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Physical Literacy Vindicated: The Mind Is the Function of a Body Embedded Brain

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Abstract

Margaret Whitehead purports that a belief in monism and holistic perspective results in a "lived embodiment" that is fundamental to the appreciation of physical literacy. In this article, we document how our species evolved the ability and need for persistent movement as a means for survival and discuss the merits of Whitehead's perspective from both a philosophical and scientific perspective in the context of physical literacy. We argue that science has replaced existentialism and phenomenology in justifying and explicating the importance of physical activity and physical literacy for human beings.

Keywords

Physical Literacy, Monism, Embodiment, Phenomenology, Existentialism

1. Introduction

Prior to the twentieth century, the prevalent view was that the mind was non-physical, fixed and preexisting, a cartoon version of reality (Graziano, 2021). Empirical neuroscience research in the twentieth-first century demonstrated instead that the mind is an embodied process of a brain within a body, interacting with its environment (Johnson & Tucker, 2021). Embodied cognition has three themes (Shapiro, 2019).

1) The properties of an organism's body limit or constrain the concepts that it can acquire.

2) The computer digital model of cognition is replaced by empirically analogue models.

3) The body and world interact constitutively rather than one causing the other.

In this article, we examine the notion of Cartesian dualism that differentiated the brain and mind as separate entities based on the current scientific knowledge about the brain and human evolution. We describe four perspectives on the nature of what it is to be human: 1) the philosophy of monism, 2) the science of monism, 3) the philosophy of lived embodiment, and 4) the science of lived embodiment.

Early 20th-century science faced an identity crisis. Science was just getting accustomed to James Maxwell's linkages of electricity, magnetism, and light as different variations of the same phenomenon when along came Albert Einstein with his 1905 Special and 1915 General theories of relativity spouting unintuitive explanations of the relationships between space, time, mass, and energy. Accompanying these shocks to conventional existential views of nature were the historically devastating ravages of hate-mongering tribalism expressed as two grotesque world wars, and the weaponization of science culminating in threats of genocidal and nuclear holocaust. Important ontological questions were asked. What is real? What is it to be human?

One response was Karl Popper's crystallization of the scientific method (Popper, 2002, Original German Published in 1935), followed by Thomas Kuhn's reconceptualization of science as paradigms of changes in world views (Hacking, 2012; Korzeniewski, 2019; Kuhn, 2012, orig 1964). A second response was by Edmund Husserl, followed by Martin Heidegger's foundational work on the method of phenomenology (Bragg, 2015; West, 2017).

The core logic of the scientific method is the testing of ideas with evidence (University of California Museum of Paleontology, 2019). Phenomenology, on the other hand, distinguishes between comprehending subjects (humans) and comprehended objects (real world). The scientific method builds models of reality based on objects that would exist independent of human consciousness. Phenomenology builds models based on "phenomena" that are created after input from our senses are filtered by assumptions and biases.

In this persuasive essay, we examine how modern science has replaced philosophy. Specifically, we argue that scientific support for physical literacy has superseded reliance on philosophical underpinnings. Historically, Whitehead's explication of physical literacy referenced phenomenology and epistemology instead of science, so that perspective is also addressed.

2. Monism

Educators long placed cognitive skills in high esteem. Educational policy was premised on the false dualist assumption that the mind and body were separate entities, giving short shrift of time and status to physical education. Physical Literacy is a countervailing paradigm that posited that the mind is holistically a part of the body and cannot exist without a body. Modern science has empirically demonstrated that increased cognitive performance is linked to and undergirded by increasing physical capacities, predicted by the Physical Literacy paradigm.

2.1. Low Status of Physical Activity Was Linked to Dualism

When Margaret Whitehead was a professor at the University of Bedfordshire, she had a "deep-seated belief in the *significance and value of physical activity* for all" [emphasis in original] (Whitehead, 2018: p. 1). However, Whitehead was troubled that physical activity held "low status in the UK, in education, and thus in the curriculum" (Whitehead, 2018). She felt that physical activity should have respect commensurate to any academic courses (Whitehead, 2018). She disagreed with the dualistic perspective used in the UK educational system, treating the body and mind as separate entities, and viewing the body as simply a vessel that houses thought (Whitehead, 2018).

Physical literacy posits that human physicality and movement be considered as part and parcel of all things human (Whitehead, 2018). The term physical literacy was first introduced into the physical education literature in 1938 (Robinson et al., 2018). A salient feature of Whitehead's belief has been her persistent insistence that physical literacy is conceived monistically (Whitehead, 2010c, 2019a, 2019b).

Whitehead's definition of physical literacy is rooted in the concept of grounding philosophy within human experiences. Research and practice that reference her definition empirically are often simplistic attempts to implement or link that philosophy for institutional gain, ironically sometimes decentering the holistic nature of her definition (Jurbala, 2015). Indeed, the theoretical fluidity of Whitehead's definition of physical literacy has led to the emergence of various conceptions of the term beyond phenomenology, including in motor development, practical applications, and the political sphere (Jurbala, 2015).

Nonetheless, monism and embodiment are foundational Whitehead presuppositions of physical literacy (Whitehead, 2010b, 2019a). They are necessary and perhaps sufficient preconditions to viewing a human being, not as a sequence of singleton states from birth to death, but rather, as a dynamic, integral part of a larger, more dynamic process. This idea is captured in recent literature that conceptualizes physical literacy as dynamically communicative between the embodied self and the environment (Jurbala, 2015), or as an integrated and overlapping individual-environment system (O'Sullivan et al., 2020).

2.2. Cartesian Dualism Is the Culprit of Educational Curricula

Cartesian dualism, named after the 17th century philosopher René Descartes, postulated the human mind a thing separate from the human body; that the mind existed separately from the body and may persist even beyond the death of a human body (Descartes, 2018, orig 1637). The notion that the mind can be disembodied from a physical body may be apparent in physical education curricula which separate physical and academic courses and classes, effectually treating the mind and body as different entities.

Thought does not exist independently of a brain or facsimile. Thought is what a brain does. It makes as much sense to speak of thought without a brain as eat-

ing without a mouth or walking without legs. The mouth eats. Legs walk. The brain thinks. When the body dies, the mouth stops eating, the legs stop walking, and the brain stops thinking.

The notion that thought happens independently without a material platform such as a brain is called dualism. The notion that thought is a function of a material platform like a brain is called monism. "In the philosophy of mind, dualism is the theory that the mental and the physical—or mind and body or mind and brain—are, in some sense, radically different kinds of thing" (Robinson, 2020).

2.3. Monism Is an Empirically Observational Proposition

Monism holds that humans a defined by affective, physical, and cognitive domains, and that these are intricately interrelated (Whitehead, 2019a). Monism is important if people are to treat humans holistically. The holistic nature of being human means that experiences impact the affective, the physical and the cognitive (Taplin, 2019). The central premise of monism is that the body and the mind is one intricately intra-dependent whole (Durden-Myers & Whitehead, 2019a).

3. Embodiment

3.1. Physical Activity as Embodiment—A Paradigm Shift

The introduction of physical literacy initially presented a paradigm shift in the way educators thought about the role of physical activity in school curricula, and then more broadly, for all people everywhere (Whitehead, 2010a). Physical education is any purposeful physical activity within the curriculum in compulsory schooling (Whitehead, 2010c). Whitehead's philosophy of physical literacy advanced a different way of thinking about the role that physical activity played in the lives of people as embodiment, "the potential individuals have to interact with the environment via movement. This covers both the embodiment-as-lived as well as the embodiment as an instrument or object" (Pot et al., 2018; Whitehead, 2010c: pp. 202-203). This represented a shift in vision, a revolution in a world view that applied beyond the physical education curricula and courses in UK schools. The notion that physical activity is experienced as "embodiment" was a revolutionary gestalt that required a complete rethinking about how to incorporate physical activity in school curricula and the full life-course of all persons. "Therefore, at times of revolution, when the normal-scientific tradition changes, the scientist's perception of his environment must be re-educated—in some familiar situations he must learn to see a new gestalt" (Kuhn, 2012, orig 1964: p. 112).

3.2. The Mind Is an Executing Brain

There may be no such thing as "normal science" (Kuhn, 2012, orig 1964). However, there is a consensus that scientific ideas need to be testable, that there need

to be multiple lines of evidence drawn from different sorts of tests and different fields of study, and that evidence needs to be publicly available for scrutiny (University of California Museum of Paleontology, 2019).

Science requires that assertions be evidence-based and publicly available for scrutiny. Monism is a scientific fact. The brain is a noun. The mind is a verb. "Minds are simply what brains do" (Minsky, 1986: p. 10). People's phenotype (P) is the product of the interaction of their genotype (G) with experience and environment (E): P = f (G, E). This formula is axiomatic to understanding biology.

The construct of physical literacy rests upon the ontological monistic premise that physical, cognitive, and emotional wellness are holistically intertwined (Whitehead, 2010c). A hominid mind does not exist or function without a physical platform. A major obstacle to internalizing physical literacy is showing how lived embodiment supports a monist view of a human being (Whitehead, 2010b). "I am who I am because my brain is what it is" (Churchland, 2013: p. 11).

Pinker (2003) told his TED Talk audience those genetics and neuroscience are increasingly showing that the brain is intricately structured (2:43), that brain differences are just differences in anatomy, …with consequences in thought and behavior…. (4:05). By 2018, Whitehead et al. (2018: p. 254) confidently claimed that practically all neuroscientists refuted dualism.

Humans inherit brains that enable minds. Pinker (2002), in rejecting notions of dualism, followed the 21st century confluence of evidence from cognitive science, neuroscience, and ethnology. "[T]here can be no learning without innate circuitry to do the learning" (Pinker, 2002: p. 35). "One can say that the information-processing activity of the brain causes the mind, or one can say that it is the mind, but in either case the evidence is overwhelming that every aspect of our mental lives depends entirely on physiological events in the tissues of the brain" [emphasis in original] (Pinker, 2002: p. 41).

4. Phenomenological Perspectives

4.1. Humans Are of the World and Not Just in the World

In a 1924 lecture, *The Concept of Time,* Heidegger (1992, orig 1924) proposed a reconceptualization of what it is to be human. "Our inquiry points in the direction of Dasein or 'being there'." (Heidegger, 1992, orig 1924: p. 6E). Heidegger (1924/1992) argued that Dasein (human) could not be reduced to a biological body or zoological species, or to minds or consciousness. He was searching for what people really mean by "being." Heidegger talked about "being *in* the world" as being involved with other beings [emphasis in original] (Heidegger, 1992, orig 1924: p. 7E).

Durden-Myers and Whitehead (Durden-Myers & Whitehead, 2019b) suggest that interaction with the world existentialist, who propose humans become human by interacting with the world. Humans do not literally create anything, for

humans are as constrained by the laws of physics as is the rest of the cosmos. However, the body is of the environment and not just part of the environment. The tail of a dog is of the dog. When the dog is excited, the tail wags because the tail is of the dog.

Analogously, a human is the constituent parts of its environment and not a being set apart from it, and not simply a sum of the parts. The larger environment is the coffee and humans are the creams. The human body is not a single "thing." Microbial cells in human bodies outnumber human cells by perhaps ten to one. Ninety-nine percent of the genes in a human body come from microbes (Knight & Buhler, 2015). The microbes are of the human body and not simply inside the human body. The human body is partially the microbes, and the human experience is an environmental process of the interaction between the microbes and the rest of the body. A 21st century science-based paradigm of the human body does not so much contain microbes as being, in part, defined by the microbes and the internal environment within the body that houses the microbes. This is a scientific, evidenced-based, testable paradigm that supports Whitehead's introspective, existentialist holistic conception that human nature cannot be separated from human embodiment (Durden-Myers & Whitehead, 2019b; Pot et al., 2018). People cannot use the scientific paradigm to determine whether Whitehead's phenomenological deductions are correct but using science does allow them to arrive at similar conclusions, albeit for different reasons.

4.2. The Problem with Grounding Physical Literacy in Phenomenology and Existentialism

A major challenge to phenomenology and existentialism is that they are mental constructs and not "objects" of the world. The objects of these philosophies are mental phenomena in the abstraction that is the mind. Husserl argued that human experience is not objective; that experience is based upon sensing the real world through a default state of uncritically accepted beliefs that he called "the natural attitude" (Manen, 2014: p. 43). He may be correct, but people cannot know this because people cannot enter his mind, play with its contents, and experiment within his mind.

The surmises of phenomenologists might well be correct, but their hypotheses are only testable by logic and not by experimentation. The objects of phenomenology and existentialism cannot be weighed, measured, or physically observed. Like shadows on the wall, they reflect a distillation of reality but not reality itself. Their hypotheses are not falsifiable. Someone must enter your mind to observe what you observe, but they cannot enter your mind and therefore they cannot know what you know except by what you describe. This then results in hearsay knowledge, a type of knowledge that is not empirically credible because hearsay knowledge relies upon the perception of the beholder. Therein lies the irony. In phenomenology, "phenomena" perceived by the mind do not depict reality, but rather, depict filtered versions of reality distorted by assumptions and beliefs.

The irony is that because phenomena of the mind cannot be relied upon, neither can people rely upon its methodology; the resultant is a private phenomenon and not a public outcome.

5. Embodiment: Human Brain Is an Organ, Not a Computer Component

5.1. Embodiment via Existentialism and Phenomenology

Bodily experiences physically impact brain performance and functionality. Brain functionality, or "mind" or "thoughts and emotion" is an "embodiment" phenomenon.

Whitehead (2007) set forth her adaptation of the philosophical basis for the meaning and significance of "embodiment in life" (p. 282) in the philosophy of physical literacy, referencing among others existentialist Jean-Paul Sartre (1956) and phenomenologists Maurice Merleau-Ponty (1962) and Ian Burkitt (1999) in rejection of Cartesian dualism and explication of the role of "embodiment in life" in service of the realization of people's full potential.

Embodiment philosophically states that humans are at one with the world that they can only experience with their bodies, and presumably not with a separate mind. Existence is realized and experienced by bodies through their reciprocal interaction with the world. Humans are with the world rather than objects in the world. It is people's movement in the world—Whitehead uses the term "motility"—that facilitates their social as well as physical experience with the world (Whitehead, 2001). Existentially, humans create themselves through their interaction with the world.

Phenomenologists tend to disagree about the content of phenomenology:

> What unifies the tradition of phenomenology is…a shared preoccupation and a shared conception of method and…the fact that we grasp and comprehend all of the various entities, objects, activities, and events that the world throws at us in the course of our everyday experience…and…they're intelligible to us so what they're interested in the way that reality manifests itself to ordinary human subjects…that relationship between appearance and reality. (Stephen Mulhall speaking at 1 min 24 secs in Bragg, 2015)

Whitehead (2007) surmises that humans are embodied rather than having a body, that embodiment contributes to human life through self-realization, perception, concept development, language formulation, rationality, emotion and that development of interpersonal relationships. Humans are "beings-in-the-world" and their "body is integral in, and indispensable to, realizing our [their] very existence" (p. 282).

Whitehead (2007) infers from Burkitt (1999) that meaning comes, not from rules of cognition or grammatical construction, but from people's "embodied interaction with the world" (p. 284). For Whitehead (2007), "there is no doubt that our motile capacities are absolutely crucial to the contribution made to existence by our embodied nature" (p. 283). Embodiment makes intellect possible.

5.2. The Human Brain Is Not a Von Neumann Computer

von Neumann computer architecture, named after work in the 1940s by mathematician and physicist John von Neumann and others, follows the stereotypical Input-Process-Output model of computer processing (Centre for Computing History, 2021). A central processing unit contains a control unit and an arithmetic/logic unit that receives digital input, exchanges data with a memory unit and generates output data. That is not how the human brain retrieves and processes information. Rather, the human brain is the organ that enables the mental processes of the human mind. Real-life sensual perceptions get processed while memories are constructed.

The human brain is a complex organ that carries a legacy of adaptations to prehistoric environments, and uses cognitive biases, heuristics, and rules of thumb in making judgements and decisions (Kahneman, 2011). Unlike a von Neumann computer that processes raw data as collected, the human brain constructs mental models through interaction with perceptions that are sensory impressions shaped by cognitive biases. The human brain constructs memories through synaptic modifications that do not precisely mirror reality. This statement is a derivative of both science and phenomenology.

The human brain was engineered by natural selection to maximize the number of progenitors and not by software to electronically implement algorithms. Hodent (2018c) describes the evolution of the human brain:

> The human brain began evolving well before any hominids walked the Earth and has further evolved over thousands of generations as our ancestors survived the harsh life of the African savanna. However, our modern life is very different from prehistoric times, and we face many problems that are new for our brain in terms of the relatively slow scale of evolution. (Hodent, 2018c: p. 9)

5.3. Human Minds Are Electro-Chemical Patterns in the Wetware of a Brain

Computers and human brains have different substrates. The human brain is not a computer processor, but both processor and brain are platforms that retain and process physical representations of abstractions. Computer data is algorithmically manipulated as electrical patterns in a computer hardware processor. Computers have a digital architecture whereas human brains have an analogue morphology. What both platforms have in common is that both store and manipulate abstract representations of real-world information. Information, such as thoughts, is manipulated as electro-chemical patterns in the wetware of macaque, human and other brains.

5.4. Perception

The science of perception resonates with Heidegger's (1992, orig 1924) description of reality as objects and events as they are perceived or understood in hu-

man consciousness, except that cognitive science does not include untestable abstractions.

Perception is the brain processing sensory information to make sense of it; humans don't perceive the world as it really is, but instead perceive representations of it (Hodent, 2018d). Perceptions are processed as cognitively massaged data and not exclusively as raw data. The brain and its mindful functions were not engineered for digital accuracy (Barrett, 2020; Cobb, 2020), but instead for successful or benign adaptations to past environments that promoted procreation over extermination. Memory is not just a record of events. Memory can change and memory can be false (Cobb, 2020). When an imperfect sensory impulse signaled that there was a small possibility that a venomous snake lurked in the shadows, the ape that took time to rationally reflect on whether the shadowy perception was reality or illusion stood a higher likelihood of being permanently removed from the ape gene pool than did the ape that impulsively took flight. The impulsive ape is the humans' ancestor, the one with the brain engineered for survival over contemplation, the ape that shoots first and asks questions later. The *Homo sapiens* brain is malleable (Eagleman, 2020; Marcus, 2004; Merzenich, 2013). The emergence of virtual environments, gaming, and applications in the 21st century have amply demonstrated that the *Homo sapiens* ape brain can be willingly manipulated by virtual environments that defy empirical laws of physics (Hodent, 2018a). "VR [Virtual Reality] changes the world we're in and we accept the illusion eagerly" (Fink, 2018: p. 30). It is a brain adapted for survival as well as a rational calculation that allows for broad variation in senses of presence.

5.5. Memory

Brain areas are functional components and not necessarily physical regions. The architectural model of human memory has three components: sensory stores, short-term store, and long-term store (Atkinson & Shiffrin, 1968). Sensory memory is part of perception; short-term memory stores items for less than a minute (Peterson & Peterson, 1959). Working memory is a type of short-term memory that allows people to temporarily store and process information. It is working memory that accomplishes executive functions and complex tasks. The human brain has limited attentional resources and is poor at multitasking. Long-term memory is not limited by time or space (Hodent, 2018b: pp. 35-44).

Memory is a process of reconstruction and not one of storage and retrieval of data (Hodent, 2018b). Each time humans reconstruct a memory, they retrieve, not sensory data, but rather a processed or massaged past memory which again undergoes further processing (Hodent, 2018b: Chapter 4). Memory is a process of adaptation for survival and an engineered store of information.

5.6. Attention

Attention is the selective focusing of consciousness and receptivity (Merriam-Webster Dictionary, 2019). Attention decreases when multitasking is at-

tempted by humans. When multitasking, humans actually "switch" among tasks and may experience "interference" in decision-making, effects described as a "cognitive bottleneck" (Borst et al., 2010; Welford, 1967). Even brief mental blocks created by shifting between tasks can cost as much as 40 percent of someone's productive time (Rubinstein et al., 2001). Learning suffers if attentional resources exceed working memory limits (Sweller, 1994). The brain switches between tasks so fast that we think that we multitask, but the brain actually performs tasks sequentially (Gupta, 2021). Costs of switching during multitasking can challenge attention and thus reflexes.

5.7. Embodiment

Whitehead argues that physical literacy is an embodiment phenomenon, that it is holistic (Whitehead, 2010b, 2019a). Holistic embodiment makes sense when people track the correspondence between fundamental movements and cognitive skills, although fundamental movement skills are not synonymous with an embodiment.

Physical literacy is, to some great extent, about movement "with competence and confidence in a wide variety of physical activities that benefit the healthy development of the whole person" (Mandigo et al., 2009: p. 6).

We have reviewed scientific evidence that refutes Cartesian mind-body dualism without reliance on existentialism and phenomenology. Scientific evidence demonstrates that "mind" is not a "thing", but a set of brain functions. The philosophies of existentialism and phenomenology are unnecessary to refuting Cartesian dualism and the acceptance of a monistic perspective of the brain and its associated mind functions.

5.8. Embodiment Is a Paradigm Shift

Embodiment is a different way of thinking about the importance of physical activity. Thinking about the human body as of the environment instead of being part of the environment has profound implications for theory, research, education, health, and fitness policies, and how people think about the human experience. "Go with the flow" is a more accurate way to think about physical activity than "Do your exercises now and your math later." The body is not divorced from the rest of reality, but rather is of that reality.

5.9. Human Flourishing as Embodiment Is an Empirically Observable Proposition

Human flourishing is about "human embodiment as the ground of human existence" (Whitehead, 2019c: p. 275). Human flourishing is the ultimate end of human conduct but also concerns itself with understanding and valuing the means to that end (Durden-Myers et al., 2018). In line with Whitehead's phenomenological thought, humans create themselves as embodied beings through embodied interaction with the world (Whitehead, 2019c).

6. Physical Activity Is the Human Evolutionary Heritage

6.1. Behavior Is Shaped by Evolutionary Natural Selection

Natural selection designs the physiology of human bodies, including the organs. The brain is as emphatically an organ as is the heart, lungs, and kidneys. The behavior of each organ is shaped by the DNA coded design of that organ. Hearts pump blood, lungs absorb oxygen, and kidneys filter blood, all commensurate with the design of the respective organ. Brains record, store, manipulate, and generate information and patterns of information.

Even social behavior is shaped or optimized by evolution, just as biomechanical optimization sculpts the size of a giraffe's heart (Sapolsky, 2018). Animals do not behave for the good of the species; they behave to maximize the number of copies of their genes passed into the next generation (Dawkins, 1976).

Locomotion is circumscribed by the design of the vehicle. Behavior is shaped by the design of the brain. Some vehicles are faster because they were designed to be faster. Some animals are smarter because the brains of their ancestors were selectively favored for their intelligence. Brains do not cause behaviors, but they favor and circumscribe propensities.

6.2. Cognitive Executive Functions Evolved as Adaptations for Movement

Movement is the single most important expression of physical literacy. Whitehead is adamant that "humans rely on movement potential to stay alive. To be is to move" (Whitehead, n.d.). Movement is convenient shorthand for operationalizing thoughts and discussions about physical literacy, but physical literacy is not synonymous with movement.

"Physical literacy is the cornerstone of both participation and excellence in physical activity and sport. Individuals who are physically literate are more likely to be active for life" (Sport for Life, 2019).

Hominid cognition is thought of as a collection of information-processing programs evolved in the Pleistocene to solve the adaptive problems regularly faced by the hunter-gatherer ancestors of humans; problems such as mate selection, language acquisition, cooperation, and sexual infidelity (Barkow et al., 1995). If so, then, "[W]hy do we [humans] and other animals have brains?" (Wolpert, 2011: 0:15).

Brains evolved to produce adaptable and complex movements. Sensory, memory and cognitive processes either drive or suppress future movements (Wolpert, 2009, 2011: 1:15). The same brain that evolved in adaptation to physical movement is the brain that executes executive functions of working memory, mental flexibility, and self-control. When K-12 teacher Heather Gardner (2017) involved her students in "games for developing confidence and competence in physical activity" to develop "fundamental movement skills" (Gardner, 2017), she engaged students in games that cultivated cognitive development because those faculties reside in the cerebral cortex that evolved for movement.

6.3. Embodiment Is Brain with Body Interacting with Experience and Environment

Biologically and holistically, physical literacy describes the embodiment of the brain with the body. For *Homo sapiens*, extensive movement is a necessity and not a luxury for healthful well-being as:

1) Humans bodies evolved to run hundreds of miles without stopping (Karnazes, 2006; McDougall, 2011).

2) Human persistence hunting worked by chasing prey to exhaustion, sometimes taking days (Liebenberg, 2006, 2008; Raichlen & Alexander, 2020).

Homo sapiens is the proverbial naked ape (Morris, 1967). Lack of fur allows cooling by perspiration. Humans require high levels of exercise to be healthy. For humans, unlike other living apes, "exercise is not optional; it is essential" (Pontzer, 2019: p. 28).

Hominins shared their last common ancestor with chimpanzees and bonobos about seven million years ago. Four to two million years ago, *Australopithecus* appeared with long legs at the same ratio as in modern humans but still mainly ate plants (Rogers & Gibbs, 2014; White et al., 2009).

Modern human brains contain an average of 86 billion neurons (Herculano-Houzel, 2016). Although the human brain only weighs two percent of the body, it alone uses 25 percent of all the energy that a body expends (Herculano-Houzel, 2013: 2:53). The human cerebral cortex, with an average of 16 billion neurons, has more neurons than any other brain (Harari, 2018; Herculano-Houzel, 2013: 5:51, 8:30). If humans ate mostly raw vegetation like other primates, humans would have to eat eight to nine hours per day to get enough energy to support their brains (Herculano-Houzel, 2013: 10:20).

Two things happened to allow humans to consume enough energy to support their energy-demanding brains:

1) Human ancestors invented cooking, allowing more energy to be consumed in less time (Herculano-Houzel, 2013: 10:58; Wrangham, 2009).

2) Human ancestors added meat to their diet, a significantly more economical source of energy than plants (Pobiner, 2013).

By 1.8 million years ago, prime-aged ungulates were being butchered by hominids (Wrangham, 2009: 2017). The consumption of meat necessitated that human omnivorous ancestors, not unlike carnivores, travel further for food than herbivores. Nearly every organ adapted down to the cellular level. Human VO_{2max} output is four times that of chimpanzees (Pontzer, 2017, 2019). The human body evolved to hunt by persistently chasing prey for a hundred miles, and for days if need be.

The agricultural revolution was a recent occurrence: 11,000 - 9000 years ago with the domestication of wheat and goats in south-eastern Turkey, western Iran, and the Levant (Harari, 2018), a blip of time in evolutionary development. Contemporary human bodies are bodies of hunter-gatherers, bodies designed to run vast distances for long periods. For example, Tarahumara natives living in

the Copper Canyon have been observed to run 100 miles in less than 24 hours, with races lasting 48 hours (Balke & Snow, 1965; McDougall, 2011).

Accounts of persistence hunting in 1985, 1990, 1998, and 2001 by Kalahari San peoples illustrate that modern hunter-gathers can run down large antelope and kudus by chasing them until the prey drops from exhaustion (Liebenberg, 2008; Lieberman, 2020a). Even urbanized runners can catch a pronghorn antelope, North America's fastest animal, by persistent chasing (Bethea, 2011). "[T]here is a need to encourage everyone to love being active" (Almond, 2010: p. 129).

6.4. Human Thought Is a Function of a Hunter-Gatherer Brain

The *Homo sapiens* brain tripled in size in the last $1\frac{1}{2}$ million years (Herculano-Houzel, 2016). *Homo sapiens* evolved from 7 million years old tree-dwelling apes to become bipedal, persistence hunting, ultra-marathon running, naked apes chasing prey over savannas until prey dropped from exhaustion.

The brain's evolution, in concert with the rest of the body, evolved "propensities", or motivations to do one thing rather than another, to prefer one response over another, to confer euphoria rather than disdain when running extended distances, to favour ways of thinking one way over another that increased fitness to survive and reproduce. "With each new mechanism that is added to the mind, an organism can perform a new task" (Buss, 2019: p. 35).

6.5. The Sedentary Brain Is a Hunter-Gatherer Brain

The human hunter-gatherer brain evolved in concert with the hunter-gatherer body. It takes more brain resources to be physically active than sedentary. In an approach-avoidance task study at the University of British Columbia, using electroencephalography (ECG) to measure cortical resources, researchers found that it took far more brain resources to move toward physically active images of avatars than toward sedentary images (Newman & Chacos, 2018). Matthieu Boisgontier, who led the study with Boris Cheval, stated, "To me, these findings would seem to indicate that our brains are innately attracted to being sedentary. …The results make sense from an evolutionary standpoint" (Reynolds, 2018: para. 23). "Conserving energy was necessary" for humans as a species (Reynolds, 2018: para. 25). Dr. Boisgontier further explained that the fewer calories that atavistic humans burned, the fewer they had to replace at a time when food was not available (Reynolds, 2018).

6.6. The Hunter-Gatherer Brain Is a Phenomenological Brain

Intuitive judgements rely upon basic assessments shaped by human brain-body evolution as described below by Kahneman (2011):

[Intuition] has been shaped by evolution to provide a continuous assessment of the main problems that an organism must solve to survive. …The questions are perhaps less urgent for a human in a city environment than for a gazelle on

the savannah, but we [humans] have inherited the neural mechanisms that evolved to provide ongoing assessments of threat level, and they have not been turned off (Kahneman, 2011: p. 90).

Judea Pearl is a Turing award-winning computer scientist and engineer. His 2019 commentary could have been lifted from a Heidegger lecture:

Eventually, to get to consciousness, you apply what you understand about the world to yourself, and you look at yourself as one of those factors that's called the neutral factors, operating in the world, and now everything that you learn about the environment applies to you as an agent within this environment (Pearl, 2019: @ 1 hour 51 min).

7. Discussion

When the authors of this article initially read Margaret Whitehead's definition of physical literacy, we immediately thought, "Somebody finally got it right." We empathized with Whitehead's (2010a) despair that "the importance of movement development in early childhood was being forgotten. The focus…was directed principally towards the development of language, numeracy and social skills" (Whitehead, 2010a: p. 3).

The introduction to human evolutionary biology described in this article came from the first author's experience in his undergraduate years when he read *Mankind Evolving* (Dobzhansky, 1970). Today, few scientists would debate the statement: "Nothing in biology makes sense except in the light of evolution" (Dobzhansky, 1973: p. 125).

Whitehead (2010c) described embodiment as "the potential individuals have to interact with the environment via movement" (Whitehead, 2010c: pp. 202-203). Physical literacy is now generally recognized as being about movement "with competence and confidence in a wide variety of physical activities that benefit the healthy development of the whole person" (James Mandigo et al., 2009: p. 28). We offer the hunter-gatherer paradigm as an empirically testable, evidence-based explanation that holds that, for humans, exercise is essential and not elective for human health (Lieberman, 2020b; Pontzer, 2019). This is a necessary, though perhaps insufficient, condition for achieving "embodiment." Phenomenology is not needed. Existentialism is not needed.

8. Conclusion

In our understanding of the power and efficacy of physical literacy, philosophies such as existentialism and phenomenology have been superseded by science, by empirical evidence that the mind is a function of the brain and not capable of existing independently of it, and the proposition that physical activity and physical literacy are a sine qua non to being human.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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