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Neuropragmatism, the cybernetic revolution, and feeling at home in the world

Tibor Solymosi[1]

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Abstract
In recent work, Mark Johnson has argued that a scientifically updated version of John Dewey's pragmatism affords human beings the opportunity to feel at home in the world. This feeling at home, however, is not fully problematized, nor explored, nor resolved by Johnson. Rather, Johnson and his collaborators, Don Tucker (2021) and Jay Schulkin (2023), defend this updated pragmatism within the historical development of the sciences of life and mind from the twentieth century to the present day. A central theme in this defense is the affinity pragmatism has with neurophenomenology, especially the enactivism seen in 4E cognition. Another theme is the future orientation of pragmatism, especially as it is focused on developments in cybernetics and artificial intelligence. Given Johnson's previous work on expanding the number of E's to 7, and other pragmatist suggestions for more, I argue that neuropragmatism's development of Dewey's conception of experience as organism-environment transaction (symbolized by the diphthong, *Œ*) is critical for understanding what Johnson and Tucker call the cybernetic revolution as an enchanting and welcoming future instead of a disenchanting and alienating one.

Keywords Neuropragmatism · Pragmatism · Enactivism · Cybernetics · Artificial intelligence · 4E+cognition

1 Introduction: feeling at home in the cybernetic revolution

Pragmatism is not only the first neurophilosophy (Solymosi, 2011) but also the underlying philosophy of cybernetics (Solymosi, 2023a). This fact orients contemporary inquiry into brains and machines across related but distinct problems. The problems are distinct because they range from the scientific questions like how brains work and

✉ Tibor Solymosi
tibor.solymosi@villanova.edu; tibor.solymosi@gmail.com

1 Department of Philosophy, Villanova University, Villanova, PA, USA

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whether we can construct artificial brains that work like human brains to normative questions like whether we should build such artificial intelligences and to what ends. While classical pragmatists like William James and John Dewey, along with their student, Norbert Wiener, wrestled with such questions, the state of the art is importantly different today (Moorhead, 2015; Solymosi, 2023a). Recent work in pragmatism engaging the sciences of life and mind—referred to as neuropragmatism (Solymosi, 2011; Solymosi & Shook, 2013)—not only demonstrates beyond reasonable doubt the ongoing vitality of pragmatism as the philosophy for making sense of the sciences but also raises further questions for philosophical and scientific investigation.

Two such possibilities have been raised by Mark L. Johnson in his recent work with neuroscientists Don M. Tucker (2021) and Jay Schulkin (2023). The first is the general philosophical problem of feeling at home in the world. The second frames this problem within our contemporary situation with what Johnson and Tucker call the cybernetic revolution. Such a revolution has yet to take place but promises to transform our lived experience should human beings understand and put to work the understanding that our cognition can be investigated in terms of distributed computing (Johnson & Tucker, 2021, 112). To many people, such discourse sounds reductive or alienating—surely nothing like what it is to feel at home in the world. How to reconcile our best science about how nature, including ourselves, works with our qualitatively rich lived experience is a core problem for classical pragmatism, for neuropragmatism, for neurophilosophy, and for philosophy generally.

While Johnson, Tucker, and Schulkin have provided a framework rich with platforms for further inquiry, they do not explore what this feeling at home in the cybernetic revolution could be like. I argue that a key aspect for such an exploration requires emphasis on the neuropragmatic conception of experience as organism-environment transaction (symbolized as *Œ*) in tandem with current trends in 4E+cognitive science as *embodied*, *embedded*, *enactive*, and *extended*. Johnson has already argued for additional Es (*emotional*, *evolutionary*, and *exaptative*) (Johnson, 2017), while I have proposed more (*ecological* and *educative*) (Solymosi, 2018). In this paper, I further elaborate on the science of experience in terms of the various Es with the goal of sketching how to feel at home in the world of the cybernetic revolution. Such feeling, I contend, requires a reconstruction of experience not only as Œ but emphatically as an *entangled enactivity* or *enactive entanglement*—an *event* as Dewey described it (1929).

My argument proceeds as follows. First, I discuss feeling at home in the world as a way of characterizing the problem of reconciliation in general, relating neuropragmatism to neurophilosophy and neuroexistentialism. Once this problem and the options for its resolution are reviewed, I relate it specifically to the cybernetic revolution. In doing so, the utility of a neuropragmatist approach that draws on 4E+cognitive science should become apparent. I make it explicit with a tour of the various Es in drawing out experience as Œ. Finally, I return to the reconstructed sense of feeling at home in the world that Johnson and Tucker propose as an ameliorative vision for the cybernetic revolution.

2 The reconciliation problem and feeling at home in the world: neurophilosophy, neuroexistentialism, and neuropragmatism

One way of characterizing the need to feel at home in the world is to frame it in terms of a duality between mind and nature. This dualism plays out in various permutations in western history, a review of which is beyond the scope of this essay. What is common to these variations is the opposition between mind and nature that causes a sense of alienation to be overcome through reason, intuition, or faith. With the rise of secularism and naturalism, the dualism receives an influential articulation through Wilfrid Sellars's distinction between the scientific image and the manifest image of human being in the world (1963). These terms have been taken up by contemporary philosophy as its central task is to reconcile these two images. The problem is that each image conceives of itself as not only complete and internally true, but also at odds with the other image. The scientific image is the causally determined and closed description of matter in motion. If this image is true, Sellars argues, then the claims of the manifest image must be false. This image is the familiar humanistic image of conscious, free, and morally responsible selves that nevertheless interact with but are not reducible to the physical world. According to the manifest image, humans are immaterial souls that are self-causing yet somehow able to engage with the causal world without being fully determined by it. For Sellars, both images are true, complete, and, though dichotomously opposed, somehow capable of being reconciled.

Within neurophilosophy, the two main options for reconciliation are forms of eliminativism (Solymosi, 2017). For the eliminative materialist, the manifest image is reduced to or explained solely in terms of the appropriate science. Folk psychological discourse, for instance, is supplanted by neuroscientific discourse. For the eliminative idealist, the authority of science is rejected, leading to competing language games or final vocabularies that best suit the idiosyncrasies of the language user. On the one hand is Patricia Churchland, on the other, Richard Rorty, with Daniel Dennett somewhere in-between. Regardless of the specific resolution to the problem of reconciliation, there remains some sort of division between the quantitatively explainable causal nexus and the qualitatively lived experience.

A special case of this dilemma is neuroexistentialism as developed by Owen Flanagan and Gregg D. Caruso (2018). They not only take up the Sellarsian dyad (with Caruso endorsing eliminative materialism and Flanagan gesturing toward something like neuropragmatism). They situate the conflict in a historical development of growing alienation and angst, that is, in the history of existentialism. The first wave of existentialism is signified by the rejection of religion and the supernatural as the source of meaning in human experience. The key philosophers of this wave are Kierkegaard, Tolstoy, and Nietzsche. Meaning may not be found in the supernatural, Flanagan and Caruso suggest, but perhaps it could still be found in human polity. Not so, says the second wave existentialism of Sartre and Camus. Human communities can be oppressive, suffocating, and genocidal; they are not trustworthy sources of meaning. Yet, the argument goes, people still find hope in the possibility of the individual mind, through a self-causing reason, to determine meaning in the world. But, as Flanagan and Caruso argue, the successes of evolutionary science and neuroscience clearly show that mentation is not only a thoroughly natural process but one that is entirely within the closed causal nexus of the natural world. Thus, the third wave existentialism, neuroexistentialism, in which we find ourselves today. Flanagan's eudaimonics (2007) is his proposal for a better scientific image than the one Caruso endorses. Yet, Flanagan, like Dennett, has not yet provided an adequate account of scientific inquiry beyond asserting that it deals with causality. Caruso and Dennett recently debated such issues regarding reconciling free will with the scientific image (2021). Similar efforts to resolve this conflict between the manifest and scientific images are also seen in neuropsychoanalysis (Northoff, 2023; Solymosi, 2023b).

What each of these various attempts at resolving the problem of reconciling the scientific and manifest images have in common is what Dewey referred to as a quest for certainty in which knowledge, at least in principle, ultimately represents a fixed and final reality (1929). Regarding scientific knowledge, the presumption is that the mathematical formulas of scientific theories are expressions (or our best attempts thus far) of natural law (so conceived as the first principles governing all motion). This conception of science is what Johnson and Tucker describe as *pristine objectivity* as it ultimately rejects any role the knowing subject has in the search for and the development of knowledge (2021). Dewey went so far as to characterize the problem of reconciliation as a problem to be overcome and discarded, not resolved, because it is a problem only for those who conceive of knowledge as a representation of antecedent reality unaffected by the process of inquiry (1929). We do not feel at home in the world, according to Dewey's criticism of the reconciliation problem, because we misunderstand what it means to know, unnecessarily creating a separation that alienates us as knowers from the world to be known.

Much of Dewey's work on experimental logic is an effort to naturalize human intelligence as an ever more creative activity of modifying organism-environment interaction with an aim of amelioration (1916a; 1938). What is neglected, lacking, or inadequately discussed by neurophilosophers, neuroexistentialists, and neuropsychoanalysts alike is the full circuit of inquiry that begins and ends with qualitative lived experience.[1] Dewey situates experimental inquiry within a qualitative situation that moves from the problematic or indeterminate—where perplexity and uncertainty become the dominant qualities—to a phase of active inquiry in which qualitative objects of everyday life are analyzed into data, relevant to the problem, through which causal relationships are established (Dewey 1910, 1916a, 1925, 1929, 1930, 1938; Leonelli, 2016). Such relationships include the inquirer, not as a god looking from above or from a view from nowhere, but as an active participant in the process of inquiry. Inquiry is successful once the new knowledge about how things operate is put to work in order to relieve stress, to overcome doubt, to resolve the problem, or to make the situation determinate again. That is, successful inquiry is marked by a shift in the qualitative experience from the discomforts of doubt to the pleasure of consummation. As neuropragmatism details, this process of inquiry has deep evo-

[1] Though neuropragmatism draws from the classical pragmatists, especially from Dewey, it is not a mere recapitulation of Dewey for today. However, one of Dewey's key insights very much relevant today regards the nature of inquiry, specifically the relationship between qualitative feeling and quantified data. The details of how such inquiry operates are beyond the scope of this essay. For more, see Dewey 1930; Hickman, 2007, 206–230; Alexander, 2013, 27–71; Fesmire, 2015, 206–208; Pappas, 2016; Johnson, 2017; Johnson, 2018; and Johnson & Schulkin, 2023, 49–74, 99–120, and 149–180.

lutionary roots in organic life yet develops through a blind evolutionary process to yield human beings who cooperate in order to consciously and deliberately inquire in an experimental manner (Solymosi 2016 and, 2018).

This developmental story is not one about reconciliation but of reconstruction. Where the Sellarsian tries to reach rapprochement via reconciliatory efforts, the neuropragmatist never faces the problem of reconciliation because knowledge is instrumental. Theories are not representations of fixed reality but are solutions of problems that become tools for aiding future inquiries. While this is easily stated and perhaps practiced by avowed (neuro)pragmatists, the fact remains that such inquiries nevertheless occur in the culture we currently have, not in an ideal world. Our culture, while multifaceted, is one still riddled by the dualities that make the Sellarsian dyad feel intuitive, suggesting the need to reconcile, in order to feel at home in the world. Much of Johnson's work with Tucker and with Schulkin details the histories of these dualities between pristine objectivity and intolerable subjectivism in science and in philosophy through the 20th century; for present purposes, I take their histories as given.

What such histories illustrate is the struggle to overcome genuine difficulties in lived experience. The problem is with the conception of knowledge as distinctly separate from action. Dewey's historical review of this problem in *The Quest for Certainty* (1929) situates it as a uniquely western problem, not to be found in non-western cultures. Though Dewey did not use the expression, *disenchantment of nature*, he nevertheless described it (1929, 33, 78–79). Like the neuroexistentialists, Dewey recognized that the advance of modern science seemed to many people to remove meaning, based in the certainty of human essence as the center of creation, from nature itself, forcing its retreat to the supernatural or transcendental realm alone. What neuropragmatism does is naturalize, without eliminating, what it means to be at home in this world of change.

3 The cybernetic revolution

Johnson and Tucker follow Luciano Floridi's description of four revolutions that transform humanity's understanding of its relationship to the world. Johnson and Tucker provocatively propose a Fifth Revolution in human development. These revolutions complement the neuroexistentialist view of alienation and disenchantment (Floridi, 2014; Flanagan & Caruso, 2018, 5–7). Sigmund Freud saw the march of modern science as disenchanting and alienating as Copernicus removed Earth from the center of the universe (Floridi's first revolution, 400 years ago), as Darwin removed humanity from being of special creation (Floridi's second revolution, 160 years ago), and as Freud himself removed the conscious mind as being transparent to itself and thus a reliable source of knowledge (Floridi's third revolution, 100 years ago).

Following heliocentrism, evolution, and psychoanalysis is Floridi's fourth revolution, the information technology revolution. The IT revolution of the past 60 years is one in which we have modified our environment such that it affords us the speed and efficiency of information processing devices—computers with their silicon chips—that perform computations at speeds well beyond what a human being can do unaided. This revolution alone has a disorienting effect because it has not only further automated human occupations once taken for granted (from the bank teller to the factory worker) but because it has changed social relations in myriad ways. The ubiquity of smartphones, it could probably go without saying, has not only made communication among individuals much easier but also has done so in socially transformative ways. On the one hand, social media brings together families and friends from wide physical distances. On the other hand, there are social media's misinformation and disinformation dividing people politically to the extent of violent insurrection as seen in the January 6th attacks on the US Capitol to other events of violent oppression against minorities, such as the Buddhist majority in Myanmar's treatment of Rohingya Muslims, as Jeff Horowitz details (2023, 116–118). The previous three revolutions disoriented human self-conception in that humans are no longer the center of the universe, specially created, nor transparent to their own minds. The fourth revolution radically modifies the contemporary environment through automation of jobs once taken-for-granted by humans as irreplaceable to the instantaneous global connectivity of the Internet. The IT revolution's disruption has more to do with the environment in which humans live than it does with how humans self-conceive, leaving the transformation external to the human organism, so it seems.

For all its promise, however, the fourth revolution seems to pale in comparison to the significance of the forthcoming cybernetic revolution. Johnson and Tucker elaborate:

> If [Floridi's history of transformative revolutions is] so, then it may be recognizing the principles of distributed computing in our own cognitive operations that provides the insight required for a fifth revolution when we understand the process of mind in cybernetic terms. Until this happens, progress with AI remains a technology trick — something that transforms our world at the hands of technical engineers who have little training in humanistic principles and little insight into the subjective process of human minds. This may result from a century of striving for pristine objectivity in psychology and neuroscience, as the science of intelligence has been kept as a disembodied artifact, rather than a way to understand the conscious, subjective process of experience. (Johnson & Tucker, 2021, 112)

The IT revolution maintained a separation of organism from environment, thereby making it easy to maintain further divisions such as mind/body, mind/world, or subjective/objective. The information technology is taken to be outside of the organic body. As such, it can even be treated as only approximating human abilities but through different means than the human—namely, through mechanism and not through transcendental reason. What the cybernetic revolution affords, to be explicit, is a further loss to the traditional western conception of human uniqueness by situating human creative intelligence in naturalistic terms consistent with cybernetic mechanisms. Thought, as Aristotle saw it, was the divine part of human beings; if we humans are not only able to generate thinking machines but now understand ourselves as thinking machines, what is left of anything special or divine about us? Like the previous revolutions, this Fifth revolution directly challenges how humans conceive of themselves in the world, this time by opening human creativity and intelligence to experimental investigation previously used to inquire into the world external to human subjectivity.

AI as a technology trick maintains an illusion of feeling at home in the world insofar as human and machine are fundamentally different. The concerns and alarm surrounding recent advancements in these tricks has multiple causes. Most of them can be framed in terms of feeling at home in the world, from practical concerns regarding privacy, the availability of work and kind of work, to existential questions about what it means to be human when artifice becomes superior in what once were considered uniquely human traits. Such concerns are ones Dewey's pragmatism addressed in his time, and, as Johnson, Tucker, and Schulkin all agree, Dewey's pragmatism still has much to offer us today, insofar as we update pragmatism with our best current knowledge. Among the updates are the dovetailing between contemporary neuroscience and advances in artificial neural networks, whereby both disciplines inform and aid one another. These artificial neural networks also have led to recent advances in generative artificial intelligence and large language models. Together, these new technologies and the dovetailing of the human with the artificial mark the cybernetic. Neuropragmatism's emphasis on continuities across brains, bodies, and worlds, natural and artificial, is well suited to contextualize these new developments, so that we may reconstruct ourselves and our worlds toward genuine growth in ordered richness, toward feeling at home in the world of the cybernetic revolution.

4 Œ as *n*E: enacting neuropragmatism with 4E + cognitive science

One version of a scientifically updated pragmatism is *neuropragmatism*. Its inspiration comes from Dewey who writes, "[to] see the organism *in* nature, the nervous system in the organism, the brain in the nervous system, the cortex in the brain is the answer to the problems which haunt philosophy. And when thus seen they will be seen to be *in*, not as marbles are in a box but as events are in history, in a moving, growing never finished process" (Dewey 1925, 224; Solymosi, 2011, 2023a). This nested dynamic hierarchy could easily be expanded to include, in one direction, synapses and neurotransmitters, and, in the other direction, neurotechnologies, from smartwatches and prostheses to a cybernetic environment well beyond the now familiar Internet of Things. Johnson has reflected that

> Whenever I hear the term "neuropragmatism," I am reminded of J. L. Austin's opening words in his famous article "Performative Utterances," where he says, "You are more than entitled not to know what the word 'performative' means. It is a new word and an ugly word, and perhaps it does not mean anything very much"… Likewise, you are more than entitled not to know what *neuropragmatism* means. It is, indeed, a *new* word, and it is perhaps an *ugly* word, but I daresay that it is not an inconsequential word. (Johnson, 2018, 96)

"What pragmatist philosophy has to offer," Johnson elaborates, "is the broader philosophical context necessary for understanding the grounding assumptions of cognitive neuroscience, its fundamental limitations, and its implications for our lives. In short, to riff on Kant's famous quip: pragmatism without neuroscience is (partially) empty, but neuroscience without pragmatism is (partially) blind" (Johnson, 2018, 96). Neuropragmatism as a neurophilosophy, Johnson suggests, keeps us from making the mistakes of earlier varieties of neurophilosophy: "to think that the work of neurophilosophy—or at least its important work—is done by the neuroscience alone, thereby denying any serious role for philosophical reflection" (Johnson, 2018, 96). The eliminativist either removes the qualitative import of such reflection or eliminates the limited authority of experimental insight into natural and human affairs. The neuroexistentialist commits a similar reductionist sin. As Terrence Deacon recognizes, such approaches to science make science itself impossible (2012).

In this section, I relate a few key tools of neuropragmatism—its conception of continuity in nature that includes culture, its conception of experience as organism-environment transaction (symbolized as *Œ*), and its conception of intelligence—to 4E+cognitive science. I argue that in considering Œ as *n*E, there need not be a fixed number of Es, so long as intelligence is understood in a non-transcendental manner. That is, it is not reduced to the disembodied technology trick of the IT revolution. Rather, in naturalizing intelligence, we can appreciate the various Es as points of emphasis for inquiry. As such, enactivism's emphasis on action is of specific import as not only does neuropragmatism share such an emphasis, the role of action is integral to understanding Œ as *n*E as a means for feeling at home in the world throughout the cybernetic revolution. I begin with an initial exploration of enactivism and pragmatism before moving specifically to neuropragmatism on continuity, experience, and intelligence. From there, I take a brief tour through the original 4Es, Johnson's additional 3Es, and my further additional 2Es. At the end of this tour, I suggest another E, the *event* as Dewey conceives it, which can be understood as an *enactive entanglement* or *entangled enactivity*.

4.1 Pragmatism and enactivism

Pragmatism as a name for a philosophical movement or school of thought expands beyond its original conception as an alternative to representational epistemologies seeking certainty (Shook, 2023). Pragmatism as an operationalism or an instrumentalism, for instance, was understood by Dewey as part of his greater philosophy, which he variously called empirical naturalism or cultural naturalism. At the core of pragmatism as both an epistemology and a philosophy is finding connections and relations throughout the experiences of inquirers. As such, many pragmatists have striven and continue to strive for connections with other philosophical efforts, despite different origins. In doing so, pragmatism also resists essentialisms that demand fixed or absolute distinctions. Rather, pragmatism emphasizes the need to frame differences as differences that make a difference given the facts of the case, given the contextual whole or situation in which inquiry occurs. Since the historical development of 4E cognitive science generally and enactivism specifically is not from the American pragmatist tradition but out of European phenomenology, it is only later that the affinities between pragmatism and phenomenological 4E cognitive science are recognized and elaborated. Given the pragmatist tendency to find connections, relations, and continuities, real differences (for non-pragmatists) are often overlooked because such differences (for pragmatists) are functional choices determined by the specific problem at hand.

For this reason, Johnson's characterization of 4E cognitive science and his extension to 7Es reads as though the Es are of equal and complementary standing. But, as Shaun Gallagher rightly observes, there are various strengths of each of the Es, as well as contentions across them, e.g., extended-mind theorists may maintain a representational account of mind that is otherwise disembodied (as the information the representation stores can be realized in various substrates) and at odds with the enactivism that is more ecological with its preference for affordances over representations (Gallagher, 2023). The way through this possible conflict between Johnson's more harmonious complementarity of the Es and Gallagher's observation about the state of inquiry among various theorists in embodied and enactive cognition is the way of neuropragmatism.

Dewey's philosophical project emphasized the need to replace the dichotomies of modern philosophy, like mind/body and mind/world, with continuities that are empirically and experimentally investigable. To aid in this effort, Dewey proposed the postulate of continuity (1938) that establishes continuities in the following senses. First, a continuity between inner and outer, wherever that boundary is drawn. An easy example of this is that there is not a hard and impenetrable boundary between the inside and outside of an organism or a cell. Rather, there is a semipermeable membrane, like the skin or the cell membrane, that mitigates what goes in and out of the organism or the cell. Such transactions are not random or chaotic but organized with an aim toward maintaining the dynamic equilibrium of the internal milieu with the external milieu. This is basic homeostasis. Another sense of the continuity Dewey promotes is one of growth at both the ontogenetic and phylogenetic levels. Evolution occurs within a population when traits accumulate given natural selection and other drivers (like genetic drift). Over time, members of the population adjust to environmental demands with the diminishment of traits less suited to that specific environment and/or proliferation of traits better suited to it. This evolution can be retrospectively examined in terms of a general tendency toward complexity, from lower or simpler functions to higher or more complex ones. The later developments grow out of and put to new uses the earlier traits. Within the development of an individual organism, from being a neonate to mature adult, the growth of organs and of skills are also sequential (though, to be sure, this is not a matter of ontogeny recapitulating phylogeny) in that the more complex develop out of the earlier and less complex organs or skills.

These two senses of continuity complement the third sense I address here, the continuity between the physical and the mental. The previous two senses of continuity are natural or physical, but they apply just as well to the development of mind out of body out of world. A closely related continuity is that between nature and culture. Larry A. Hickman has usefully described Dewey's continuity by distinguishing between nature-as-nature and nature-as-culture (2007). In the former, nature is haphazard, precarious, unknown and uncontrolled. Natural or physical bodies are not yet inquired into, so the causal relations within events are not established, so there can be no purposive or meaningful activities among these mere happenings. But once these affairs evolve to an organized complexity that allows for the deliberate effort of altering the transactions between organism and environment in order to improve the lived experience, mind emerges out of body (what Dewey calls *body-mind* (1925), an early statement of embodied mind). This body, of course, grew out of previous physical interactions within the world. As organisms mind their environments and social cooperation evolves from such mindings, culture as symbolization of gestures and calls deliberately made to modify behavior of oneself and others emerges. The environment is further transformed through ecological niche construction of language-using organisms capable of reflecting on their well-being and acting to improve upon it.

Dewey's postulate of continuity, in other words, serves as the basis for his conception of experience as organism-environment transaction that neuropragmatism symbolizes with the diphthong *Œ*. This conception of experience not only expresses the postulate of continuity but also offers a conception of inquiry that cuts across the familiar choice between scientific realism and scientific antirealism (Tschaepe, 2011, 2013). Understanding experience as Œ and inquiry as a phase of such experience or transaction evades debates about coupling and rejects any need to prioritize one E over the others or to fix the number of Es at play. To appreciate and defend these claims, I turn specifically to the neuropragmatist conception of experience as Œ.

4.2 Experience as Œ

Philosophers of biology Paul Griffiths and Russel D. Gray argue that the proper unit of evolution is not the genotype nor the phenotype but the inextricably related organism-environment (2001). Since genetic expression is both affected by and affects the environment, to focus the selection pressure on any specific facet would be to prioritize without warrant or outright ignore other factors at work in the evolutionary process. Since there is no exact ontological boundary between an organism and its environment, it is methodologically better to speak of the evolutionary unit as organism-environment or, as the diphthong illustrates, *Œ*. Following Dewey's conception of experience as a historical development within natural processes, from the experiences had but not known by the simplest organisms to the artistic and scientific wonders of human cultures, neuropragmatism sees evolution and experience as co-extensive, thereby warranting *Œ* as the unit of experience as well as evolution (Solymosi 2012, 2018, 2023; Johnson, 2017). The postulate of continuity is operative in the historical continuity of evolution as well as the continuity between the internal and the external. Experience as a process of familiarization with oneself within a world is not just transactive between organism and environment but *transformative* of both. Experience, for both Dewey and neuropragmatism, is life function (Dewey, 2012) and, especially in humans, educative (Dewey 1916b; Solymosi, 2018). This stands in stark contrast with the sensationalistic spectator theory of experience and knowledge that is emblematic of modern philosophy and much empiricism today (Dewey 1929; Janack 2012; Johnson & Tucker, 2021; Johnson & Schulkin, 2023).

Key to appreciating the epistemological import of Œ is Dewey's development of the pragmatist pattern of inquiry, from psychology to biology to physics. Following Charles Sanders Peirce (1877), Dewey understood inquiry as the struggle to overcome the feeling of doubt that arises from failure to act meaningfully in one's world.

Belief is a disposition to act, a guide or habit of action. If your beliefs are accurate enough for the task at hand, there should be no problem in carrying out the action. But if the belief is not up to the task at hand—either it is simply a false belief or the world has since changed, rendering a once true-enough belief into a false one—action will be difficult or problematic. Phenomenologically, this is the experience of uncertainty, perplexity, discomfort—an irritation that must be addressed through some sort of further activity that reduces or eliminates the doubt, restoring somehow the ease and harmony of belief. Scientifically, in terms of Œ, the internal milieu of the organism is actively anticipating (both subconsciously and, at times, consciously) what is most likely to occur next in the external milieu, the environment. Brains coordinate the various bodily processes and their energy demands in order to best fit the likely environment to ensure an efficiency of energy and action. Whether this activity is characterized in terms of allostasis, predictive processing, or free energy is inconsequential for the present point: living bodies without brains are relatively reactive to their environment whereas living bodies with brains are both reactive and actively anticipatory. For humans, the evolution of, development of, and maintenance of cultures as symbolic scaffoldings of an environment to ease navigation of the world while also affording new avenues of activity are elaborations of the basic life algorithm of *need-search-satisfaction* as Johnson, Tucker, and Schulkin describe it (Johnson & Tucker, 2021; Johnson & Schulkin, 2023; Solymosi, 2023a; Solymosi & Schulkin, 2024).

This life algorithm and the pattern of inquiry are continuous; the latter develops from the former. Similarly, more advanced forms of inquiry grow out of less complex methods. Dewey noted a difference between merely empirical methods that simply waited for experiences to occur from which data would be catalogued, and deliberately experimental methods that controlled the conditions in order to isolate variables to generate the data from which to establish the relations within and between natural processes (Dewey 1910 and 1929). Experimental method, moreover, is value-laden and thus sensitive to the situation at hand. The facts of the case and the operative values (moral, aesthetic, epistemic, etc.) frame the possible solutions available for overcoming the felt difficulty. All inquiry begins with the qualitative feeling (the uncertainty) and moves through reflective phases, such as the experimental quantification and datafication, before returning to the qualitative in the resolution of the problem (the return of a feeling of belief, ease, harmony, etc.). The significance of the pragmatic pattern of inquiry and the cycle of quality to quantity to quality is underappreciated in current debates within 4E+cognitive science. The ambiguities Gallagher observes within these debates (2023, 3) are not problems for neuropragmatism because these ambiguities reflect value choices to be made for specific inquiries. The ambiguities are not about what is real as many scientists and philosophers think. What matters is not the state of reality prior to inquiry, but what the products of inquiry empower and afford the inquirer.

4.3 How many Es? *n*E

Johnson observes that there is a strong affinity between pragmatism's conception of experience as organism-environment transaction, *Œ*, and recent developments in 4E cognitive science. As mentioned earlier, Johnson's presentation of this affinity passes over in silence any disagreements among other theoreticians about any dominance or priority of a specific E over the rest. In the pragmatist spirit of making connections in search of harmonies, Johnson elaborates the affinity in the following passage:

> In recent years, this general orientation toward the grounding of mind in [… Œ…] has come to be known as '4E cognition': that is, cognition as *embodied*, *embedded*, *enactive*, and *extended*. Cognition is *embodied* in [the dynamic coordination of the nervous system with the body], it is *embedded* insofar as it arises from interactions with its environments (both physical and social), it is *enactive* in the way it creates meaning and thought in an ongoing fashion, and it is *extended* in the sense that we offload certain cognitive operations and contents onto (or into) aspects of our environment, such as books, computers, buildings, and signs. (2017, 34)

Experience, at least in its cognitive phases, *is* all four Es, according to Johnson. In fact, he argues that Œ is also *emotional*, *evolutionary*, and *exaptative*.

Johnson follows Antonio Damasio's work on feeling and emotion, in which emotions are assessments of bodily processes that may be subsequently felt via conscious attention. As experiences are had but not always known, bodies emote but are not always felt. Brains are especially useful for these assessments of bodily processes because brains do allostasis, the anticipatory regulation of the internal milieu to coordinate various bodily processes to best fit the changes in the external milieu (Schulkin 2011; Barrett, 2018; Sterling, 2020). Emotions, as the etymology indicates, are about the motion out of—generated from, initiated from irritation in—experience, the movement of organisms in environments, Œ.

As discussed above, Œ is the experiential and evolutionary unit. It is no surprise that Johnson emphasizes this point regarding cognition and the scientific study of experience. Œ is not only a process for individual organisms engaging their particular environments; Œ reflects the history of that species, indeed of the history of life. This history can be traced backward toward simpler forms of life and further to simpler molecular mechanisms, etc. But this evolutionary and experiential process is still in the making. History implies a past; but evolution also indicates a future. Though, naturalistic, neuropragmatism allows for telic processes, end-oriented skills that evolve, while the process as a whole isn't heading toward some fixed goal.

The telic but not teleological activities of organisms-transacting-with-environments, of Œ, is illustrated further with Johnson's emphasis on Œ as exaptation. Johnson quotes from Lakoff and Narayanan, to define *exaptation* as "'the use of evolutionary inherited traits for new purposes.'… (Lakoff & Narayanan, 2017, Chap. 1, Sect. 1)" (Johnson, 2017, 34). Ecological niche construction theorist, Kevin Lala (formerly Laland), elaborates that exaptation is "a trait originally fashioned by natural selection [evolutionarily repurposed] for an entirely different role" (2017, 286). Notably, this repurposing of traits and skills is an evolutionary precursor to Hickman's conception of technology, itself an evolutionary descendent of Dewey's theory of inquiry. Take, for instance, the following descriptions of technology Hickman makes: "technology […is…] an active method of generating and testing new skills, as well as reconstructing old ones" (1990, 19); "*technology [i]s a cognitive activity within the evolutionary history of complex organisms*" (2001, 21, italics in the original); and, lastly, technology as "*the invention, development, and cognitive deployment of tools and artifacts, brought to bear on raw materials and intermediate stock parts, with a view to the resolution of perceived problems*" (2001, 12, italics in the original). Another connection worth noting but beyond the scope of this paper is Michael Anderson's neural reuse theory (itself drawing on Dewey (Anderson, 2014, 168–170) as a neural analog to exaptative processes. Given earlier similarities between neural pruning and evolution via neural Darwinism (Edelman, 1987), this is unsurprising.

These new 3Es elaborate the intricate distinctions inquirers can make regarding the dynamism of Œ. Organisms embody mental activities in their embedded environments through which they extend information patterns to afford greater enaction, such transactions are inherently emotional, requiring regular assessments of the transaction between the internal and external milieus, as these are not only products of evolution but ongoing participants in the evolutionary process, which itself makes exaptative use of old traits, skills, and resources for new experiences in need of adjustment, be it at the population scale on which natural selection operates or on the individual scale in which individual organisms cooperate to engage in experimental inquiry and technology.

Two further Es enrich the possibilities for inquiring into Œ: ecology and education (Solymosi, 2018). Enactivism and ecological psychology are unquestionably closely related (Chemero, 2009; Kaüfer and Chemero 2015; Gallagher, 2023). By emphasizing ecology as its distinct E, neuropragmatism emphasizes the radical empiricism of Œ in which relations are primary, not secondary (Solymosi, 2013). Though William James and Dewey share much in common in their respective philosophies, there remain significant differences metaphysically. Notably for present purposes is Dewey's rejection of James's neutral monism. For Dewey and for neuropragmatism, neutral monism retains a dualism between subject and object that the pragmatic naturalism of both Dewey and neuropragmatism rejects (see Heras-Escribano, 2019, 68ff; Solymosi, 2023c).

Key to this ecological approach are Gibsonian affordances that Johnson and I independently developed along pragmatist lines into natural affordances and cultural affordances (Solymosi, 2013; Johnson, 2014, 95; Solymosi, 2018). Following the pattern already developed between Dewey's empirical-experimental or Hickman's nature-culture, the natural affordances are the physical opportunities for action presented to any organism in its environment. So, what a set of stairs affords an ant is very different than what it affords the human who made them. To the ant, such stairs is just another physical object—to be clear, the ant has no conscious conception (or any conception) of physical objects—but to a human stairs are cultural artifacts, not simply found in one's environment the way piles of stones may afford a means to a waterfall. Stairs, of course, are not the only artifacts, and they very much resemble natural affordances (like stone piles). Other artifacts are cultivated well beyond any obvious natural precursors but nevertheless afford humans possibilities otherwise unavailable. From oral stories to printed books to streaming films or TV series, the transformative effect within Œ of information conveyed via culture is orders of magnitude greater than what nature-as-nature accomplishes on its own. Tools empower human Œ well beyond what forms of life without tool-use can afford and are afforded.

The next E is what makes this empowerment possible for humans. Without the deliberate ecological construction of an educational niche that affords learning from both familial and non-kin, there would be no culture—no arts, no science. Lala (2017, 5) argues that what distinguishes human beings from the rest of life is not consciousness, language, or tool use, but education. Even among primates, only humans devote extensive resources to construct elaborate spaces in which to instruct, develop, and cultivate not only traditions and values but methods and attitudes regarding how and what to inquire, including into inquiry itself.

Education is a central theme in pragmatism, specifically as a deliberate activity (Dewey 1916b; Kitcher, 2022). Education as both enactive and transformative of Œ is understood not just experientially, that is to say with a vested interest in the phenomenology of the lived learning experience of the student, but as evolutionary within human cultures. Education is an event in the history of the human species and is an event in many humans' lives. An evolutionary conception of education must be an embodied one, whether expressed in terms like Dewey's body-mind or neuropragmatism's Œ. In either case, the anti-dualism at work means that understanding education for inquiry is to understand an event in nature-as-culture. If education is, at least in part, about generating habits of mind out of bodily operations—that is, of cultivating certain attitudes and beliefs out of the organic algorithm of *need-search-satisfaction*—then education itself can be inquired into through empirical and experimental methods. For education as transformative is not only aligned with Dewey's method of creative intelligence but also with Hickman's conception of technology and science.[2] Without education there could be no science, and without science, there could be no intelligent changes in the world. As Matthew J. Brown observes, "Science is, first and foremost, practical inquiry which sets in motion practices of prediction and control that remake the world we live in" (Brown, 2020, 100).

Neuropragmatism follows Dewey's experimentalism's emphasis on scientific inquiry's target as events in nature (1929). "What science is concerned with," Dewey writes, "is the *happening* of these experienced things [under consideration]. For its purpose, therefore, they *are* happenings, events. Its aim is to discover the conditions and consequences of their happening. And this discovery can take place only by modifying the given qualities in such ways that *relations* become manifest" (1929, 84, italics in original).

[2] The limits of this essay prevent further elaboration on ecology and education. However, resources on ecology abound in previous work in Dewey studies, such as Alexander, 2013, as well as recent work connecting pragmatism and cognitive science, like Crippen & Schulkin, 2020. Solymosi, 2018 focuses both ecology and education on the use of digital devices and their weaponization against democracy. Johnson and Tucker make a strong endorsement for a liberal arts education that better respects the humanities but without ignoring the sciences (2020, 302). Since no ecology is strictly identical with another, how education is enacted will vary according to the needs and resources of its locality. This is unsurprising given the account of Œ thus far developed. Nevertheless, for a global and cybernetic culture of care, there should be shared creatively democratic goals, on which see Dewey 1939; Solymosi, 2018, 2023a; and Kitcher, 2022. Extending this neuropragmatic account to ecology and education remains a promising and important avenue for further research, especially regarding the intelligent use of data and the relationship between the local and the global.

By deliberately and conscientiously controlling conditions in which the inquirers themselves are involved, scientists can establish relations between events that were previously unknown. By reflectively and experimentally inquiring into events experienced, humans through technological and scientific inquiry can not only understand how otherwise disparate events are related, humans can better modify their environments to encourage or discourage future events. "For if we can judge events as indications of other events," Dewey suggests, "we can prepare in all cases for the coming of what is anticipated. In some cases, we can forestall a happening; desiring one event to happen rather than another, we can intentionally set about institution of those changes which our best knowledge tells us to be connected with that which we are after" (1929, 170). Such anticipatory preparations are products of inquiry and can be understood as *enactive entanglements* or *entangled enactions*, that is meaningful events in Œ.

When it comes to building better bridges or other physical external modifications of the environment to effect new experiences for the organisms involved—a faster and more secure route in the instance of a new bridge—remaking of the world in light of science clearly and unproblematically (conceptually speaking) affects experience, Œ. When it comes to the science of Œ and thus the remaking of Œ, there is no principled reason why the same intelligent methods of experimental inquiry should not remain at play. In other words, debates about coupling organism to environment, debates over which E is most dominant or the only E in which experience "really" occurs miss the point of doing science. For neuropragmatism, these sorts of debates are descendants of those old problems that haunt philosophy for failure to see the neurotransmitter in the synapse, the synapse in the cortex, the cortex in the brain, the brain in the body, and the body in the biocultural environment. But once seen, difficulties can be seen as events in nature-as-culture, as active events in history, as open to experimental inquiry and reconstruction, and as events in "in a moving, growing never finished process" as the neuropragmatist motto indicates—as entangled enactions or enactive entanglements.

There is no absolutely fixed number of Es for understanding Œ. What matters is the particular problem at hand, the facts of that case, and the resolution of that problem through intelligent inquiry. If some inquiries require focusing on embodiment over extension, then so be it. Others may require emphasis on embeddedness, and others on emotion, evolution, exaptation, etc. To isolate any one of the Es as having priority or prominence over the rest is to close off the road to inquiry, undermining human Œ to examine itself and improve itself.

As an illustration of how the Es can be in tension with each other, I point to Andrew Sullivan's autobiographical account of his internet addiction (2016). He writes about how his job as an influential blogger, for over 15 years, about how contemporary politics and culture embedded him in a world rich in cultural affordances of a near constant stream of information—"My brain had never been so occupied so insistently by so many different subjects and in so public a way for so long." Such immersion led to his overextending himself into the virtual realm, trying to keep up with and anticipate news cycles, nevertheless taking a genuine strain on his organic wellbeing. In the year prior to publishing the essay, Sullivan notes that he suffered

4 bronchial infections in 12 months, that his vacations were nothing but sleep, his dreams of code. His doctor asks, "Did you really survive HIV to die of the web?"

Sullivan's afflictions can be put in terms of Œ. Peter Sterling argues that "The allostasis model defines health as the capacity to respond optimally to fluctuations in demand. This definition applies across levels to internal systems, individuals, and social groups. And it applies to all sorts of demand: infection, cancer, mental disorder, social stress, and war" (Sterling, 2020, 154). When the organism is out of synchronicity within itself within its environment, demand in fluctuations for energy and resources create discord, undermining the capacity of the allostatic system to maintain or achieve improved fitness between organism and environment. In other words, Œ can become dismantled through unintelligent choices, through a failure to see how events relate, including the events of the various 9+Es.

Another reason for considering a case like Sullivan's is that he speaks to Floridi's fourth revolution, the IT revolution. Though it may only seem like the IT revolution has changed our environment but not ourselves, experiences like Sullivan's are more common, if not endemic. Moreover, such experiences point to the entangled nature of events within Œ. Yet further advancing the neuropragmatist cause to treat the various Es as qualities of Œ and possible instruments for inquiry within Œ. If there must be a concrete answer, not an open-ended one, to the question of how many Es there are, then the answer must be one: the *event* that can be inquired into in myriad ways because it is an entangled enaction or enactive entanglement of all the other Es, those proposed today and those still to be imagined tomorrow.

5 Conclusion: feeling at home in the cybernetic revolution

The core insight Johnson and Tucker make regarding the cybernetic revolution is that it follows through on the naturalization afforded by experimental inquiry that the previous four revolutions saw displace human exceptionalism. The displacement of human uniqueness began with Copernicus' moving Earth from the center of the universe, continued with Darwin's situating humans as products of blind and purposeless evolution along with all life, became even more unsettling existentially with Freud's showing the opaqueness of the human mind to itself, and then more alienating with the direct transformation of human culture and indirect alterations to the human body with the IT revolution. Given the recent advances in so-called artificial intelligence, namely the large language models that depend on vast amounts of human-generated data, many people are understandably worried about what comes next in terms of technological-scientific development. The worry manifests itself in existential angst and the fear of nihilism is real among many humans, scientists, philosophers, and laypeople alike.

An underappreciated reason why so many people have felt that science eliminates meaning and value in the world is due to what Dewey diagnosed as the quest for certainty (1929). This quest mistakenly believes that knowledge represents a fixed and final world unchanged by human activity, including human inquiry into the world. The consequences of the presuppositions of this epistemology cannot be overstated. These include the isolation of the individual as a knower unconnected to their body, their environment, to their societies, friends and family—the very sources of meaning through dynamic transaction. Moreover, the presumption that reality is already fixed and final implies a lack of agency over the course of events. At best, an individual might be able to align themselves or cohere with reality as it is. This may be pleasing to some individuals, some of the time, but many individuals' lived experiences speak to the contrary. The anxiety and fear of nihilism that the technology tricks of recent AI advances, as Johnson and Tucker suggest, are, as many tricks can be, cruel jokes—and unnecessary. Neuropragmatism—with its emphases on continuities, on knowing-as-enaction, on Œ as *n*E, on creative intelligence in entangled enaction—evades this deprived conception of nature, including human nature. Among the intractable problems that haunt philosophy which neuropragmatism gets over is this problem of meaning based in fixities and arrests that deny the very reality of genuine possibilities for change in oneself—body and mind—and one's world, in Œ. Nature, including human nature, evolves; it changes in part through the action taken by human inquirers. Expanding cybernetics beyond the environment and into the organism does not necessarily mean a loss of meaning or purpose. It can mean the creation of new and richer experiences.

What are we to do when the cybernetic revolution takes hold? Already, there is great insecurity and subsequent anxiety from these various disruptions to our individual and collective Œ. Dewey provides an insight that may afford us an answer to this question. "The quest for certainty," he explains, "by means of exact possession in mind of immutable reality is exchanged for search for security by means of active control of the changing course of events" (1929, 163). That is, through creative intelligence humans can understand themselves as part of the evolutionary process and as participants in natural-cultural events. What Dewey calls for is what I call entangled enaction or enactive entanglement. As Johnson and Tucker indicate, this understanding goes beyond standard scientific, technological, engineering, and mathematical (STEM) training, requiring humanistic education about the subjective undergoings of various individuals in various situations (2021, 302–303)—in the plurality of Œ. The liberal arts need not only reinvigoration but reconstruction to be more continuous with STEM, and STEM with the liberal arts. Among what we have painstakingly learned is the entanglement of Œ, without which there would be greater entropy, less growth in ordered richness, as Dewey would say (1939). The cybernetic revolution is an opportunity to build from the affordances such insights already provide but also build up and enrich meaningful qualitative experiences that seem to be missing from so many lives today. To feel at home in the world in the cybernetic revolution is to feel secure in our ability to understand how we humans work with the rest of the world *and* to feel able to respond in a caring and intelligent manner to the myriad problems of lived experience.

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