing kinship need not make this move. I attach importance to the
performativity of our epistemology, but I do not deny its ontological reality either. When we take up another being as our teacher and dedicate ourselves to learning and relationship, they really do become a part of us, altering our manner of thinking, feeling, and acting. They are not tools for thinking or techniques for sustainability. It is not that "animals are good to think with" (Levi-Strauss, 1963). The relationship is an end in itself, one that modifies each of its participants' manner of being (and becoming). This is social psychology à la G.H. Mead (1934): our kinships really are parts of us, they become inner voices, that very chorus of "significant others" that dialogues our Self into being.

Our role in the process is to cultivate an openness to kinship with those we encounter. We can work at enabling unannounced creatures we encounter to infect us with their novelties and passions, growing our souls with their struggles and accomplishments, elegance and grit. We can surrender our subjectivity and allow ourselves to be subjected to the process. Totemic identification is more than just an imposition of a similarity. We do not 'construct' experience as a condition for having the sense of 'affinity.' This is not a transcendental move: as long as we remain Kantian, we lose out on possibilities and intimacies, and become ontologically impoverished.

Practitioners often speak of their animal choosing them. This protects the very real mystery and romance of the encounter. This way of speaking, of inverting 'the chooser', may however be less convincing to us postcartesians, for whom the mystery is perhaps better kept alive by eliminating the notion of 'chooser' altogether. Such a term, from our historically situated, scientizing metaphysics, seems to invoke too much agency and teleology. A complex progression both individuated and brought the beings together, enabling care, love, and surprise, blossomed surely by the fact that the world can be open
to itself, to interact with itself and grow in new ways, breaking symmetries, modulating, harmonizing, and counterpointing in all its rejoinings and differentiations.

**Analogies and anthropomorphisms**

Totemism is sometimes interpreted as analogical or metaphorical, but most who traditionally practice would reject this phrasing. It recalls Western anthropologists discrediting different cultures, convinced that their own conceptual frameworks are universally valid means by which to gauge others. Calling a totem an analogy certainly seems to weaken it, to render the affinity "just" a construction of the mind, and to smuggle back the epistemologist's echo-chamber (borrowing Jensen's terrifying term (2012)) that this article emphatically rejects. As mentioned though, the task here is to make kinship a conceivable pedagogical project for the Western world pulling out of modernism, not to explain its origins or functions in other cultures. A way to do this, I believe, is to warm to the notion that there is an analogical element to this emerging sense of totemism, but to shed our entirely sterile notion of what analogies are. Analogies themselves have a mysterious otherness and are no more anthropomorphic than totems. An analogy jumps out of nowhere, drawing together the unanticipated present with various pictures, feelings, or thoughts from vastly different places and times. We should be suspicious in assuming that we are authors moulding the process. Analogies may well be the "core of cognition" (Hofstadter & Sander, 2013) but cognition is not something that happens "in the head" (or the body!). A complex circuitry, webbing the murky past with what is immanently bubbling forth in ongoing sensorimotor couplings with "the environment," delivers the analogy. It is this circuitry itself, enfolding on multiple scales in all its physicochemical ebbings and semiotic exchanges, that is composing the linkages
and unities. Analogies are a part of a process whereby the world rethreads kinships between its individuating parts, tethering new connective significance, birthing new shared trajectories and themes. They are our micro-kinships. If a totem is that to which we are wed, organizing our life with a broad and sustained sweep that contextualizes our daily encounters, analogies are our friendships, acquaintances and passersby. They may require less commitment or discipline, apprenticeship or fidelity, they may indeed later prove misleading or foolish, and yet they are born of the same interthreading world.

People who most closely interact with, observe, and depend on other species are those most likely to do what Westerners label "anthropomorphize." Many turn the finger backwards: is it not we, by distancing ourselves from other species, in our shelters, our cities, our food production systems, who are really the anthropomorphizers, laying our perceptually vapid experience of other species onto them? Are we, through the constraints of scientific protocols, really improving the clarity and objectivity of our understanding of other species? Are not machines, computers, and other constructed devices activating mechanistic analogies that anthropomorphize our conceptions of other species? This criticism is tempting, indeed I often make it, but it reifies much of what I am trying to shed. To accuse anyone of anthropomorphism reveals a still-too-simple conception of human activity, one that does not admit of the messy, interlocking, historical, recursive nature of the process of thought production in the world. We assign authorship to the location out of which the final idea emerged, the mouth or pen, without acknowledging the long centripetal process that preceded it. Our errors are multitudinous and serious, but if we seek to experience the world less anthropocentrically, perhaps the
first step is to realize (playing with Latour here), that we have never been anthropomorphic.

The movement in analogy generation that pulls an essence out of one context only once it is seen in another bothers analytic philosophers because it is certainly neither deductive nor inductive (and are even those logical distillations, at bottom, really "human"?)! There is a magic otherness in it that we cannot exactly schematize. Douglas Hofstadter (Hofstadter and Sander, 2013) describes an experience with his family at the Grand Canyon. After marveling in the awesome expanse, he glanced down at his 15-month old son. Instead of gazing wondrously outwards, the boy was fixated on a few ants on the sandy dirt. Fifteen years later, and now in Egypt, he visited the Ancient ruins of Kamak. On the trip, he noticed someone collecting bottle caps instead of paying attention to the vast, timeless temples. He immediately recalled his child's preoccupation with the ants decades before. At that moment, the meaning of the event in Egypt got defined by that in the Grand Canyon. The Grand Canyon served as "the source" for an analogy, lending the new experience (the target) its structure and significance. Hofstadter now recognized that both were instances of people paying attention to small details because they were unprepared (developmentally in one case, culturally in the other) to see something larger. But the source also got redefined by the target. Until that point, the source was contextually less defined and semantically more nebulous. We can imagine a different target might have linked up differently: had Hofstadter seen a child gleefully chasing a butterfly, the connecting sense may instead have been about children having a natural appreciation for life without judging insects as less worthy on some hierarchy of value. It was, in Hofstadter's words, "the mental mapping onto each other of two entities
one old and sound asleep in the recesses of long-term memory, the other new and gaily
dancing on the mind’s center stage” (p. 504). Our memories and present experience are
both beyond our grip, forming and reforming in a duet with one another, fed constantly
by the irrevocable tendency for each to feel out the other. We cannot (as the straw-man
epistemologist I keep resuscitating would have it) "apply" categories that we have formed
from earlier experiences to constitute new ones because the categories themselves are in
flux, open to the very experiences to which they get associated. Something quite
delightful is happening here. Was the story of the ants just sitting await for something
with some similarity to come along? Did the story have an indefinite number of tentacles
(or, as Hofstadter elusively suggests, a "halo") reaching out for future encounters to join
with in kinship, for a partner to complete it? The number of events waiting for relevant
connections may literally be infinite because it is always possible for an experience to
join with others or split to form new ones (for example, the ant story plus whatever
happened just before it might end up as an example of something else if a situation came
up that conjoined them). And this happens continuously and daily. Details of the
transaction are a matter for further empirical study but what is key here is that neither the
phenomenology nor the physicality of the process indicate either a reductionistic
determinism or any privileged agency on behalf of the human. Either side of the dualism
collapse under the indeterminacy and opaqueness of the world's subterranean
networkings.

Once formed, the mutual semantic modification between memories and
experience may slow but it does not ossify. Even concepts considered to have become
fixed, with meanings triangulated by countless sources and targets, are hardly
permanently etched. Each analogy ages according to its own élan, with a tempo and rate of change specific to the type of events it draws together. Partnership continuously re-adjusts, re-qualifies, or re-calibrates, but never fully settles as a completed linkage. The initial basis for kinship sometimes dissolves only to be replaced with another kinship more attuned to the dynamism of experience's integrations and differentiations. When we do use humans as direct sources, such as when we say that a river is sad, we need to recognize the analogy's role within a broader trajectory that it helped instigate. Over time, how we understand comes to be less and less orchestrated by that initial interpretation and more about the perceptual reshaping that it subsequently aroused. We leave equipped with dimensions of thought and feeling not possible before because apparently anthropomorphic concepts can seamlessly de-anthropomorphize through the encounters with nonhumans that they make available, in a process within which we are merely afloat.

Analogies emerge out of our interactions with the things around us, be they other people, technologies, other organisms, or systems, molecules, cities, or mountains. Granted that the process of forming analogy is more-than-human and that many of our ideas, feeling and projects emerge through encounters with nonhuman presences, does this necessarily imply that all analogy is nonanthropomorphic? Are we mixing up process and content? Can we not admit that the process is nonanthropomorphic while maintaining that the content is not, at least when the source of the analogy is a human? But even this won't do. Even surface-level anthropomorphism hides a vast history of more-than-human apprenticeship. To claim anthropomorphism is to punctuate the process incorrectly. Humans that become sources for analogies are never purely and hermetically just people
because their thought and activity has been constitutively invaded since inception by interbreeding with countless other elements, from European buckthorn to the starling's evening exaltations, from library cataloguing systems to iPhones apps. If someone is suffused with these experiences, the analogies based on her are as well. Analogies derived from technologies that may have first seemed technomorphic are more complex for the same reason. For example, we may use a technology based on a biological analogue to understand some other biological phenomena (with some amazing eventual inversions: "look mom, thistle is like Velcro!"). Concepts bear the traces of intermixed biomorphic, geomorphic, and technomorphic pedigree. Typically when we call an analogy anthropomorphic, technomorphic (or vegemorphic, etc.), we only refer to the last manifestation of an enormous historical crafting. If an idea comes to us through directly examining a person and we call it anthropomorphic, what we are really saying is that the direct source was a human, even though that source itself emerged through some more or less translucent past.

While intermixing is inevitable, both the sources and the targets that come to dominate our minds will be based on the sorts of environments we live in. Because what we see and how we see are mutual modifications of one another, perception is not merely a matter of gaining content. It is methodology-yielding. This is fundamental to totemism and analogy making: the process of engaging in a study modifies the way in which the study unfolds. What we pay attention to, what we think about, and what we observe, feed back into how we pay attention, think about, and observe. Whether we pay attention to fixed or fixating systems or to growing and developing ones, in either case these enter our analogical repertoire. We can therefore accept that all our activity is part of the dynamism
of nature while enabling practices that are congruent with the broader life-generating movement that our dissonance emerged in.

**Urbanizing and industrializing totems**

In discussing totems, Bateson (1979) claims that overarching isomorphisms connect the way people view nature and how they organize their societies. Analogies have an interlocking, self-validating capacity that shapes future experience. They are performative because the ontological reconstitution which they bring forth entails new emotional, physical and epistemological orientations that in turn further constitute ontological relations. Totems orchestrate feedback loops because the consideration that humans pay towards their kinships provides meaningful contexts, structure, and actions that lead to further respect and deeper consideration. However, what's good for the goose is not always good for the gander. As humans urbanize, their analogies and totems become increasingly saturated with the built up environment, its organization, and the technologies that run through it. Just as 19th-century Europe's industrialization is putatively responsible for the organizing descriptions of both a capitalist social order and a competitive interpretation of biological evolution, we might expect that analogies taken from one sphere of experience might spread and duplicate in another (in social systems there is the tendency of oppressed people to mirror the oppressor's social order by becoming "sub-oppressors" (Freire, 1972, p. 30)). Models becomes self-validating because each new successful application affirms the pragmatic validity of that conception of the structure of the world. Dualisms themselves, once evolved were perpetuated in this way. But this can limit the creative growth of concepts. Like a hurricane gaining in strength by absorbing energy and matter into itself, a destructive analogy can destroy the
diversity it encounters. This is why the same mechanisms that generate fertile semiotic
diversification can also lead (temporarily) to pathological subsets.

In an urbanizing environment, the rest of the biotic community's contribution to
analogies dilutes in potency. Nonliving things increasingly end up as direct analogues,
and as our environment is ever more populated by such nonliving elements, the more-
than-human component of our ontological constitution becomes increasingly
technological. Kinships with nonliving things, regardless of whatever traces they carry
with them, are empathetically void. If retaining other species as totems is important, short
excursions into 'Nature' are probably insufficient to curb the tide of urban self-validating
processes. It is said that it takes at least four nights in the woods before the animals come
and visit us in our dreams and it seems to me that they are much more quickly frightened
off once we return. The best bet, I think, is to actively engage in practices with the
nonhuman biotic realm in our cities to repopulate our totem and analogy worlds with
living beings. In part this requires the very practical task of creating habitats to encourage
urban biodiversity. It also requires an ongoing re-interpretation of emerging biological
sciences that trouble our sense of human privilege, such as developmental systems theory
and biosemiotics. In the next section, I introduce another of the many possible practices
that educators can explore to invite organic life back into our inner worlds.

**What Drawing Draws Out**

Every plant I have drawn has transformed me through the process, not merely in
what I learn about myself, but also in attuning me to the species, that forever afterwards
jumps out at me as I walk down the sidewalk with a spirited presence and lovable
animality. Still, I often ask myself: drawing is ocular-centric and many species on earth
do not even have eyes, so is drawing an anthropomorphic way to engage? Of course, if we rely exclusively on a single mode of interaction we entrap imagination, so drawing should be part of a larger repertoire of organic analogue repopulation work, both sensory and theoretical. Nevertheless, drawing is important. Plant worlds flush with intensities of light and chemicals, not well-defined, spatialized objects, but they clearly have styles of growth and becoming revealed for visual beings and drawing hones our perceptual sensitivity. Their flashes of colour and striking architectures are outward expressions of their being even if they themselves do not see themselves in these ways. We do not need to put up unfair criteria here since much of what we consider 'most authentic' in another human is what comes out unintentionally as well: the glimmer of a smirk, a glint in the eye, a blush. Plants have a physiognomy and our simian physiology is not a blinder to their essence but another way into their being. We can experience the story of their life. Like wrinkles on a face, the particular architecture of a plant reflects its history, encoding its experiences in a visual medium. Phenotypic plasticity is expressive not merely adaptive.

Staring deeply at a plant (is that the right word? The action is loving, like 'gazing' but more focused) through the guidance of pencil and paper, our eyes open us up to the limitations of eyedness: we become ever more aware of this as we contemplate this hopeful being with a skin that grows towards the light. We see that the eye's concentrated messaging creates a front and a back, blind spots, distinct assumptions about other creature's perceptions, and sharp self/other boundaries. And yet without our having eyes, it would be impossible to conceive of how plants have a full bodied, distributed vision (and full-bodied yes --- even roots have light-sensing properties driving them away rather
than towards the light (Burbach et al., 2012)). Drawing establishes kinship, and kinship
draws us into experiencing difference. Drawing is therefore an empirical method for
postdualistic science, seeking integration and relationship rather than Goethean essences.
Analogies that form through carefully considering plant, such as the analogy between
their experience of light and our own, break down our sense of what vision is by shining
an alterity accessible enough to be contemplated, imagined, and indeed, grown towards.

Organic totems and analogies, by definition, vitalize our thought. Luckily, there
are still organic teachers all around us. Consider Amaranthus palmeri, known as pigweed,
and present in most gardens and urban fields. We are currently so tone deaf to its mode of
being that most of us have hardly paid it any notice. How might we sensitize? How might
we approach it such that its alterity is within our reach, drawing us into it and passing
through us so we grow and develop? The extent to which we are capable of having our
thoughts take on the balanced branching, the saturated inflorescence, the slow verdant
pace, and the fluid dynamism of an amaranth plant depends on how much we are able to
let it into and in-form our mental worlds. Drawing slows the mind and opens it to the
form, harmony, symmetry, and edgy individuality of each plant. At some point we may be
able to see how just this thought or this situation or this feeling is homologically related
to the architecture or style of negotiating space of pigweed's particular manner. This
might seem like a long shot, but the nature of analogy essentially guarantees this. The
deeper we infuse ourselves within a phenomena, the more we see its character in other
phenomena in the world around us, and the analogy enables us to feel or see something
new that we would not have otherwise. Since analogy reciprocally determines both
source and target, we are now also capable of realizing that the amaranth plant also has
characteristics of the conversation to which it intertwined. Its form becomes semantic and aural just as our conversation becomes visual and structural. All the while, our receptivity stretches its arms to the latent possible interrelations between plants and experiences that once were not imaginable. If eventually, through exploring the matter further, we come to realize the limitations of an analogy, it is only because the amaranth plant helped us to see it: without the formal similarity between these two experiences joining each to the other and us to them, we would never have had the foothold to examine the issue further. Ever after it lingers in scent and residue in our future conceptions, vegemorphizing it according to its own modulation. In sum: educators can explore and diversify sensory activities to invite organic sounds, behaviors, smells, shapes, and struggles into their students' worlds, so that the empathic and conceptual repertoires available to analogical and totemic unfolding be ever richer, more hopeful and alive.
CHAPTER 7: Deweyan education and democratic ecologies

Abstract

From a Deweyan perspective, the capacity to learn is enabled or restricted by the clutch of one's habits, which are established and maintained by the mutual eliciting of action and reaction between an organism and its environment. Relationships which constrict the capacity for organisms to interact and learn from each other are undemocratic so far as they curb the direction and suppleness by which mutual growth can occur. Dewey saw that education and democracy were therefore inseparable pursuits. However, he developed a conceptual orientation which prevented entry for other species. This paper seeks to open a Deweyan approach to considering ecological communities politically and pedagogically. Ecosystems, like human societies, form and develop through complex learning interactions. This has been recognized for centuries by local and indigenous group and more recently by modern science in differently operating biological processes, from the Baldwin effect, to niche constructionism, and epigenetic inheritance. As Dewey continuously noted, the immediate encounter is a necessary but not a sufficient condition to ensure growthful, democratic environments, because patterns of behavior, thinking, and affect are channeled by the structural contexts within which encounters occur. It is therefore necessary that educators focus on the experimental reconstruction of infrastructure, buildings, institutions, technologies, and other material structures that habituate us to normalize miseducative and undemocratic relationships with our own and with other species.

Introduction
Dewey worked hard to bust many impervious binaries that dislocate people from the rest of nature, but his critical reconstruction of his own thought was incomplete. While arguing that culture, symbolic interaction, and experience were natural processes arising through particular configurations in the organic world, he nevertheless maintained that such processes and their consequences were by and large exclusively human affairs. Unlike Peirce (see Romanini and Fernandez, 2014), he did not seriously consider biological semiosis and how an account of it would have to be a part of any comprehensive understanding of biological phenomena. Instead, he repeatedly maintained that it was human symbolic activity that ushers in a new dimension of interactions and consequences in the world, leaving the law-like regularity of the physicochemical world, along with the rest of the biosphere, behind.

For someone concerned with building a pedagogy for relationships with other organisms, why, then, revisit Dewey's thought? The simple answer (beyond the fact that Dewey's thought has so thoroughly permeated our educational ethos) is that Dewey had a deeply ecological approach to understanding human activity, and in particular education, pedagogy, politics, and ethics. Though hardly a neo-Darwinist (in the doctrinaire sense of the term), he was an anti-foundationalist, evolutionary thinker and pushed the consequences of evolution through to the core of philosophy itself. He also realized that most of the pressing problems humans faced were ultimately the result of our creating a needless ontological gulf between how we understand humans and "the rest" of the natural world. Finally, Dewey sought to unify democracy and education in a way that naturalizes democracy as the most prosperous process of human evolution and which sees education as both the means and ends in achieving it. Combined, Dewey's thought

21 For his most explicit treatment of nonhuman semiosis, see Dewey (1929).
provides a rich theoretical landscape for imagining a posthuman pedagogy and the
democratic context needed for its flourishing.

Dewey would readily acknowledge that his development of the concepts of "democracy" and "education" were incomplete, their having emerged through the very same never-ending experimental and communicative processes that they seek to describe and improve upon. His conception of these terms necessarily represented a particular historical period and the problems that the people of its time were facing. It is a purpose of this paper to examine how current research in biology ought to lead us to reform these very concepts so as to be inclusive of ecological communities. I will examine the notions of learning and communication in ecosystems and consider some adaptations Deweyan democracy and education need to undertake in order to accommodate them. This is itself, obviously, a Deweyan approach: to use empirical studies to revisit established dogmas and habits of thought that serve to limit understanding and create or exacerbate problems. To work towards this reconstruction, I first describe how biological systems have inadequately been conceived in a mechanical sense that does not recognize the role that learning and communication play in the biosphere. I then consider Dewey's concept of democracy and examine how Dewey's concept of communication needs to be critically re-examined in order to democratize our understanding and interaction with ecologies. I explore the role that humans could play in listening to and communicating other species' voices. Finally, I take up some possible ways that the formal educational environment and society more generally will need to develop a pedagogical consciousness that fosters more democratic ecological associations.

Learning in Ecosystems and Evolution: Beyond Physicochemistry
In keeping with the models emerging in Dewey's day (Eton, 1927; Hutchinson, 1957), ecosystems are still often regarded as evolving systems regulated by energy and matter exchanges, to be adequately understood on the basis of a physical analysis of their components. Although nonlinear forms of interaction make ecology a science unlike many other physical sciences, the fact that the research strategy still models diverse phenomena according to a limited number of physical constraints implies that ecologists are using the physicochemical sciences as analogues for how their discipline should become a science. This paper argues instead that the maturity of ecological sciences will require the same dynamic flexibility, reflexivity, and sensitivity to politics, pedagogy and ethics that inquiry into human social systems demands.

It is clear that ecosystems, like anything else in the universe, cannot contradict the physicochemical basis upon which they are constructed. But this only makes physicochemistry a necessary but not a sufficient condition for understanding ecological dynamics. If the basic properties of matter allow for a vast number of possible configurations, physicochemistry (and reductionism) will not provide any explanation as to why the universe sedimented into the particular relationships that we see enabled and expanded upon in the biosphere. To be fair, the notion of feedback, so key to ecology, has assisted in breaking down the assumption that explanation is strictly a bottom-up affair: physicochemical systems are capable of producing organization between their component parts that alters the mode in which the structure interacts with what is around it, which in turn can modify the parts that created the organization in the first place. This leads to what some authors call "physicalist" or "mechanistic" anti-reductionism (Rosenberg, 2006; Griffiths and Stotz, 2013).
However, feedback is also insufficient to explain the origin and dynamics of the emerging system. The larger context, the "whole" in the case of organisms, interacts with an environment that it has constructed (a phenomenal world, as phenomenologists would say) to supply the significance, valence, affordances, and desires that contextualize and elicit whole-organism activities. This phenomenal world has become the subject of some contemporary subfields on the edges of biology (for foundational texts, see Maturana and Varela, 1992; Gibson, 1979; Thompson, 2007). For example, recent fields such as sensory ecology (Dusenbery, 1992; Burnett, 2012), and biosemiotics (Hoffmeyer, 2008; Emmeche and Kull, 2009; Favareau, 2010) are now theorizing and developing empirical methods to research the role that perception and interpretation play in ecology. If an organism is organized so that it can perceive and respond to certain things in its surroundings, then the very nature of the feedback loop between it as an organized system, its parts, and the surrounding ecology requires perception (and response) as part of its explanation. Indeed, the genetic determinist's dream is disemboweled from the inside out when molecular biologists discover that gene expression is regulated by environmental signals coming from outside the cell (and often mediated by the activity and perception of the organism as a whole) (Juliano and Haskill, 1993; or more to the point, Cole (2009)). The phenomenal presentation of the world becomes an active factor in the dynamics of inter-organismic systems, phenomena to be described and understood as part of the naturalistic enterprise of the sciences, and not epiphenomena to be explained away. This integrated approach, advocating organisms as actively reconstituting their relationships with their environments is described in Walsh's Gibsonian concept of an "affordance landscape," where organisms are treated seriously as
"subjects of evolution" (2014, p. 233). Before readers hit the panic button, it should of course be mentioned that, as used here "phenomenal" (but also "experiential") is stripped of any idealistic overtones, conceived simply as defining those modes of interaction that emerge through certain (biological) configurations of things in the world. Along with it, the so-called ontological distinction between primary and secondary qualities must be thoroughly rejected. Though exciting for their capacity to combine a faithfulness to the vision of science with a sonorous anti-reductionist brio, the limitation of these approaches to perceptual ecology is often that they tend to assume that what and how a given (nonhuman) organism responds is somehow fixed, stereotyped either as congenital instincts, or as responses typical of normal phenomena that develop at a certain stage of ontogeny (such as polyphenisms (Gilbert, 2003)). If we talk about learning in other species at all, it tends either to refer to the fulfillment of a typical "species-specific" unfolding (such as a bird learning its parents' song to which it is pre-primed\textsuperscript{22}) or mindless and passive association or habituation constrained within strict bounds (functioning, of course, solely to "buffer" the organism in a changing environment long enough for it to pass on its genes). Novel perceptions or responses are ecologically meaningful only insofar as natural selection will select for an organism (or stable organism-environment coupling) that has randomly acquired such changes in their hereditary material. This has led to an approach that has kept biological inquiry by and large free of ethics, politics, and pedagogy.

\textsuperscript{22} For example, consider Bateson's suggestion that the "genetic contribution [of an organism] ... might take the form, not of fixing the given behavior, but rather of making this behavior easier to learn" (1972, 426) given, of course, certain environmental stabilities. This approach has found experimental evidence in developmental systems theory's rejection of the genotype/phenotype dichotomy (see Oyama, Griffiths, and Gray 2001).
And so, although it is clear that mainstream ecologists bent on the sufficiency of mechanistic explanation cannot offer a compelling or constitutive role for learning in the dynamics of ecosystems, the fact is that most biologists working to integrate perception into their understanding of these systems do not do much better. By contrast, "true" learning, the acquisition of perceptions or behaviors which are thought to be "unexpected" given the makeup of the organism, is generally assumed to be unique to humans. A few species are given their token status as learners through "exceptional" news stories such as the tool constructing crow, that affable urbanite Nim Chimpsky, or those meticulous monkeys now washing sweet potatoes along some Japanese island shore. Nevertheless, the breadth and significance of unexpected novelty and acquired versatility of an organism actively brokering perceptual/behavioral readjustments to its environment during the course of its life is scarcely featured in mainstream ecology - and certainly not in evolution.

In sharp relief, humanity's overwhelming capacity to learn is also often considered to be the reason why humans can't seem to keep themselves within any so-called "ecological balance" (whatever that might mean) conceiving themselves as beings that sprout novelty constantly, messing up the order that the rest of the world is working indefatigably, though senselessly, to maintain. This assumption places freedom (as modernly conceived) in the hands of humans and determinism in the rest of the biosphere. Even when notions of equilibrium or balance are abandoned from ecological descriptions (such as the work following Holling [Gunderson and Holling, 2002]), the consequent incorporation of a chaotic element is only refit into a larger cyclic equilibrium
that still eschews the creative and unexpected role of spontaneity and learning by those within the ecological community.

Dewey builds an argument against learning in other species by drawing a distinction between training and learning. He says that some animals are capable of novel actions through being trained but not of true learning because they are being directed by the interests and concerns of the human training them rather than by their own goals and purposes (1916, p. 12-13). In order to have one's own goals and purposes, one needs the detachment and imaginative character that arises through language. Animals, for Dewey, are capable of altering their habits but only because their environment is controlling them, not because it is they who are taking hold of a situation and redirecting it. In other words, animals are passively habituated rather than actively adjusting habits to ongoing situations. More can be said about whether this constitutes an empirically real dichotomy; however, for now I want to point out that there is little evidence that other creatures are incapable of engaging in problem-solving, with vast numbers of studies showing planning, episodic memory, crafting of tools, and memory of food locations. For example, Clayton, Bussey and Dickinson (2003) describe experiments revealing planning and memory in jays, countering Suddendorf and Corballis' (1997) "mental time travel" hypothesis, which states that the capacity to consider past or future states is unique to human cognition.

Despite the general reluctance to recognize learning as a common or significant aspect of the nonhuman biological world, there are theories on the role that learning plays in ecologies (for a comprehensive treatment, see West-Eberhard (2003); Weber and
Depew (2003). Early on, Baldwin (1903) argued that organisms learn and that learning can make them modify their relationship with their environment in a way that makes them more likely to survive. But since learning is metabolically expensive, takes time, and is therefore (in the long run) more risky than genetically encoded behavior, if the new environment ends up being stable, the organism will eventually catch up by filling in its DNA with genes to encode the behavior (through processes such as genetic assimilation (Waddington, 1953), or through making more permanent alterations epigenetically (Jablonka and Lamb, 1995). This occurs whenever those that have to learn the new behavior compete in this new context with differential success compared with those that can do the same thing easily and without work. In essence, learning pulls the organism into a novel stage of its evolution by its shoestrings, allowing the organism to act in new types of environments that a strict and limited set of instincts would not enable, but which it is ultimately capable of evolving the genetic apparatus to deal with. By doing this, learning speeds up ecological interactions, or at least prompts ecological shifts, and may be responsible for the phenomena that Eldredge and Gould call "punctuated equilibria" (1972). This is particularly true if the learning modifies the environment in such a way that the young of the species are given new possibilities of learning from within this new

23 An objection to the notion that phenotypic (or developmental) plasticity and learning are synonymous might lie in the observation that many organismal adjustments occur without the organism itself being involved. "I" have nothing to do with the fact that my skin tans in the sun and presumably a bird did not actively adjust its coloration in response to its perception of its context. A great deal of human readjustments to the environment are undertaken without passing through the interactive medium of a "phenomenal world." It is assumed that in the case of other species, and certainly those without brains, that learning cannot be said to meaningfully occur. A closer look, however, reveals that while in these cases learning may not be going on in the larger organism-with-central-nervous-system/environment circuit, it may be occurring in smaller circuits (such as cell/extracellular environment circuits, etc.) (for a discussion of this in relation in plant learning, see Affifi 2013).
environment, spurring a new environment in turn (for an example of this, see Deacon’s take on the evolution of human language (1997)).

There are other ways that learning can directly impact ecologies. If an organism learns to modify its environment in some way (for example, learns an easier way to retrieve clams from their shells), then the interaction between many organisms readjusts, changing the selection pressures on each of them. Even if the Baldwin effect is not possible (or at least not common), it is likely that learning has strong and irreversible effects on ecological evolution through how the organism modifies the niches of other organisms through constructing its own (on "niche constructivism" see Lewontin (1983); Odling-Smee, Laland and Feldman (2003)). A related phenomenon, known as "maternal effects" is also now the subject of an active research program (Maestripieri and Mateo, 2009). Many behaviors are subsequently learnt and releartnt, creating "animal traditions" (Avital and Jablonka, 2000) that have significant effects on the broader ecological dynamics.

**Ecological Pedagogy**

As learning becomes increasingly acknowledged as constitutive in the development of organism relationships, the inadequacy of the split between "ecosystem" and "social system" will become undeniable. If living beings are sensing, perceiving, and learning, and if their doing this really matters in the ongoing co-construction of ecologies, then we ought to develop practices so that we can begin seeing them as sensing, perceiving, and learning beings, and not bundles of instincts (i.e. Lorenz or Tinbergen), vehicles or extended phenotypes of DNA replicators (Dawkins, 1982), or giant biochemical machines (cybernetic or otherwise). To borrow from Roland Martin (2011), the cultural
stock of other species "yoking together" and with us, generate socioecological patterns, novelties, and interdependencies essential to the ongoing flourishing of the planet.

Concern with the perpetuation and vitality of ecosystems becomes a concern with the processes of learning that create and recreate them. We must therefore learn to see other species pedagogically. Unfortunately, with Dewey's help, education as a field operates as though learning only really matters when it is going on among humans, and whatever else is left to the biologists. As educators, we involve ourselves in the role that education plays in inducing the young into their communities or in helping them stand up against whatever ills that their cultures are promoting. But in theorizing on the purpose, role, and possibilities of education, educators do not consider that we may also be teaching other organisms (and their young) through how we go about our lives in interaction with them, and indirectly through the modifications that human structures and institutions make on the landscapes of the earth.

In an earlier paper, I considered the Deweyan concept of growth and how it might help develop a richer pedagogy for our interspecies relationships (Affifi 2014). If growth is defined as the formation of habits that enable further habit formation, increasing the flexibility and dexterity of organisms instead of corralling and enclosing their possibilities, the pedagogical question to ask is what practices we can and should develop to enable growth for both parties in an interspecies interaction. Growth would free up ecologies to diversify and experiment, to regenerate and flourish, to enable both the spontaneity of life and its capacity to respond. We do not need to fix the "hole" that Stewart Brand (2013) says we've created in nature since the Pleistocene by resuscitating extinct species like the mammoth or the passenger pigeon. We must instead accomplish a
much more difficult albeit essential task: to alter our behavior such that the creative and regenerative processes of ecosystems are released from the binds we've tied. This requires a shift in our perception and our relational sensitivity, opening ourselves to the "affective ecologies" we are ever participating in (Hustak and Myers, 2012) and not merely the acquisition of technical skills for DNA manipulation and the funding streams to accomplish it. Insofar as this is in large part something that happens through learning, this is a pedagogical -or biogogical- question.

Now, in opposition to what some of his critics proclaim (such as his spirited nemesis, Chet Bowers, 1993), Dewey rarely advocated change for its own sake (though his long-winded style makes it all too easy to cherry-pick from his writing to make this argument). Instead, he repeatedly insisted that habits (and traditions) were useful in the economy of an organism and were good so long as they did not interfere with its capacity to respond fully and sensitively to the situations it is faced with. What Dewey maintained was that since contexts are shifting, the ability to evolve must be valued and this is why it forms the cornerstone of his philosophy. It is interesting how Bowers' star player, Gregory Bateson (1979), takes up a similar discussion of habit and flexibility -and reaches similar conclusions- also arguing that both are necessary for life. What Bateson notes is that the increasing dependence and rigidity of a repeatedly employed habit is a positive (i.e. runaway) feedback loop, which tends to generate pathologies in living systems (p. 504-505). For Bateson, flexibility means the capacity to attenuate runaway feedback through altering habits in response to changing conditions, and is essential for any organism's sustainability. Against this, one could argue that it is our very capacity to alter our habits that is being capitalized on (and indeed stimulated) by consumer society,
as new products are continually developed, each reorganizing the lives of those who
interact with them. Bateson would reply (and I think rightly) that such flexibility is only
within the overall context set out by the consumerist economies. Since this larger context
is itself in a runaway feedback loop, habits established in service of its trajectory are
severely constrained. Dewey, however, makes this same point in pre-cybernetic language
in his discussion of socialization into a band of thieves (1916, p. 78), where the individual
is "growing" but only within an increasingly narrow field of interactions. Flexibility does
not merely imply versatility within one set of circumstances but versatility to move
between and create new circumstances.

In that earlier paper (Affifi 2014), I focused on interspecies learning from a dyadic
perspective, on what happens to a human and another organism through interaction, and
specifically through the human becoming aware that this interaction is occurring and that
it matters. As nebulous as the paper perhaps was, it built itself up on the crucial
foundational point that every ecosystem (i.e. social system) and institution is rebuilt every
moment by immediate encounters between beings. However, without taking into account
the structural context of the would-be educator, the dyadic perspective I entertained is
naive. In this paper, I seek to broaden the analysis. Although direct encounters can
influence social systems, social systems enfold upon and powerfully influence the very
sociality of their members. We are currently living in a world structured by technologies,
language, institutions, values, and infrastructures such that patterns of thought not
reifying a human-nature split are continually dissolved. Dewey recognized this problem
in his discussions of democracy, insisting that although democracy ultimately referred to
the quality of openness within an immediate experience between people in a community,
humans would have to continuously reconstruct their contexts so that they can work towards promoting democratic community aims.

**Democracy and Learning**

Dewey saw that an experimental approach to physics and chemistry had led to massive societal and political changes through the ease of communication, transportation, and technology. He feared that unless we strive to make the human sciences (which meant art, ethics, social science, politics, philosophy, and education) experimental too, we would be incapable of assessing, communicating, mobilizing, and redirecting for better purposes these massive reorganizations. In contrast to dogma and authority, he saw a deliberative and participatory democracy as an ideal to which humans must strive in order to enact an experimental approach in dealing with their affairs. However, he warned that we must not import the particular experimental methods of physics and chemistry into human sciences, because the experimental approaches required for human issues must be much more tentative and self-reflexive, altering at the tempo through which the consequences of these approaches become anticipated or known. For Dewey, democracy, like science, depends on a flourishing experimental attitude towards the problem at hand and broad and unrestricted communication between people, which allows for a more adequate assessment of the evolving situation, the approach taken, and which frees the process from insularity and stagnation. To this extent, he considered democracy as the very process by which the experimental method could evolve to face the challenges of the human world.

Deweyan democracy thus envisions a limber and embracing approach to developing theories-in-action by unhinging habits and dogma through social intercourse.
He also thought it worked best if it was believed in. Democracy contributes to identifying and solving human problems when it is approached as a goal or ideal to strive for. It is "the tendency and movement of [some specific community life] carried to its final limit, viewed as completed, perfected" (1927, p. 148), never achieved but ever the vision (or meta-hypothesis) to guide inquiry and action.

Openness to mutually reciprocal learning forms the foundation of Deweyan democracy. Dewey claims that democracy is "primarily a mode of associated living, of conjoint communicated experience" (1916, p. 83), which to be realized "must affect all modes of human interaction" (1927, p. 143). Engaging and collaborating openly and receptively with diverse people is the best way to ensure that novelty emerges, is attended to, and is given the support it needs to turn into new (albeit also tentative) habits. Without such an environment, people are easily led to rely on a stock of established habits (dogmas, principles, truths, addictions, etc.). One's personal growth depends on the growth of others and vice versa, and since we cannot grow at the expense of another, there is a democratic core at the root of any interaction. Encounters with others are therefore the means for stoking that stochastic creativity at the root of life, but can only do so if accompanied by a faith in the possibility of mutual growth and improvement that the democratic nature of interaction can afford. Otherwise interaction becomes reduced to the attempt to structure another according to one's pre-established schema. Democratic interactions occur most fully when there is an attitude in encounter such that each party treats the other's ways of being in the world as worth a vote in the ongoing negotiation of the relationship and consequently in how and what each will feel, think, and become. This sympathetic attitude is both the means and end for democracy. Political (and other)
institutions are themselves democratic to the extent that they foster this in daily encounters.

Democracy is therefore only secondarily a form of government. However, this does not mean that larger structures play no role in the possibilities of democratic relationships. Indeed, technological, institutional, and material circumstances have consequences on human interactions insofar as they constrain or enable possibilities. However, for Dewey, although the material and cultural conditions set the context for interactions, *reflection* on these conditions and their likely consequences transforms them. These consequences are differentially realized to the extent "in which knowledge of consequences is equitably distributed, and action is animated by an informed and lively sense of a shared interest" (1927, p. 156). So, for agile mobilization against structures that put the democratic potential of direct encounters at risk, we need broad and unimpeded communication.

The establishment of common interests is important not merely because it enables people to organize and work together towards common goals, and to thereby enter relationships that further seed mutual growth, but also because it capacitates the formation of a *public*. For Dewey, a public "consists of all those who are affected by the indirect consequences of transactions to such an extent that it is deemed necessary to have those consequences systematically cared for" by some sort of representative (1927, p. 15-16). This occurs when a community has identified a common problem and has politicized itself by electing certain members to specifically attend to it. The public can therefore be thought of as the particular way in which humans communicate with each other to identify problems, and develop and assess solutions. The public is democratic to
the extent that this process is open-minded and experimental, capable of adapting itself responsively to the voices of those concerned, and able to hold representatives to account in their given functions.

From our description of democracy so far, it is easy to see how Dewey's concepts of common interests, diverse associations, local community, the public, and democracy, are all adaptable to incorporate other species. It is possible to see how the various ways in which other species learn enables them to act differently in the establishment of the common interests brought forth by the ecosystem, and that each organism is more or less able to fulfill and re-invent its roles in the ecosystem according to how freely it can learn. Conversely, our own capacity to learn is enriched or restricted by our openness to form associations with other species and recognize our mutual participation in communities. However, many of Dewey's political concepts hinge on his understanding of communication, which was born of the same conscious/non-conscious dualism as his distinction between learning and training. We shall have to explore these issues in more depth to better enunciate a Deweyan conception of a democratic ecological community.

**Limits of Dewey's Concept of Communication**

Dewey has sometimes been brushed aside in discussion of environmental philosophy because his anti-foundationalism is seen to ultimately privilege humans over other species. Because Dewey's ethics are considered context specific and contingent, it is sometimes taken to be incompatible with the notion that other species have "intrinsic value," a concept thought to underpin an environmental ethic that goes beyond the instrumentalist desire to protect ecosystems merely to continue propagating the human race (see, for example, Katz (1996)). However Dewey's interrelated pair of concepts,
growth and democracy, which yearn and reach out for the progressive attainment of a richer and more vital life, suffuse his work with a sense of the deep inherent value of coevolutionary processes. If ecological relationships are capable of producing more or less growth for those involved in their formation, it is consistent with Dewey's spirit to base an ecological ethic on his work (a point touched on by McDonald (2004)). It is not his alleged anti-foundationalism that is ecologically problematic, it is rather the theory of communication that grounds his approach to pedagogy, community, and democracy that needs scrutiny.

Dewey held that transaction is the norm in both animate and inanimate life, that organic beings are associated with one another in such a way that their constitutions and behaviors are continuously reciprocally determined by one another. But he also felt that transacting organisms, in themselves, do not make life a community (or, therefore, a public). For Dewey (as for Mead), a community requires communication so that shared interests and interdependent activities may arise, shaping not only people's goals, thoughts and emotions, but also their actions in the world (1927, p. 155). This communication has a self-reflexivity such that each participant is aware that the other is interpreting them and is attempting to express themselves so as to help make sure that what is being understood is accurate. What is being communicated is modified by both the evolving anticipations of how the utterer expects the listener to understand what is being said and by the actual way that the listener responds to the utterance. For example, Dewey explains that

Note that this argument for reciprocity is echoed in Noddings' notion of care (1983), which also excludes other species. Unfortunately, her position has remained static on this front despite three decades of ethological inquiry that have occurred between her initial formulations and her recent explicit treatment of democracy and education (2013).
The experience has to be formulated in order to be communicated. To formulate it requires getting outside it, seeing it as another would see it, considering what points of contact it has with the life of another so that it may be got into such form that he can appreciate its meaning. (1916, 5-6)

In doing this, "you will find your own attitude toward your experience changing" (p. 5-6). To gain this degree of detachment and flexibility, symbolization is required, which Dewey considered impossible in other species. For this reason, he was able to formulate and enrich a powerful concept of democracy throughout his long career while maintaining an impassable moat that would prevent his experimental reconstructions from entertaining a broader interspecies notion of communication and of community.

Two objections can be raised. Is this distinction between humans and other species as absolute as Dewey would have it? And if it is, does this necessarily bar other species from contributing to the establishment of a public based on an understanding of shared interests? I argue that neither is likely true, but will address the second question in the next section. What I will argue here is that the types of interactions that ensue through linguistic communication are only a partial and isolated type of communicational interaction that misses the nature of how common activities, emotions, and behaviors are established in humans and other species.

What Dewey's concept of communication seems to require is an actual motive to communicate. Assume for argument's sake that other species communicate "inadvertently" for the most part. The transactional interactions they are capable of are still modulated through how their behaviors get interpreted by others, to which they in turn respond. They would not be consciously reformulating their actions ahead of time to establish coherence, but may still be using past experiences to fund what responses may
be appropriate, and still manage to evolve a coordinated pattern of interaction. The path to learning is a little more circumlocutory but it is learning all the same. Dewey discounts the extent to which not-fully-explicit adaptive fitting is ubiquitous in human interactions and indeed an essential part of a lithe responsiveness to circumstance. We are not always aware of the communicative dimensions by which we operate because we focus on what is being purposefully communicated while other interactive modalities slip constantly through our fingers. And thankfully so, because it is these that form the structural basis for others' understanding of what we are doing and the context for it.

For Dewey, a community must have "aims, beliefs, aspirations, knowledge" (1916, p. 4) in common. He is not always consistent in how he defines "in common," but in this section he describes it as "similar emotional and intellectual dispositions - like ways of responding to expectations and requirements." When other species expect certain things to occur, they are forming associations and therefore signs. When we observe and interact with them, we can see what is significant for them. Signification is being communicated via whatever sensory pathways we are using for the interaction even if it is not being intentionally communicated. We are capable of then experimenting with actions in line with the interests that emerge from our understanding of their signification. Conversely, other creatures develop associations when in encounter with us. They expect us (or humans in general) to act in certain ways and modify their own behavior accordingly so that they can meet their needs in light of the contextual factors that the humans create in the ongoing environment. But what actually happens is that both of these processes are operative at once, however imperfectly or slowly. Conjoint activity means coevolution, pervasive across the biotic realm on multiple spatiotemporal scales. "Intellectual" or
"emotional" dispositions are hard to assess, but we see clearly that "like ways of responding to expectations and requirements" are commonplace. To arrive at co-regulated associations is a collaborative solution, more or less democratically negotiated without requiring the explicit self-consciousness that Dewey seems to require.

Dewey certainly recognized that consciousness was only a small part of the manner in which humans adjust to evolving environmental contexts, but he set up an untenable dichotomy between reflective intelligence as a pivotal source of novelty and merely machine-like, habitual, or haphazard behavior. In fact, it is often the sub- or semi-conscious currents of any organism that provide the agility needed to respond in novel ways and to twist habit gracefully to the affordances of the new situation. To be sure, Dewey did not always hold this dichotomy strongly (see his discussions of art (1934), for example), but he maintained it decisively when it came to the difference between humans and other species. What seems more likely is that communication operates along a spectrum, with "wholly unconscious" and "entirely conscious" interaction both poised as limit cases. In any given interaction between responsive organisms, some aspects of the interaction will be more within the focus of awareness than others, but only rarely will they be the fully self-reflective, second-order consciousness that he places so much weight upon (think of jamming or lovemaking - are these really just the playing through of machine-like habits just because they are not conducted with metacognition?). Moreover, these varying degrees of sensitivity and (un)awareness to the different aspects of the interaction interact together as well (which, again, Dewey acknowledged in humans). However, reflection is not necessary in the process of drawing these aspects of the interaction together. Whether or not people (or other organisms) co-develop a pattern
of interaction (i.e. something in common) depends on how these different aspects of the interaction are integrated in the ongoing negotiation of the whole organism with its situation, which may or may not include conscious thought as an integrating factor, as the case may be.

**Democratic Generosity**

To address the second objection I posed to Dewey (about the necessity of communication for the development of community), it is instructive to pay attention to how Dewey handles cases of infants and the voiceless human. He certainly includes them as participants in communities and in the formation of the public, insofar as their behaviors elicit certain forms of care in others and form the basis of their emerging shared interests. In this sense, Dewey advocates for a broader sense of equality that seems not to depend on his criterion of communication for inclusion in the democratic process. Tellingly, he writes that *equality* "denotes effective regard for whatever is distinctive and unique in each, irrespective of physical and psychological inequalities" (1927, p. 151).

Thus,

"[a] baby in the family is equal with others, not because of some antecedent and structural quality which is the same as that of others, but in so far as his needs for care and development are attended to without being sacrificed to the superior strength, possessions and matured abilities of others" (p. 150).

Dewey had a generous outlook when it came, at least, to humans:

While what we call intelligence be distributed in unequal amounts, it is the democratic faith that it is sufficiently general so that each individual has something to contribute, whose value can be assessed only as enters into the final pooled intelligence constituted by the contributions of all. (Quoted in Boydston and McDermott, 1987, p. 220).
We can develop a sense of "democratic generosity" (Pappas 2008, p. 225) so that we can experience and be sensitive to the unique individuality of all others, not just voiceless humans. This alone will foster the flexibility needed to fashion our imagination, judgment, and thinking to respond and to communicate our understanding—all preconditions for developing a public that is acting on the interests of an ecological community. Other organisms are also continually engaging in new and established relationships. Insofar as ecosystems foster diversity through such encounters, they are already functioning to some extent democratically. The question before us is how to turn human intraspecies and interspecies relationships around so as to protect and nurture the contexts that enable continued diversification and experimentation.

Dewey noted that human democracy arose out of a shift in material conditions, including commerce, transportation and intercommunication, but that these factors would be insufficient to sustain democracy. Democracy could only be sustained through "a deliberate and conscious effort" (1916, p. 83). This is the case for democratic ecologies as well, where an ecological public is already forming through the relational shifts our society is undergoing. Although other organisms communicate with us in a very different way than Dewey would have accepted as the type necessary for democratic relations, it is clear that in some sense (and perhaps many senses) we are being communicated to (and with) nonetheless. Through the effects of technological shifts in our environments, the seeds for an ecological democracy are sprouting from varied directions—both direct and mediated— including in overwhelming experiences of witnessing environmental destruction and animal abuse. Despite software developers’ intentions, the voice of suffering comes through in the sounds and images of slaughterhouses and clearcuts.
shared across social media, and regardless of the intent of scientists, a dizzying diversity of intelligences and interdependencies across the biological world are being uncovered daily. For example, the biotech industry intent on economic gain is largely responsible for discovering the extent of genetic networks, complex epigenetic contingencies, and genomic integration, all of which make the very transgenic technologies they deploy seem so rudimentary and haphazard. It is also coming through in voices of indigenous and local people struggling to pursue their own decolonizing epistemologies and the often very different practices they are engaging in with other species. And yet, without that "deliberate and conscious effort," these novel understandings and felt affects will not be brought productively into concrete school curricula, or into the reconstructions of cities, governance, and "natural resource management" plans, etc. In a fractured way, we will only become increasingly "aware" of injustice of which we are implicated but powerless to engage.

What is happening now is ripe with consequences. Relationships come forth and flourish for a time or recede in stagnation, spilling out and affecting other relationships in turn. The educator's intellectual vision looks forward, as the educator is not concerned with patterns that "are" or "have been" but with what is coming to be. Being oriented temporally in this way requires a different sort of listening to the subject matter. It requires attention not to what that thing "is" but rather to what it is "becoming" or "capable of becoming." The educator's hypotheses about the outcome of a pedagogical situation are themselves saturated with ethical import because they can affect the very possibilities of what may come about (how well we know the Pygmalion story (Rosenthal and Jacobson, 1968)). One pedagogical challenge is to establish what factors may be
implicated in affecting these possibilities of becoming. Pappas recently commented that "[a] community nurtures its own means of improvement when it makes it possible for everyone to develop their own unique voices" (2008, p. 225). This should be considered the challenge set for our means of instituting structural change: our formation of a public, our push to change governance, and our work as educators.

**Listening, voice, and democratic imagination**

There are many tools to employ and while none are sufficient, all may be necessary in order to give a voice to other species in the constitution of an ecological public. We need to make use of the opportunities afforded by the particular material circumstances that we live in and the ways in which they allow and restrict community voice, adequate public representatives, and flexible, experimental responsiveness. We need to acknowledge the role that humans can play in this, as beings that can self-consciously represent this process symbolically and communicate it to one another. The fact that the public needs "representatives" while language (and other media) "represents" is not merely a happy verbal coincidence. They both refer to the fact that on very different scales a degree of self-reflective consciousness emerges and summarizes a situation by emphasizing aspects of relevance. They also suggest that, on the one side humans are positioned with a particular responsibility in the emergence of the ecological public, and on the other that language itself is inherently political (so mechanisms need to be continually established that ensure it is representing responsively the evolving mutual concerns of the ecological community).

This does not mean that humans are the "rights-granting, voice-giving, and value-ascribing uncontested authority" (Pedersen 2010, p. 244), thereby extending the
indefensible humanism project. Networks much larger than humans, including other species and material structures have co-evolved to produce the particular niches that humans have in ecological dynamics. What the human can do has been given to it by its place in a complex field of spatiotemporal interactivities which it did not design but which it can respect by taking its position seriously.

The dominant trend brought about through the technological developments of the past few hundred years is that the sciences have been both silencing and giving voice to other species, through the process by which new, distal, and technical findings emerge in the biological sciences and replace proximally intimate (and sometimes Indigenous) knowledge. We do not need to erect a dichotomy here, placing science as "bad" against "sacred" Indigenous knowledge systems. Rather we need to listen to the voices from all directions, allow them to dialogue together to whatever extent they are able, to argue and deliberate, as Latour's (2004) colorful yet very Deweyan approach advocates. This means not only examining sciences as they have been developing so far, opening us up to new understandings about other organisms, their behavior and their needs, but also developing paths of inquiry that function in explicit self-conscious recognition that they are communicative tools to be employed for the formation of an ecological community and a public that can better represent it.

Ecology can be considered as this very approach, an emerging science of the community, which needs to be as ongoing, as loose-limbed, and as sensitive as the type of experimental science that Dewey envisioned for human affairs. Rather than being an

25 But not by flinging "agency" over everything that exists, flattening ontology so much that chairs and cars are given the same voice in democratic assemblies as life, ignoring the needs, growth, and interactive potential manifest in biological organization. This approach inadvertently reifies human supremacy (such as we find in Bennett (2010) or Bryant (2011)).
extension of methods suited for exploring physicochemistry, it needs to be the unremitting process of discovering the wants, needs, and developments of each organism and how their conjoint activities establish characteristics that are mutually beneficial for the shared interests of the ecological community at large. Ecology would therefore become a necessary part of the process whereby ecosystems become conscious of their interests and concerns, and form into ecological communities working to protect those interests. Humans are positioned in this process with roles that emerge through the types of conjoint associations that ecosystems make possible for them. This includes (for example) our symbolic activities, but also our affections and admirations for these myriad ecological processes, and our expanding, yet conflicting range of approaches, discoveries, and communications with and about those beings that have organized in such a way that provides us with this niche and its responsibilities.

New knowledge needs to be connected to our stock of operative understandings and specifically to its relevance for the development of ecological communities. In particular, new knowledge must be connected with the practical goal of establishing an ecological community, which means tracing out explicitly how the new knowledge can be understood in terms of impacts for other organisms, for ourselves, for our mutual possibilities for learning and growth, and in terms of what sorts of implications could be drawn from it for future action. New knowledge needs to be integrated together with other new knowledge as it arises, and ecologists need to be always open to revision and experimentation in terms of how they conceive their own models, recognizing that in complex and evolving systems (and indeed in systems that are also self-referential, changing in response to the way that the scientists are modeling them) any model will be
at best a temporary and useful approximation. This does not mean that we should throw in the cards and commit to relativism. As a result of observing and interacting with other organisms, humans have developed a richer sense of their needs and also of how their needs and ours intersect. Though partial and evolving, there is no reason to assume that this sense needs to be discounted entirely. We need to simply get better at imagining consequences, acting on knowledge, and at becoming increasingly flexible in our understanding of our evolving ecological community. No relationship is without this contingency. This is why Latour advocated that we must redistribute speech to nonhumans while learning to be evermore "skeptical of all spokespersons" (2004, p. 62) (and this includes people, language, apparatuses, media, other nonhumans, etc.).

Further, this new and integrated knowledge needs to be communicated. This does not simply mean that it be integrated into school curricula, be distributed more effectively across the media, and be represented more explicitly by politicians. It also means that we need to do something about the onslaught of distracting and irrelevant news and infotainment that prevents us from not only developing a richer human public but also an ecological public. Dewey's dialectical conception that a public will rise up to address new concerns once the old one has ossified into a government errs in the same way that Marx's dialectical materialism did. Though he did not see the stages as being strictly necessary as Marx did, he did seem to have faith that this evolution could and would occur. He warned of the consequences of a distracted population unable to join together to form a public (1927), but he was unable to see to what extent industries promoting distraction would be able to clutch the imagination of so many people.

26 I suspect, however, that he articulated this position for pedagogical reasons, realizing that broadcasting pessimistic and fatalistic positions was self defeating. Indeed, this would be in keeping with his insistence on the effectiveness of a "democratic faith."
Dewey's own approach demands free and wide intercourse with diverse people in order to promote growth and bring about reconstruction. His chauvinism against technologically less-dependent cultures, like his bias against the possibilities of other species, is therefore not consistent with his own educational and experimental methodologies. By contrast, we have all the reason to believe that those cultures that Dewey denounces as "savage" have some of the very approaches needed for widening our concept of communication and of community beyond the stranglehold of definitions that Dewey has succumbed to.

Insofar as humans erect dichotomies in their relations with other biotic groups, they are unable to interact sufficiently to establish interests informed by the needs and demands of those biotic groups. This is especially so in light of the fact that those groups' common interests are the construction and reconstruction of ecologies on which we depend. Without this free play, humans develop cocooned interests, with ethical principles that only make sense within their group, just like Dewey's famous band of thieves (1916; 1927). Thus, the possibilities of mutual enrichment, ethical attention to the uniqueness of particular situations, and the democratic capacities of the ecological communities that we participate in are all kept in rigid habit (or destroyed entirely). For example, if economic efficiencies facilitate more predictable and biologically less diverse ecosystems (such as tree plantations with thousands of hectares of genetically identical plants growing in synchronicity), assemblies are established that are miseducative for those that interact in them (from the plantation workers to the trees themselves and all the other organisms in between). Insofar as we live in structures that affect our growth and the growth of others in our ecological communities, and insofar as we are capable of
modifying the varied structures so as to promote growth, democracy is inseparable from biological evolution.

As needs and interests become known and communicated, a Deweyan public emerges to confront the factors that are conflicting with the shared interests of the ecological community. Although the sciences of ecology are still (generally) framed in narrow and physicalist frames, they currently represent a very real and direct component of democracy, so limiting ecological investigations (such as The Harper Government of Canada's cuts on scientific research (Klinkenborg, 2013)) is direct assault to democratic ecologies. A democratic encounter depends on listening skills (Dobson, 2010). The sciences of ecology, in however piecemeal a fashion, are providing just this. Their approaches need to be magnified and enriched, so as to include not merely the modeling of physical systems but the development of a "perceptual ecology" (Thomashow, 2002) in each of one of us so that we are capable of listening to, identifying, and responding to the interests and needs of the members of the ecological communities within which we live, human or otherwise. In the pedagogical sense developed in this paper, ecology cannot be considered as a subject matter to be investigated by a narrow field of experts but rather as an aspect of the structure of our experience that enlarges our experience so as to be sensitive to a fuller range of the relations through which it is composed.

Representing other species (and having them represent us) can be as experimental as the process of exploring our relationships with them and discovering their evolving senses and needs. If we get caught up in the politics of whether our representation of them is dominating them according to our frames, we will permanently prevent ourselves from doing the very real and concrete work of listening with increasing acuity to those
voices around us and making these voices heard. Representation always has the possibility of dominating; it is never neutral, as the poststructuralists insist. But representation occurs anyway and all we can do is develop our sensitivities so that we resist being dogmatic and unresponsive to what it is representing, fostering care, love, and respect for what we are coming to understand while increasingly aware that our understanding is forever but a partial and temporary position by which to engage. This is one reason why Rorty (1982) maintained that pragmatism was waiting at the end of the "philosophical road" upon which the postmodernists were traveling. In this way, it is like any knowledge or activity. Fixed habits are undemocratic and stifling to everyone in the transaction, dominator and dominated. So the rich, in all their misery, trample the poor. Ecology, considered as a means of improving communication of meanings of all organisms in an ecosystem is in this way part of the democratic process of developing an ecological community.

**Ecological democracy and education**

Dewey (1916) described the role of formal education as to bridge the gap between the child's perception and the society's cumulative understanding and activities, a gap that gets ever wider as humans accumulate knowledge and technical skills. The lesson for interspecies pedagogy should be obvious: the cross-talk of local ecological knowledge systems, the growth of scientific explorations, the burgeoning of naturalists, along with the inevitable cross-fertilization between these varied sources of knowledge through the internet and other rapid communication technologies, is leading to a world where our understanding of the biological world will undergo continuous reshaping and refining. As a whole, societies will have to respond in ever more nuanced ways to increasingly
complex and dynamic evolutionary changes of the ecosystems that they live in and co-
constitute. This process is unfolding and will only increase as economic and
technological factors cause increasingly traumatic disruptions to biological systems. It is
this bridge that needs to be made: formal education can and must cultivate a more
focused, a richer and deeper, more mature and more responsible immersion of people in
all their biotic relationships - stronger than would ever be possible merely through having
children exposed constantly to green spaces without the tutorage of our developing
wisdom and knowledge.

Democracy is not something that is ever achievable completely, and even partial
achievements can quickly distort into undemocratic regimes. In a sense, this is due to the
very nature of habits. The very actions, systems, or relations that collaborate to produce a
mutually satisfying solution to a shared emerging interest tend to become procedures or
algorithms, fixed and fixating, dogmatic and authoritarian. Dewey recognized that habits
are part of the economy of an organism but he also recognized that they can be perilous
for both the organism and the other organisms it interacts with.

As Dewey said, "[n]o amount of preaching good will or the golden rule or
cultivation of sentiments of love and equity will accomplish the results. There must be a
change in objective arrangements and institutions. We must work on the environment not
merely on the hearts of men" (1922, p. 22). The method he advocated was to work on the
environment through intelligent experimentation. The material structures we live in
modify our ways of thinking, feeling, and being in extremely complicated ways that we
cannot entirely predict. We must become experimental, but not in a blind trial-and-error
way. Instead, we must continually inform our experiments with our sense of what is
desirable. Though fallible, we can use our imaginations to predict consequences with more than random success. This does not eliminate error but it does prevent the likelihood that we will continue down some of the most destructive paths that lie before us. An experimental spirit does not merely mean trying out different ways of reconfiguring one's environment, and continually informing the experiments with our evolving sense of values, but it also involves adjusting the experiments continuously as we observe the results. An ethical sensitivity to the responsibilities and paradoxes of being a representative forms the basis of the experimental method at every point.

It is beyond the scope of this already lengthy article to describe what recommendations need to be made to school curricula to integrate humans into democratic ecologies. It would also be against the experimental approach Dewey would uphold to present such an across-the-board list of specifically needed changes. However, I can give an example that would at least nudge school curricula in the right direction. Linking ecological research directly to schools through curricular changes is a possible way to give other species a voice. One possibility is to assign a species to each person, for whom they are honored as a lifelong representative. This could be assigned during their early school years, and their assignments thereafter in biology, geography, history, art and various humanities could (sometimes) be explicitly focused on helping that individual understand the particularities of their species' world, its challenges, opportunities, and prospects. In postsecondary education, the student would take some courses specifically on understanding the ecology, and behavior of the organism. If there are 7 billion people on earth and about 8.8 million species, then this means we have about 800 people to represent each species. It could start as a pilot project in one country, say
the United States, where there are about 70 million school-aged children, or about 8 children for every one species. A website could easily coordinate interactions between these eight children with an interactive program where the children themselves could establish contact with representatives of other species that have relations with their own species (something like Google+ Circles). Bringing other species' lives closer to human representatives would be the inventive work of educational technologists in close partnership with the species with whom they are working to mediate communications.

Of course, this need not, nor should it, be the only way of listening to the nonhuman voice. The formal education system can experiment with approaches to representation alongside others already articulating the needs and demands of other organisms, from indigenous and local groups, to scientists, to nature lovers, all who tend to have deep attachment and insight into the worlds of other beings through direct contact, interaction, and observation. All these representatives can work together or in isolation, but in any case they can bring the multidimensionality and complexity of each voice to those humans not able to experience it firsthand.

The assumption is that such representatives may be able to bring the nonhuman voices directly to those who are making decisions that affect their lives, such as consumers, farmers, business leaders, and politicians. This process will certainly be imperfect, and like any other democratic process, dependent on the success of representatives in voicing their evolving response and the capacity and interest of decision makers to listen. Success will surely be scattered across a spectrum. As Dewey would say, it is up to scrutiny and experimentation in the creative arts (1927) such as writing, painting, and music, to continually adapt ways of listening to and representing
other species such that decisions are made in ways that account for them. Any proposal sketched may end up abandoned but not without pointing us in a more fruitful direction.

Of course, the sciences that "experts" develop, integrate with known knowledge, and disseminate, are not sufficient for the development of an ecological public simply because, like human democracy, ecological democracy ultimately depends on real and concrete personal relations between organisms. At best, findings imported from professional researchers can open us up to the fact that there is "more there" to the organisms around us than we had previously thought, both in terms of what they are doing and responding to, and in terms of how they may affect us. But the real work is always in the daily enactment of democracy, which always is a question of actual relationships. We therefore need to organize human societies on multiple levels, from the curriculum to the institution, in such a way that we create contexts where such relationships can be paid attention to. For this reason, repopulating our lived spaces with biodiversity (or better: altering the contexts of our lived spaces such that biodiversity comes back by itself) is a simple and necessary organizational adjustment. Schools obviously need to have more outdoor time, green spaces, etc., but so do parliament buildings (inside and out), teacher education colleges, offices, and every other human institution.

Putting kids into forests when they have no foundation for patience or care for other beings just provides a green backdrop for their anthropocentric games. Filling people's heads with trivia about other species ultimately cultivates in them a capacity to learn facts predigested and processed by humans rather than the perceptual and interactional skills needed to actually engage with other living, growing beings around them. The
experimental challenge is to infuse land use, technological developments, architecture, and infrastructural decisions with a pedagogical reflexivity such that encounters with these material environments elicit attention to how they draw out or silence the unique living beings with whom they interact. During such reconstructions, what needs to be asked is what effect these environmental changes make to the capacities of humans to think about, imagine, and deliberate on their ongoing relationships with other beings. For democratic generosity to be generative it requires the skill and practice of a "democratic imagination," the ability to use one's imagination to open "an expansive field of contact with which to flexibly interact so that goods are enjoyed rather than repressed and so that difficulties can be treated comprehensively instead of in isolation" (Fesmire, 2004, p. 53; also see Fesmire (2003)). This is an educational challenge, but one that involves the organization of society more generally than the mere fixing of school curricula.
Afterword

With countless urgent ecological threats, the slow pace of relational transformation is often neglected at the expense of efficient, technical solutions. We do need technical responsiveness and resiliency to this crisis. However, we also need to examine the bedrock upon which both our problems and our solutions are founded. As long as we live in an outdated Newtonian world where ecosystems are, at best, giant machines providing us services, and not in evolving interspecies dialogue, our aims and actions will re-enforce the very cultural patterns that have fostered the errors we seek to resolve. For example, green technologies and lifestyles still precariously foreground human subjectivity at the expense of its surrounding field of relations. To get out of such a framework, I've proposed a pedagogical project that seeks ways of thinking, acting, and feeling that redistribute learning across the living world, positioning humans as beings that have been offered the extraordinary gift and burden of being immersed in this broader educational landscape.

When I first started on this project in 2011, I was approaching it as the development of a specific aspect of my Master's Thesis paper. In that paper, I set myself the task of describing and exploring a research style that I called "living environmental education," which meant trying to uncover and take responsibility for one's educational effects in all of one's encounters. I discussed the educative or miseducative aspects of various things I found myself doing as a student writing a thesis paper. This included confronting my use of a computer (while writing in remote, rural Laos), my consumption of plantation coffee to stimulate my mind, and my conforming to what I saw as problematic ontologies I assumed were underlying APA formatting. I thought a great deal
about how these and other activities were teaching or normalizing certain patterns of
behaviour while I wrote for future readers, and for how I was teaching myself. I changed
or abandoned my behavior as I wrote, attempting to make the likely curriculum
emanating from my thesis more consonant with what I, as an environmental educator,
saw as educationally desirable. I, however, considered very little how I might be
influencing other species around me. My doctoral dissertation was initially intended to be
a microscope into this aspect of "living environmental education." How do I, I asked,
develop reflective skills and flexibility of action in practice such that I can be more
sensitive and responsive in interspecies encounters? What would this even mean and
what would more "desirable" outcomes even look like?

It quickly became obvious to me that the first thing I had to do was convince
myself that learning in other organisms is an important enough and fluid enough process
to warrant pedagogical examination. I felt it to be true, but I was also influenced by
dominant conceptions within my culture that assert that other species are essentially
stereotypical, genetically programmed, or mindless, and do not learn. I was also
influenced by the fact that the mental activity of organisms plays no role in our primary
models in biology, ecology, and evolutionary theory. I felt that biology in general needed
to be rethought, brought back to Darwin's original attention to the ubiquity of
intelligence, and that non-mechanistic aspects of organismic behavior needed to be
brought out and the significance of such indeterminacy made clear for how we
understand biological relationships and evolution as a whole. I suppose I felt that such a
preliminary synthesis was necessary for my own development and assumed that there
were others who were similarly wrapped up in a cloak of Newtonian mechanism that
prevented them from openness to interspecies encounters. What I found myself thinking about was, then, how to generalize our understanding of learning so that it is seen as a process constitutive of ecosystems and evolution writ large, and to consider what humans, as beings who can think about and take some responsibility for their actions, can do in light of the fact that they are in such a situation.

As I began working on articulating a framework by which we might begin to take the learning of other species as significant educational experiences (for us and for the species themselves), I found myself changing in several ways. For one, I became increasingly aware that ever since my Master's thesis, I had been treating education in a very one-sided way. While I recognized in theory that learning was usually a reciprocal activity, with everyone both a teacher and a learner, in practice my Masters and my early thinking about interspecies pedagogy were weighted far too heavily on my trying to figure out and take responsibility for learning processes that might unfold as a result of my actions. This led me to inadequately conceive of how I might be learning through these varied relationships as well. Finding a framework to conceptualize this sort of relational learning came to be by accident. As I was trying to understand the roles of learning in ecosystems more clearly, I delved more deeply into both the biological sciences and different philosophical interpretations of biology. This led me to pragmatism, which is something like a generalized evolutionary philosophy, to cybernetics, which in some interpretations may be considered a kind of ecological philosophy, and biosemiotics, which attempts to describe the unfolding of communicational interactions in ecologies. My goal was to employ these to break down the barrier that insists that other organisms behave in a way that is ultimately mechanical.
while humans are flexible, historical, growing and free. On the other hand, I also found myself looking at educational theorists (such as Dewey) who were concerned to situate human learning within a broader philosophy of transactionalism that saw human learning as just one example (if particularly rich) of an evolutionary process whereby an organism reacts to and reconstructs its environment recursively. Perception is seen as an action undertaken in response to the consequences of an earlier action. The original behaviourists’ project, like that of Watson, becomes obsolete, as it is seen to arbitrary cut the process up and call one side a stimulus and one side a response in such a way that we misunderstand how the organism and its environment are coordinated through time. The organism’s experiences and goals ought not be divorced from the description of the process because what serves as a "stimulus" at a given time is actually itself a “response” on a broader scale, a "focusing in" given the needs of the organism and its particular history. At the same time, I was discovering biological theories, such as niche constructionism, that saw evolutionary processes as involving the mutual co-constitution of organism and environment. Here, the designation of external "selection pressures" and internal organismal "traits" were conceived as arbitrary in much the same way as the division that treats stimulus and response as separate things. Much of evo-devo (evolutionary developmental biology), I came to understand, was explicitly concerned with the reciprocal causal interpenetration of organism and environment and the ontological errors that arose from assuming a metaphysical dualism separating organism and environment. In these varied approaches I saw the possibility of a framework by which to articulate learning relationships between organisms in a transactional way that was thoroughly reciprocal, biologically grounded, and yet not reductionistic or
mechanistic. Here, I was sensing, was also a possible solution out of the bifurcation between modernism and postmodernism, with each tending toward anthropocentrism in polarized yet analogous ways, and neither recognizing that the growth of knowledge itself was transactional. The transactionalist view meant that knowledge was neither the product of viewing the world as an impartial spectator, as modernists would have it, nor merely the imposition of suspect human models, as held by postmodernists. Instead, knowledge could more fruitfully be understood as an evolutionary process where theory and theorized, much like organism and environment, mutually constitute one another over time, a never perfect nor ever complete self-correcting process, where it is artificial to separate the relative contributions of one or the other to the knowledge-making process.

I was trying to make ecological interactions "more human" while simultaneously making human interactions "more biological," and felt that educationalizing biology was a central to this project. This was done, not to produce a sloppy anthropomorphism or a sociobiological reduction, but rather to restore continuity between humans and other species, and ultimately with nature in its entirety. It was done to stitch together what had been destroyed by a long chain of events from Socrates' claim that "landscapes and trees have nothing to teach" (Plato, 1995, p. 6), to Descartes setting up his ontological dualism asserting other organisms to be machine-like res extensa, to the formation of modern educational institutions, which define the boundary along which we ought consider learning processes strictly along species lines.

With these seven papers now behind me, I feel like my work has hardly begun. As a preliminary foray into a vast field, it is perhaps inevitable that shortcomings glare at me from all sides. The most notable is the fact that I veered from my original intent and
never quite came back to it. In wanting to "live environmental education," I had intended to develop a way of engaging in actual, particular relationships with other species that I encounter in my daily life. However, instead of exploring such a pedagogy I quickly became absorbed in developing a framework in which I could find such a pedagogy biologically and philosophically credible. I do think that developing such a framework is crucial and look forward to continuing its pursuit in the future. But I do also want to go back to my original aim, back to the concrete and specific, and learn to grow better in actual relationships with actual human and nonhuman others. This includes the need to study and experiment alongside human learners, both children and adults, to develop activities, ways of speaking, educational environments, and programs that open humans to experiencing and engaging in both human-human and interspecies relationships more attentively.

In terms of the synthesis I have been trying to initiate in these articles, much work remains to be done. I feel like I am closer to understanding how learning, evolution, meaning, perception, knowing, growing, relationship, pedagogy, and related terms can be reframed and related to an evolving, living, and ecologically-sensitive conception of education. However, I am not always consistent in my capacity to frame these processes ecologically according to a transactional framework. Because of this, much in these papers is likely be disbanded as I continue to shed latent pseudo-explanatory black-boxes and escape-chutes in my writing, hidden dualisms, and falsely integrated links. I will also need to put the framework I have been developing into deeper conversation with others working in related fields, most immediately those in philosophy of education, philosophy of biology, and environmental education.
There are almost 2 million scientifically described species on Earth and still many more without Latin names. Educators have focused on how just one species learns and teaches itself, and have neglected how that species might be learning from and teaching the rest of the biotic community. In this way, educators contribute to the very factors that keep humans insensitive to the communicative realm orchestrating biological diversity, and deaf to the manners that human activities are learnt by the interspecies communities around them. This is limiting for progress in biology, but it is also an ethical tragedy and a missed opportunity in self-development. It is also a pedagogical failure. In vast and varied ways, other species interpret their worlds, change their behaviour based on their interpretations, and pass on what they learn with ecological and sometimes evolutionary effects. Our pedagogical challenge is twofold: to learn how to enter these interspecies relationships with the care and tact of an educator, and to impart such perceptual capacity and empathic responsiveness in school programs. I hope that my current and future work can be a small part of the cultural shift that lies before us as our challenge and our calling.
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