NOTES ON EMBODIED COGNITION

(Alt:

Autopoiesis[1]

or

Notice how

gravity is slicing

your

arm[2]

)

Nell Schwan

NOTES ON EMBODIED COGNITION

Are you sorry?

Sit down.
Cross your legs.

Stand up.

Turn around.
Bend over.
Knees on the floor.
Hands on the floor.
Look at me.

Lay down.
Sit up.
Raise your hand.

Higher.
Higher.
Higher!

Make a fist.
Stronger.
Stronger!
Look at it.

Go sit down.

Could you be
a mountain? (*Yes.*)

Show me.

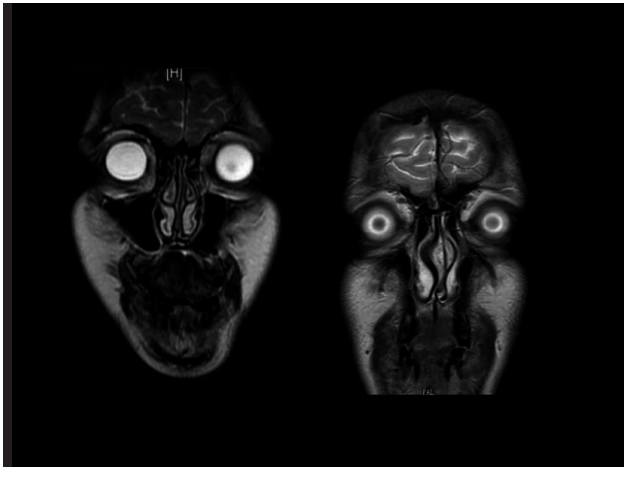
Could you carry me?

(*Yeah, I can carry you.*)

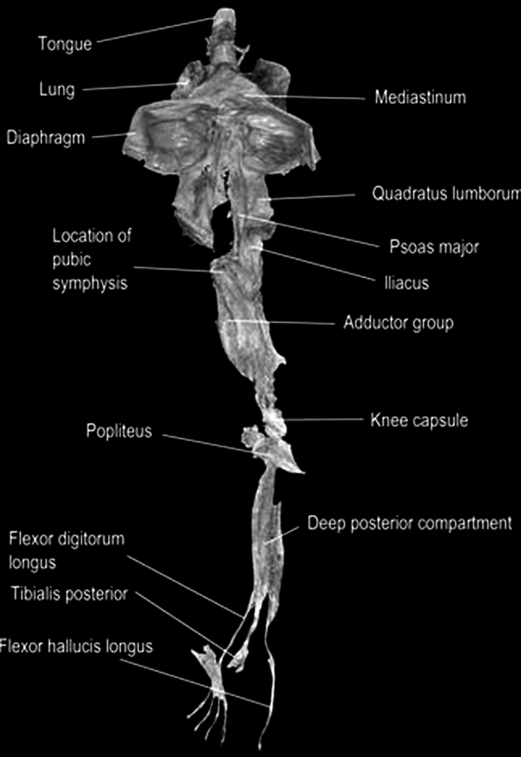
...
You could carry
a mountain?

(*No.*)

Go sit down.
On the floor.[3]



Magnetic resonance imagery of a human head [4]



‘Deep Front Line’ muscular continuity, note the unbroken kinetic chain from tongue to toes [5]

Abolish mirrors; break your mirrors in all studios. They spoil the soul and prevent you from getting in touch with the elements and multi-dimensional movements and abstract thinking, and knowing where you are at all times without looking at yourself. Dance is about sensations, not about an image of yourself.[6]

Ohad Naharin
Choreographer

· At the opera in Stockholm, I sit behind a little girl and her grandmother during a ballet performance. The former says, "Mormor, det ser så skönt ut när dom hoppar!" which could mean either "Granny, it looks so nice" or "Granny, it feels so light when they jump!". The elderly woman hums an answer while her neck sways side to side, entranced by the music, living vicariously through the dancers on stage.

· A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action performed by another. Thus, the neuron "mirrors" the behavior of the other, as though the observer were itself acting. Such neurons have been directly observed in primate species.[7]

· When I haven't been able to move, I've observed those who are with rapt attention.

· There are different ways to conduct research before writing a text: engaging with literature is one, conducting a series of direct observations is another.

· Despite the bibliography at the end, the real site of my examination has been my own body — a long inquiry through physical practices, through getting sick, through getting injured, through recovery, through failing to recover normal function, through learning or struggling to learn and failing and bec-

oming disillusioned with the sources of established knowledge (the peer reviewed ones that I expected to provide me the answer *why?*). Through asking *why?* for as long as I can remember.

· This essay departs loosely from/was provoked indirectly by: 1) the Cartesian Split 2) a hot, current topic called 'Neuroscience' 3) certain Western inclinations to equate the self with the mind and the mind with the brain

· I am a product of my environment too: I, too, have believed in perpetual progress; in the existence of a linear, just meritocracy; and in *mind over matter*.

· *Everything that can be thought at all can be thought clearly* [8], but *what if* not everything can be thought?

· Before continuing, consider the human fear of creating a sentient being who eventually overthrows its master? [9]

· Before our conversation is over, I hope you find the worry absurd. You cannot create anyone; they can only create themselves, and sentience cannot be granted, not by design.

· I have attempted to write a text that sits awkwardly between biology, medicine, biomechenics, psychology, and philosophy; but, ultimately, doesn't go specifically deep into any one. My apologies in

advance, I didn't formally study those subjects even if they often blink in and out of existence in the projects I take on.

· Actually, I did study medicine, however briefly.

· Some of my earliest memories include balancing on tip-toes on dining room chairs, reaching toward top shelves of the book cabinet, and pulling out some heavy, illustrated *Anatomy Atlas* belonging to my surgeon father to ogle, with unrestrained curiosity, the flayed, bright red suits supposedly residing right under our skin.

· (The wide-eyed morbidity of children.)

· The irony isn't lost that during one of those occasions, I fell from the chair bringing about my very first fracture.

· Which was scary/painful but also exciting. Somehow, one's own body remains invisible until it malfunctions.

· Significantly later, post x-rays and plaster, the foundational university courses in medicine included anatomy, physiology, cell biology, organic chemistry, nutrition, pathology, et al. On the basic levels, future physicians rub shoulders with future nurses and future physiotherapists.

· There is linearity to this process, however. At its end awaits specialization. To better help you, the endocrinologist, physiotherapist, and psychologist remain separate professions and skill-sets.

· I propose here a stubbornly unstructured text. Self-referentially so, since my real agenda likely cannot be put into words compartments. For lack of better tools, I will attempt to conglomerate a number of disparate thoughts and sources and, gamble on the chance that the things I cannot articulate will, somehow, be hosted inexpressibly.

· This text is, therefore, a series of notes—as collecting clues and saving them in unstable, interconnected, visceral networks seems like a better option than mimicking the linear, "logical/rational", disembodied practice of "making a statement".

· Had I not grown disenchanted with statements and were to make one, I'd yell from the rooftops, "We have academically misunderstood health."

· At some point between the Anatomy Atlas and the anatomy classroom, I was given the impression, by those already initiated, that if only I could read every footnote, memorize the Latin name of every muscle, bone, and ventricle in the body, they would somehow reveal Truth and Insight to me.

· Closer to the truth, I've found, is that our systems

of dividing, naming, and understanding the body are human constructs equally as arbitrary as the rules of motor traffic: useful in some aspects, myopic in others.

· *If all one has is a hammer, everything might look like a nail.*

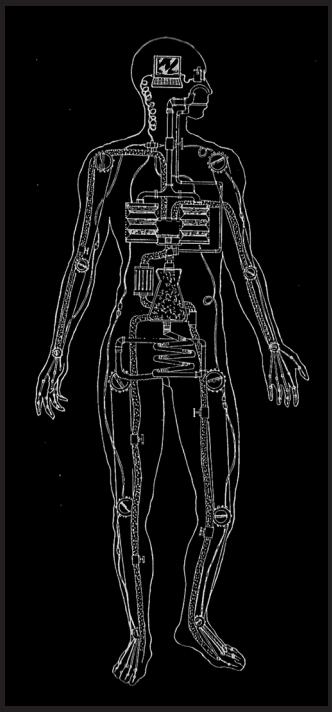
· For a long time, the principal tools our medical practice possessed were: if a body-part is sick, we can remove it.[10]

· Aside from a fluctuating medical interest, I continued inquiries into the body sincerely "hands on" through different forms of dance, sport, bodywork, meditation and adjacent practices.

· A curious, recurring event was, however, the conflict between my dancing body and the knowledge it possessed versus that of my multitude of physiotherapists and their instructions and attempts to inform me (on how to move/how to behave).

· How could embodied knowledge, things that were possible because I had felt and done them, be antithetical to scholarly books and medical journals handed down through academic and clinical tradition and finally departing from the lips of a peer sanctioned body-mechanic?

—Ok, ex-football-dude… But if I can do things which you



Body as a machine/body as a garden [11]

can't even fathom, on which one of us should I rely?

· *This is a sub-vocal, zero-irony hypothetical question. I don't know anything for sure.*

· In this very moment, both reader and writer are oxygenating our blood, beating our hearts, balancing a large number of joints and structures in relation to gravity—yet we have no conscious idea of how we're doing it. We probably paid no attention to the fact that we were.

· In this very moment, you are registering the temperature of the air around you, the texture of the surface below you, how the cloth of your clothes feel against your flesh (Where is it squeezing? Touching you softly?). Is this information available to you? And when?

· How might I explain the coffee mug perched precariously next to my keyboard to someone I consider in need of such an explanation? "It's sort of a white cylinder? With a handle, yeah?" For the cooking-savvy it might make sense as a kitchen utensil, a vessel for containing coffee. In a more abstract sense, it's a ceramic object.

· An organism is also a microcosm consisting of other organisms (e.g. gut bacteria). A mammal's cells are populated by other cells (mitochondria [12]). The delineations of whether something is a world,

a creature, or an object are difficult to make. Perhaps the coffee mug can be described geometrically, materially, and pragmatically at the same time; but if we favor some perspectives while forgetting others, our idea of the entity in question might become distorted (body as a machine).

· This is the departure point of my idea for this text: Against cementation (of models) through a multitude of examples (of where models fail).

Philosophy still hopes in the power of language to discover new things. That's not the case.[13]

Asad Raza
Artist

· I set out to examine the multitude of ways our bodies affect our ability to think. But isn't building a case for embodiment *in text* quite contradictory?

· While a linear model of origination is incomplete, on the page (apart from, perhaps, the page of poetry) it might be the only tool available.

· While words and language are incomplete, in order to find those with ideas comparable to ours, they might be indispensable.

· For years, I found myself frustrated and wordless in the discrepancy between the dance studio and PubMed.[14] They both concern themselves with the body, but where is the overlap?

· Coming across the obscure term "embodied cognition" was like an ember. Finally, an indexable label, something like a key to decades of thought and research, authored by those who don't necessarily believe that the brain rules the body like a king rules his land (plot twist: the land lay there long before the coronation).

· *Or as an equestrian controls his horse.*

· Suddenly, the embodied knowledge for which I previously had no words for (somewhat) matched a newfound concept.

· Embodied cognition was, in turn, housed under the umbrella of *cognitive science*: the interdisciplinary study of the mind and its processes.

· By all measures, cognitive science is a recent, strange animal. While its practitioners may draw from studies of the 1950s or earlier, the field didn't receive delineation as a combination of psychology; philosophy; linguistics; and, remarkably enough, *computer science* until the 1970s.

· One might wonder why it took the emergence of robotics & co to consider how (in the pragmatic, not the philosophic, sense) the mind works?

· Interestingly, before the 1990s theories of embodied cognition, the workings of the mind were, by standard cognitive science, treated as analogous to that of a machine. And some of its followers do, to present day, persist that human thought consists of *algorithmic processes upon symbolic representations*.[15]

· I rehash this: How likely that, were I to lift the hood of my mind, I'd find "algorithmic processes upon symbolic representations"? (Frustratingly for all involved, this is still how we conceive of and teach language).

· Algorithms and representations are, after all, what makes the electronic devices in our pockets tick. The ones to which we've increasingly outsourced phone

numbers, birthdays, grocery lists and geographic navigation.

— *Why do we need to learn this?!*[16]
Can't I just google it??[17]

· *Extended* cognition goes one step further and assumes not only our bodies are indispensable for reasoning, but the rest of our environment as well.[18]

· In this concept, the note book and the cell phone you consult as part of your cognitive functioning are "part of" your mind too.

· In the 1960s, cognitive scientists Allen Newell and Herbert Simon constructed a computer program designed to replicate the internal thought process that a human being undertakes when solving a logic problem.[19] In order to compare the cognitive steps of the program to a human, the latter was asked to "think out loud" while tackling a problem such as transforming the logic expression

$R \& (\neg P \supset Q)$ into $(Q \vee P) \& R$

· For the reader less familiar with computer programming, the following might feel a bit mind-numbing; but stay with me for a sec. Here is an excerpt from Simon and Newell's report on the thought-process of the program vs. the human:

COMPUTER TRACE	PROTOCOL OF SUBJECT
L0 (Q ∨ P) & R L1 R & (~P ⊃ Q) GOAL 1 TRANSFORM L1 INTO L0 GOAL 2 CHANGE POSITION IN L1 GOAL 3 APPLY R1 TO L1 [A&B→ B&A] PRODUCES L2 (~P ⊃ Q) & R GOAL 4 TRANSFORM L2 INTO L0 GOAL 5 CHANGE POSITION IN LEFT L2 GOAL 6 APPLY R2 TO LEFT L2 [A ⊃ B→ ~B ⊃ ~A] PRODUCES L3 (~Q ⊃ P) & R	I'm looking at the idea of reversing these two things now. (Thinking about reversing what?) The R's... then I'd have a similar group at the beginning but that seems to be ... I could easily leave something like that 'til the end, except then I'll... (Applying what rule?) Applying... for instance, 2

· Bafflingly enough, the authors concluded that *why yes*, human thought does take the same route as a computer when solving a problem.

· Machine logic is linear, sequential. But an ouroboros-shaped conundrum appears: was it not humans that gave this kind of language to machines?

· So while standard cognitive science presupposes that the thought processes of humans correspond to those of machines, the more recently developed branch of embodied cognition suggests that without a body, there could be no thought at all.

· *Without a body, there could be no thought at all.*

If the eye were immobilized completely, preventing even the microtremors that keep the eye in constant motion, perception would fade away.[20]

Lawrence Shapiro
Philosopher

· In 2016, in the context of a study group, I was asked to bring an object to facilitate discussion on the topic of "education" and, more generally, "learning". I brought a broom.

· I asked the moderator of the group to rise from our comfortably seated endeavor; clear away some chairs in the middle of the room; and, while fully present on his agile feet, balance the vertical broom shaft on his open palm.

· *A body is always more than one: it is a processual field of relation and the limit at which that field expresses itself as such.* [22]

· A radical model of the human senses suggests that rather than having five of them, we might have 33 (many of which are forms of interoception).[23]

· A simpler version, only 9:

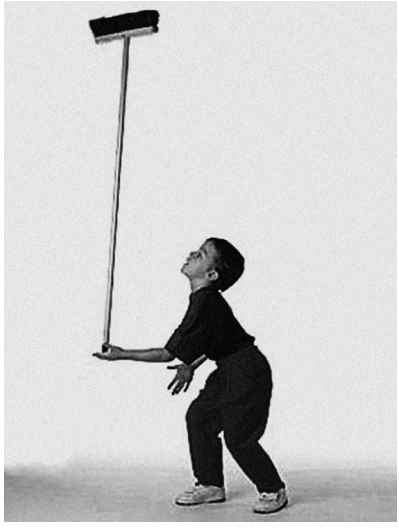
1) Vision (sight)
2) Audition (hearing)
3) Gustation (taste)
4) Olfaction (smell)
5) Tactition (touch)
6) Thermoception (heat, cold)
7) Nociception (pain)
8) Equilibrioception (balance, gravity)
9) Proprioception (spatial body awareness, mainly the positions of the joints relative to one another)

· How many senses, how many cognitive processes and action-feedback loops occur simultaneously when the moderator is moving around with the broom, his eyes seemingly on the bristled top, while speaking to me and avoiding crashing into other attendees and furniture?

· I wanted to introduce into the conversation the possibility of "knowing things of which one isn't aware"' or of performing multilayered tasks with other aspects of oneself than one normally considers "oneself".

—Who is performing this task?
—By extension, what more does that individual know?
—By extension, how do we learn?

· In 1963, American cognitive scientists Richard Held and Alan Hein performed their (now notorious) kitten experiment: Two kittens reared in the dark are subject to a vision development study. The first time the kittens see light is when they are strapped to a carousel inside a graphically demarcated chamber. One of the test subjects is able to walk freely, while the other rides a type of gondola powered by the former; consequently, both kittens receive the same visual input as they move around the circular chamber, but only one is coupling changes in the environment with its own bodily action.[24]



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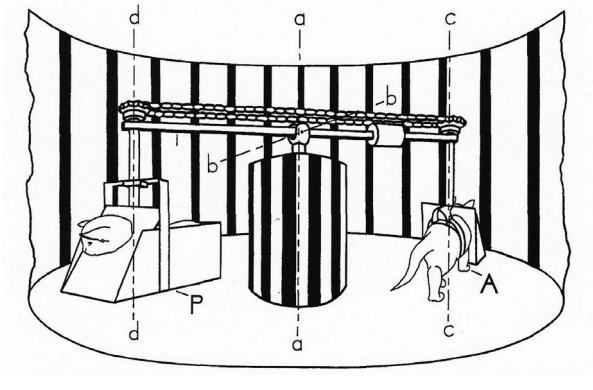

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· The findings of this ethically dubious study were that only the kitten that was able to move of its own accord developed normal vision. The stationary kitten, on the other hand, displayed uncoordinated paw movements, failed to avoid obstacles, and did not blink when objects approached its eyes. One could assume that in the world of the statioary kitten objects can "grow larger" but never "grow nearer". Pattern changes in the retinal image do not have spatial meaning for this kitten.

· What effect do baby walkers and devices that variously 'strap in' human infants have on the individual's sensorimotor development?

· And what other capacities do we fail to develop when we lack agency?

· *When we are born, we are all sensation.*

· Keen observers of developing infants know that lifting the head; rolling around; crawling; sitting up; standing; and, finally, walking happen in that order. Each consecutive step requires the one before in order to build necessary competence. So that the struggle to lift the heavy head necessarily builds enough strength and coordination until one day the back muscles are strong enough to do so.

· What happens when we are "assisted" to do something before we are ready? Or when we

are deposited into a situation to which we didn't get of our own accord?

· And so the child who is lifted to sit before they are ready or held up "to practice walking" develop skills in the wrong order or ends up performing tasks which they, under normal circumstances (yet) wouldn't. Attempting to learn something without the necessary foundational competence results in gaps of knowledge and, by extension, results in relying on compensations which, by extension, results in seeking medical attention for orthopedic (and/or psychological) problems as adults.

· *I try to help you but my desire is misguided.*

· Keen observers of developing children and consecutive adults know that the early-life sensorimotor map constitutes a neurological blueprint upon which most later functions are laid.

· Biomechanist Katy Bowman, who has spent a considerable part of her career trying to instill into frail and frightened senior citizens that they need more, not less, physical activity to stay whole has an umbrella term for human ailments of this sort: *diseases of captivity.*

· Chinese medicine, which catapulted my understanding of what lack a disintegrated body might produce, has a foundational text from

the 2nd century BC:

I have heard that
the people of high antiquity,
in [the sequence of] spring and autumn, all exceeded one hundred years. But in their movements and activities there was no weakening.
As for the people of today,
after one half of a hundred years, the movements and activities of all of them weaken.
Is this because the times are different?
Or is it that the people have lost this [ability]?[26]

· (And what is "high antiquity" when speaking from the 2nd century BC, anyway?)

· How migratory birds find the cardinal directions isn't entirely clear, but it is presumed that they sense the earth's magnetic field.

· Had they possessed compasses or smartphones, such functions wouldn't need to be hosted inside them, of course.[27]

· Tactition is a direct channel for knowledge acquisition until it is educated out of us; hence, museums and parents worldwide stress: *DON'T TOUCH!*

· Though largely losing in popularity to stethoscopes, certain medical students the world over are still taught a diagnostic method called *percussion*.

· The percussion technique involves placing an open palm on the patient's thorax and tapping the finger joints of the first hand with the second. The resulting sound, its resonance and overall qualities give the experienced practitioner an idea of what might be going on with the subject's lungs (Are they filled with fluid? Is there inflammation?).

—*How does one go about choosing a ripe melon?*

· A combination of tactile, visual, olfactory, and auditory impressions pass from patient to doctor, from fruit to shopper. *Presumably with encoding or without?*

· Does the hypothetical physician above subsequently know that the patient *has pneumonia* because they verbalize this phrase mentally? Or does a tacit knowledge insert itself first? After which the physician concludes: they *now* know that *the patient has pneumonia*?

· Forget picking out ripe fruit, it's something akin to: I know that it will rain without resorting to the weather forecast.

· One could ~~encode~~ verbalize:

—*I know that it will rain because the air pressure is different, I can feel it in my sinuses, there is a discomfort in my head.*

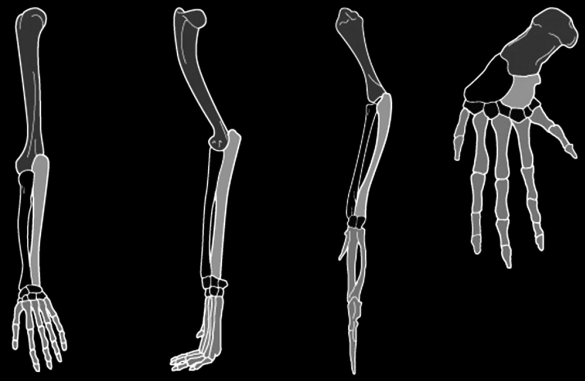
—I know that it will rain because air humidity is suddenly higher; of which my skin and respiratory system inform me.
—I know that it will rain because the color of the light in this room is cooler/bleaker; the clouds which filter sunlight must have changed.

· The difference between embodied cognition and standard cognitive science is their reliance on direct experience vs. symbolism, respectively. The latter conceives of the brain as a computer wherein representations of world facts reside, somehow stored and re-encoded. A neuron or a series of neurons may correspond to "melon". When the subject needs to think of melons—in their mind's eye—they will recall an ethereal signifier which, in turns, brings forth a "melon" (virtual).

· *Simply put, cognition is computation, computation operates over symbols, symbols begin with inputs to the brain and end with outputs from the brain, and so it is in the brain alone that cognition takes place, and it is with the brain alone that cognitive science need concern itself.*[28]

· Yet life on earth existed for more than 3 billion years without brains.

· All of us who are composed of eukaryotic[29] cells started with a single cell. All of our consecutive cells came from this one cell and are a sort of variation on it. When differentiation occurs, the initially iden-



While human movement is narrated as exceptionally diverse and adaptable, the fundamental structure on which it relies is stunningly ‘the one and same’ across all vertebrate species [30]

tical cells start to drift in some direction: nerve cell is a name we use for cells that have become particularly skilled at conducting whereas, epithelial cells are more often found as membranes. And yet, all cells can still *conduct*; all cells are a type of membrane.

· In many senses life, feeling, moving, and being didn't start when brains came around. Or nerves. Or symbols.

· For billions of years you existed: you lived, twitched, synthesized, and multiplied. You crawled, hunted, swam, and you developed many a faculty to accomplish these diverse missions, to navigate and interact with your environment. When brains did come around, for the majority of their existence, their task was to handle the body.

· Initially, I found the idea that a physician could assess his patient as a person might assess a piece of fruit or barrel of wine (= *sensuously*) absolutely staggering. Later on, while remaining grateful that tools like x-ray and blood laboratory analysis exist, I started wondering which faculties we lose when we outsource judgment from our senses and into data?

Environments are not passive wrappings, but are, rather, active processes which are invisible. The ground-rules, pervasive structure, and overall patterns of environments elude easy perception.[31]

Marshall McLuhan
Philosopher

· In 2001, Thomas W. Myers published the first edition of Anatomy Trains, his complementary encyclopedia of the human movement apparatus. Rather than dividing the body into 639 muscles, this classification divides them into 12: twelve large continuities, stretching from head to toes.[32]

· Rather than serrating the adductor from the psoas/from the transversus/from the diaphragm/ from the tongue, Myers defines these structures as one unit, and calls it ~~musculus transversus abdominis~~ the deep front line.

· Just as Borges' animals[33] might fall into other categories than Linnaeus'[34] despite both writers being concerned with the same critters.

· Practically speaking, the difference between how a standard anatomic encyclopedia and Myers came to their delineations could be said to lie in *scalpel orientation*.

· Historically, it is the tools and terminology of hunting and butchery that have been applied to the body.[35]

· Ancient Greek * νατομία (*anatomía), from νατομή (anatomḗ, "dissection"), from νά (aná, "up") + τέμνω (témnō, "I cut, incise") literally "cut up"

· A pathologist may put his tool perpendicular to the flesh at two specific points, unfasten the muscle between them, and call it "a bicep". If, on the other hand, one were to fillet the tissue rather than cut through its fibers (as to take layers off an onion vs. cut into a loaf of bread) it becomes apparent that "the bicep" doesn't start or end anywhere; it makes an unbroken continuity with the forearm (distally) and with the pectoral (medially) and they, in turn, with other structures.

· Could western taxonomy, rather than objective or even practical, be as meshed with prevailing beliefs as any other practice?

· Or with the need to uphold existing power structures?

· Or maybe just rigidity of mind?

· *... and later on, it was the tools of carpentry.*[36]

· We can perform an experiment. Take a handful of shirt fabric into your fist and pull lightly. Even if you pull at the shirt near the chest, all of the garment's fabric will be affected. The line of pull will extend along the continuity of the material; onto the sides; into the armpits and, depending on the amplitude of pull, maybe even onto the back.

· Grossly simplified, such is the functional anatomy

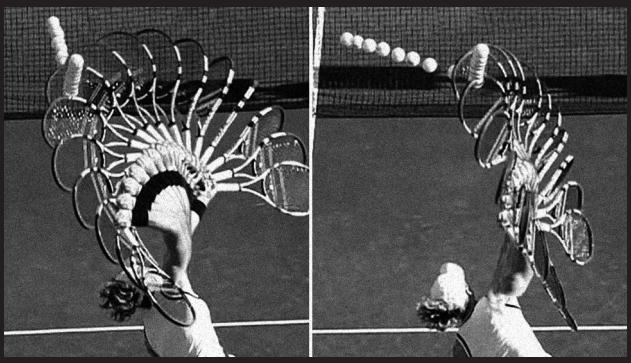
of Myers; nothing in the body is ever disconnected from anything else. Everything that happens affects everything else. Mutual origination, a circular economy.

· And if we follow this kinetic chain, the pain in your left knee could just as well originate in a restriction at your right shoulder.

· Extending the lines of Shapiro's reasoning, human cognition doesn't happen "in the brain" but as a whole-body-affair. Extending those same lines even further: our thinking is inextricably meshed with other organisms, objects, and the world.

· Early robots aimed to replicate animal vision by using a camera to take photos of the environment and a computer to analyze said photos. Before the robot can determine where to go and what are obstacles, it does a thorough analysis of the image to determine depth, surfaces, edges, etc. Needless to say, these early robots "failed", insofar as it took them fifteen minutes or more to analyze an image before determining the next step.[37] And this had to do with more than mere lack of processing power.

· If a hypothetical brain could be kept alive in a jar, this brain wouldn't be able to "see" even if its optical nerve was fed a signal. This is because part of *understanding* is located in the actions of the eyes. Your brain doesn't analyze a stationary image



consisting of different colored surfaces like a mosaic to determine which are floor/walls, how far they are from you, and at which degrees they slope; rather, the focal movement of the eye provides some information about depth (focusing light rays from a close object to one slightly behind it is a faster action than focusing from a close to a distant object). Thus human eye sight literally measures the depth of the space before it; furthermore, micro-movements of our eyes as well as larger movements of the head and, finally, locomotion (the moving about of our whole body) results in different objects moving at different rates in our field of vision. When riding a train, trees close to you will move by quickly while the distant horizon appears almost stationary. The rate at which these shapes move around our retina tell us how far from each other they are. How reflections of light change when we move tells us of which materials these objects could be made.

· Perception of differences in the environment as a result of our actions (this perpetual feedback loop) allows us to make sense of how we are situated in the world.

· *Eyes, everywhere.*[39]

· In Western medicine, a patient with eyesight problems will have their eyes (and, possibly, their brain) examined. In Chinese medicine, the liver or the

spine can also be contributing factors to declining eyesight. Progressive physio or movement therapists know that an individual might start seeing better as a result of improved balance (full body activity), improved proprioception, or changes in the orientation of their bones.

· Moravec's paradox is the discovery by artificial intelligence and robotics researchers that, contrary to traditional assumptions, high-level reasoning requires very little computation, but low-level sensorimotor skills require enormous computational resources. The principle was articulated by Hans Moravec and others in the 1980s:

"It is comparatively easy to make computers exhibit adult level performance on (logical) intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility."[40]

· Do you remember? Kasparov/Deep Blue/Mensa? Last century? For a hot minute IQ was paraded as synonymous with "intelligence".

· More things I want to yell from rooftops: Sensorimotor competence and psychosocial competence are tied together like two ends of a... scratch that, not two ends. *Maybe it's just this one thing.* An integrated nervous system. Different facets of the personality

maturing coherently (vs. arrested development in patches).

· Moshe Feldenkrais was an engineer and physicist turned martial artist turned movement therapist. Feldenkrais' gentle methods may have fallen out of fashion in recent decades but some of the underlying discoveries that prompted their development remain both provocative and sound.

· Self-image, in Feldenkrais' terms, refers to a sort of "functional neurological map".[41] A pianist may, through training, magnify and elaborate on the self-image/neurological map of their hands. Conversely, a patient with a degenerative disease (or just a rigid mind brought on by age or adverse life experiences) may lose map resolution, to the point where differentiation between the use of different fingers is no longer possible: the potential for articulation is (still) muscularly present, but neurologically not realized.

· The tools Feldenkrais developed strive to increase resolution through proprioceptive[42] measures and, yes, conscious cognitive effort. In a typical exercise the patient/student imagines points of their body in orbit while slowly moving though a wide but easy range of motion. The idea is that when our minds become more acutely aware of where our body parts are situated, we become less afraid (we need to hold ourselves less tightly) and we can move more

effortlessly and with more precision. Remarkably, this is also how compression garments help athletes move better and why weight blankets can help calm sleepless and anxious children.

What is learned are movements, not behaviors.[43]

Edwin Gutherie
Psychologist

· I knew a body builder with two MAs who liked to quote Socrates at any chance he got: *It is a shame for a man to grow old without seeing the beauty and strength of which his body is capable.*

· In Western medicine, that bacteria is detrimental to human health wasn't known until mid-19th century[44] (the anecdotes of unsanitary field surgeons I'll save for later). We understood the structure of DNA in 1953. The word 'stress' didn't become widely accepted as adverse until the 1980s or 1990s. What if, among the natural sciences, medicine is the late bloomer, the problem child? What if it's riddled with misconceptions or horses put before their carriage?

· While physics, engineering, and computer science have all embraced the transition from Newtonian physics to the theory of relativity and, further, into quantum physics, medicine has not. Medicine is still operating in the domain of biomechanics (or, if we're lucky, bio-hydraulics). Medicine is the apple that hits us on the head, the macro-level, the brick building where every brick rests on the one before it, "the femur rests on the tibia via the knee joint" etc.

· On the micro-level, the femur never touches the tibia. It doesn't "rest" on anything: they are suspended in space.[45]

· What if, with more/different structures to our understanding, the debilitating effects of age/trauma/illness could be relieved? Reversed?

· An early frustration in my pursuit of *why?* was the vague notion that what could be missing from a body lacking is: integration.

· *But what on earth do you mean by "integration"*?! For years, I kept coming back to this term, feeling as though I understood it (in ordinary language), but absolutely not (in the context of medicine).

· *To integrate: 1: to form, coordinate, or blend into a functioning or unified whole: unite. 2: to find the integral of (something—such as a function or equation) 3a: to unite with something else. b: to incorporate into a larger unit. 4: to end the segregation of and bring into equal membership in society or an organization.*[46]

· In 2009, American psychologists discovered that the ability to recognize emotions (in others) becomes impaired in people who receive Botox injections.[47] A further elaboration on this subject suggests a feedback loop between thinking about emotion and a sort of involuntary, micro-level simulation in one's own facial musculature.[48]

· Call it "mirror neurons", call it "embodiment", what have you.

· Similarly, the speed of reading is confined by the speed of speaking as most of us need to mentally articulate every word, to hear it in our mind's ear in order to understand it.[49] If electrodes are placed on the outer portions of a reader's voice box, they register involuntary low-level vocal contractions of this "silent reading".

· That is, when a friend tells me a gloomy story, I frown, partially because I want to communicate my sympathy and, partially, because I *actually feel sadness* for them.[50]

· And if I am physically restrained from frowning, what I feel will be less clear to me.

· In addition to facial expressions, body gestures are a universally human behavior. What gestures *mean* varies across cultures as do words; but their presence doesn't—it's ubiquitous. Humans gesture even when there are no witnesses, such as on the phone or when solving tasks in solitude. Evidence suggests that gesturing with the hands, for example, unloads certain cognitive burdens from the brain, akin to using pen and paper when solving an equation. Consequently, people who are prevented from gesturing take a longer time to respond to spatial questions.[51]

· In the dance method called "gaga", developed by Israeli choreographer Ohad Naharin (who at least

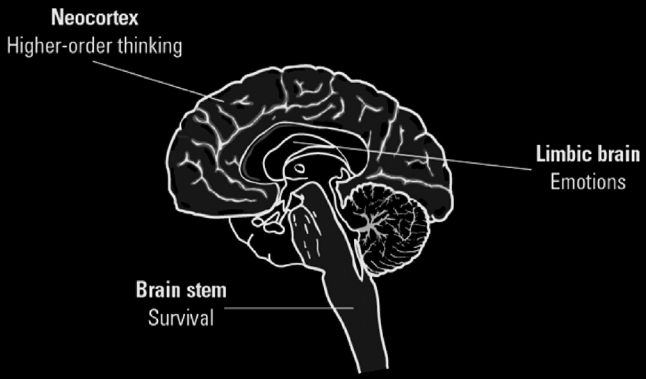
partially drew his insights from Moshe Feldenkrais) longevity and direct acquisition of physical knowledge are front and center. Dancers are not cued to do something with an explanation of how it looks, but, rather, what it feels like. *Before we tell our body what to do, we listen*.[52] By feeding ourselves increasingly multilayered tasks, we learn more about the world. This is one way in which texture can be instantly downloaded, lived.

· But when something disadvantageous has been downloaded, how do we unlearn?

· Earlier that same year, when the (broom) group was considering the "re-education" facet of "education", a guest was invited to share his experience and work. The individual in question was a psychotherapist employed by the Dutch state to work with incarcerated, highly volatile individuals. The incentive for the state to provide therapeutic treatment for the inmates is so that they don't relapse into crime once free. The most disturbing part of our 3-hour talk was his final shrug: *What I do doesn't work.*

· In the years following, as I started looking into the potential of physical/embodied interventions to restructure and unite the nervous system, I made a startling discovery: *to unlearn, you have to get to an older part of the brain than the neo-cortex.*

· Moravec again: *Encoded in the large, highly evolved*


Neocortex
Higher-order thinking
Limbic brain
Emotions
Brain stem
Survival

sensory and motor portions of the human brain is a billion years of experience about the nature of the world and how to survive in it. The deliberate process we call reasoning is, I believe, the thinnest veneer of human thought, effective only because it is supported by this much older and much powerful, though usually unconscious, sensorimotor knowledge. We are all prodigious Olympians in perceptual and motor areas, so good that we make the difficult look easy. Abstract thought, though, is a new trick, perhaps less than 100 thousand years old. We have not yet mastered it. It is not all that intrinsically difficult; it just seems so when we do it.

· In layers, the most central part of our brains is the oldest and the outer the more recent. The fundamental parts can function without the late ones, but not vice versa. A finger obeys conscious control, but not the stomach. The treacherous side of, for instance, the limbic system (our "emotional brain"), is that its invisible force affects the neocortex, our "conscious brain", without our conscious knowing. On the other hand, the neo-cortex cannot readily suppress or modify the workings of the limbic system. There is no way to command oneself to be more happy. Or less scared.

Rub your hands together. Hold them to your face.[54]

Taoist face wash

· Since the 1960s, bioengineer Gerald H. Pollack has been working in the fields of muscle contraction and motility. His seminal work from 2001 offers an update to standard cell biology[55] where the cell is no longer slavishly populated by "organelles, pumps, and channels", tiny work stations that bring chemicals either into or out of the cell. This standard model relies on convoluted explanations of how these stations work, how much energy they require to keep their actions up, and why their activity seems to stop or change at different rates.

· Pollack presents a (chemically speaking) radically more simple and elegant explanation of the cell's functions. Rather than consisting of a membrane filled with water, something akin to a water balloon (=standard model), Pollack's cell model is a gel. Its contents do not freeze, for instance, in plants that stand out in the winter. Its contents don't leak out, except marginally, when the cell membrane is perforated or cut. Compare the water balloon to a grape or cucumber. The water molecules of the latter, although abundant, are "bound" in a sort of gel-like lattice.

· It is this lattice, this gel-phase ("phase" like solid/liquid/gas) that gives the cell its properties. The gel attracts and repels different chemicals, expands, contracts, and moves about because of its structure not because of "pumps or tiny engines". Water expands when freezing into ice not due to some

specially decided effort from a celestial committee ... but because "that's what water does".

· Even a thick glass bottle full of water will shatter in the freezer, not due to sentient muscle power, but because phasetransition performs work.[56]

· Similarly, gel-phase water performs gel-phase actions.[57]

· Imagine a slinky, the classic children's toy that can walk down a set of stairs better than practically any balance calculating, joint calibrating robot. Despite lacking any kind of central processing unit, the slinky performs this task with agility and grace simply because of the *properties and structure* of the material out of which it is made.

· An extension of Pollack's reasoning leads to the living cell not having any special, magical properties due to it being living. The cell behaves like it does because it's made out of cell-stuff (similar to how water owes its properties to its material). No extra "life-stuff" need be added.

· What are the consequences of thinking about life this way? About consciousness? About the possible feelings and inner lives of animals? About "the fallacy of anthropomorphizing" them? About animism of matter?

· *Cellular processes are not necessarily anything special—cells operate by the very same physical and chemical principles that govern ordinary non-biological systems, and not by special inventions of the celestial committee. The notion of continuity across the living/nonliving boundary seems logical because the boundary is fuzzy. Is the seed living? What about the virus?* [58] *[…] Although the cell may seem special to us, its mechanisms may be fully humdrum and completely orthodox.*[59]

· The constraints of microscopes are such that we have seen only rough outlines of cells, not their inner workings. This is analogous to seeing the silhouettes of people but not the details. When biologists speak of the inner configurations of cells and the presence/absence of "pumps" or "channels" their conclusions have been drawn from chemical experiments, not direct observation. Our theories are merely: theories.

I have come to understand how magic, suffering and history are stored in (and on) the body, and passed through generations.[60]

Grace Wales Bonner
Fashion Designer

· Who rides the horse? Is there a horse? Maybe it's the rider who's redundant. Maybe there is just the horse.

· *I talk*
I smile
I bite
I bite your lip
I breathe your breath
I smell you on my skin[61]

· In psychology, misattribution of arousal is the process by which the physical manifestations of one physiological reaction get mistakenly labeled as another (i.e. because sexual arousal and fear both result in increased blood pressure and shortness of breath, individuals who have been subjected to a frightening situation (e.g. walking over a high and unstable bridge) will self-report feeling attracted to the scientist interviewing them at a higher rate than those that did the same test in a stable setting).[62]

· If you live a high octane life, frequent infatuations aren't necessarily "just part of your personality".

· What has concerned me lately is top-down vs. bottom-up regulation (in dynamic systems of all kinds).

· Coordination equals function of an integrated nervous system and of an individual integrated

with themselves. When my elbow knocks over a bottle which I didn't see and my hand instantaneously dashes forward to catch it before it has left the kitchen counter... that is not a voluntary action. It's not a skill, not something I can improve by effort or cognition.

· *Being frightened means that you live in a body that is always on guard. Angry people live in angry bodies. The bodies of child-abuse victims are tense and defensive until they find a way to relax and feel safe. In order to change, people need to become aware of their sensations and the way that their bodies interact with the world around them.*[63]

· When, instead of breaking a fall after tripping, the individual yells helplessly and falls to the ground, this is a disintegrated nervous system. Chances are high that the same individual will often feel overwhelmed by life or have troubles coping socially/emotionally. Why? Because people use the same nervous system to deal with both falls and existential frustrations.

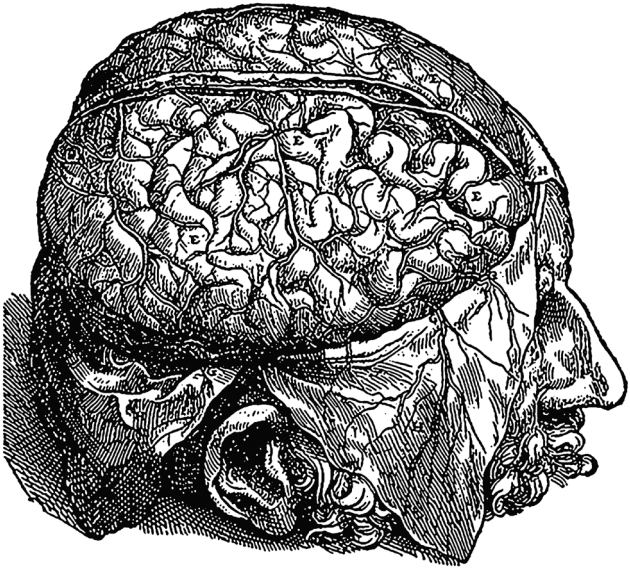
· Bessel van der Kolk is a Dutch psychologist based in the United States. During the last three decades, his work has centered on trauma recovery and his findings have had a large impact on the international community of counsellors. Among other things, van der Kolk criticizes the limitations of cognitive behavioral therapy (CBT), currently

the most popular form of psychotherapy in the West. A type of clinical heir to Freud's "talking cure", the CBT-approach assumes that a vast array of human distress can be re-programmed using speech. To quote van der Kolk:

Yet another pitfall of language is the illusion that our thinking can easily be corrected if it doesn't "make sense". The 'cognitive' part of CBT focuses on changing such "dysfunctional thinking". This is a top-down approach to change in which the therapist challenges or 'reframes' negative cognitions, as in "Let's compare your feelings that you are to blame for you rape with the actual facts of the matter" or "Let's compare your terror of driving with the statistics of road safety today." […] There is no question traumatized people have irrational thoughts, but it's best to treat these thoughts as cognitive flashbacks —you don't argue with them any more than you would with someone who keeps having visual flashbacks of a terrible accident.[64]

· Frustrated with the intractability of trauma and with the insufficiency of words to help traumatized patients (as well as the inability of chemicals to cure them, aside from making them slightly more manageable, to other people, for the duration of the treatment at least), van der Kolk started looking into what role that the body plays in recovery.

· In addition to many other ailments, traumatized children have fifty times the rate of asthma as their



De Humani Corporis Fabrica
Andries van Wesel/
Andreas Vesalius, 1543

non-traumatized peers.[65] Previously, in the history of Western medicine, the manifestation of psycho-emotional strain as a physical illness was called (among other things) "somatization". A textbook example of somatization is the unhappy and lonely elderly woman that keeps getting hospitalized for various pains for which "no physical source can be found". Another way to describe somatization is to call the patient's symptoms "psychosomatic". Yet another way to phrase it: "it's all in your head".

· One of the many alarming gaps in medicine is our inability to explain memory. Through magnetic resonance imagining increased or decreased blood flow to different parts of the brain is observable. But these activities seem to function like control centers, summoning or dampening cognitive capacities. Where the actual information of those memories is stored is something we don't truly understand.

· Memory could be housed in an array of, at first, seemingly ludicrous options (aside from brain): the peripheral nervous system? The tissues encapsulating nerves? Microtubules of the cytoskeleton? Or maybe even our DNA?

· Can memories reside in limbs? Can you inherit memories from your parents? It seems you can[66] and maybe a wider understanding of intergenerational trauma would change how we organize our lives.

· The offspring of mice who were electrocuted at the presence of a cherry blossom smell exhibit anxiety and avoidance of the scent from birth. Cherry blossom is frightening to this second generation lab mice, despite them never having encountered neither smell nor shock before.[67]

· How do we explain the presence of PTSD in young children born to holocaust survivors?[68]

· One of the ways the memory of helplessness is stored is as muscle tension or feelings of disintegration in the affected body areas, van der Kolk says[69] (but so does every somatic therapist, every holistic massage therapist, and every practitioner of integrative medicine).

· So what could help those stuck in their angry bodies, their sad bodies, or the bodies that came from stress and continue to reproduce it? We can look at a series of tools, Feldenkrais' or equivalent: Techniques and embodied exercises that increase proprioception automatically decrease muscle tone since lack of proprioception equals hypertension. Hypertension is to the ANS (Autonomous Nervous System) equal with the system holding tightly onto something/anything/oneself. Out of fear. Out of perception of danger. And *DANGER!* equals lack of control.

· *The primitive agonies: the fear of falling, falling to*

pieces, falling forever.[70]

· What if those earlier mentioned incarcerated individuals could, in fact, un-learn and re-learn to exist differently? Not though exhortations in language, but through becoming neurologically safe?

· What generations of massage and movement therapists have been able to observe (despite their observations not being integrated into the body of knowledge of medicine) is that if you change a patient's physical structure and the body's ability to carry itself through the world, their personality will change.[71]

NOTES

1 Autopoiesis (from Greek αὐτο- (auto-), meaning 'self', ποίησις (poiesis) meaning 'creation, production') refers to a system capable of reproducing and maintaining itself. The term was introduced in 1972 by Chilean biologists Humberto Maturana and Francisco Varela to define the self-maintaining chemistry of living cells. Since then the concept has been also applied to the fields of cognition, systems theory and sociology.

2 Rachael Osborne, giving Gaga class on July 17, 2019

3 Arrowed, Choreography and text by Bobbi Smith

4 Image source: https://imgur.com/YNLnDZv retrieved on September 7, 2019

5 Image source: Thomas W. Myers, *Anatomy Trains*, second edition, 2014

6 *A conversation with Ohad*, Dance Magazine, 2007

7 https://en.wikipedia.org/wiki/Mirror_neuron, retrieved on August 15, 2019

8 p. 45, Ludwig Wittgenstein, *Tractatus-Logico-Philosophicus*, 1921

9 The fear of AI

10 Silvia Federici describes the European transition from herbal healing as a primarily female endeavor, to a masculinization of the medical profession, post witch-hunts, p. 20,

90 & 132, *Caliban and the Witch*, 1998

11 Image source: Harriet Beinfield, Efrem Korngold, *Between Heaven and Earth: A Guide to Chinese Medicine*, 1991

12 In the short-hand medical textbook mitochondria are described as 'organelles'—the tiny energy producing 'organs' of the cell. When more time for discussion is available we will however admit that mitochondria inhabit mammalian cells but are separate creatures. They have their own distinct DNA. Our eukaryotic cells developed in symbiosis with them, after they were swallowed some millions of years ago. The symbiosis consists of us feeding sugars to the mitochondria, who in turn produce energy. Having hundreds or thousands of mitochondria in each cell allowed mammals to develop very complex and energy-consuming bodies, but the point stands, almost every one of your cells are populated with creatures who are not you.

13 *Spike Art Quarterly*, #59, 2019

14 PubMed is a search engine indexing 30 million citations of peer reviewed articles on life sciences and biomedical topics

15 p. 2, Lawrence A. Shapiro, *Embodied Cognition*, 2011

16 To read a map that doesn't turn when you do? To find the cardinal directions using the sun or the stars?

17 Every digital native in school, ever

18 p. 221, Lawrence A. Shapiro, *Embodied Cognition*, 2011

19 p. 9, ibid

20 p. 56, ibid

21 Illustration produced by the author

22 p. 17, Erin Manning, *Always More Than One*, 2012

23 Interoception in psychology is the ability to sense the inner states of the body, such as hunger, thirst, fatigue, etc. Impaired interoception can cause difficulties with self-regulation as well as inappropriate coping mechanisms (i.e. eating when one isn't hungry)

24 p. 212, Lawrence A. Shapiro, *Embodied Cognition*, 2011

25 Image source: R. Held & A. Hein, *Movement-produced stimulation in the development of visually guided behavior*, Journal of Comparative and Physiological Psychology #56, 1963

26 Paul U. Unschuld, Hermann Tessenow, *Huang Di nei jing su wen—an annotated translation of the Yellow Emperor's Inner Classic*, 2003

27 This isn't an argument against technology, but an inquiry into which embodied faculties we lose once we stop practicing them?

28 p. 29, Lawrence A. Shapiro, *Embodied Cognition*, 2011

29 Eukaryotic and prokaryotic cells are the two cell types that make up all living organisms on earth. The former are multicellular and

have nuclei (such as plants and animals), whereas the latter are unicellular and lack nuclei (such as bacteria).

30 Image source: https://en.wikipedia.org/wiki/Homology_(biology), retrieved on March 31, 2019

31 p. 69, Marshall McLuhan, *The Medium is the Massage*, 1967

32 Thomas W. Myers, *Anatomy Trains*, second edition, 2014

33 Jorge Luis Borges, *Celestian Emporium of Benevolent Knowledge/The Analytical Language of John Wilkins*, 1942

34 Carl Linnaeus/Carl von Linne, S*ystema Naturae*, tenth edition, 1758

35 p. 15, Thomas W. Myers, *Anatomy Trains*, second edition, 2014

36 During the writing process my thesis supervisor mentioned a surreal memory, of having screws extracted from a bone following an accident. Under local anesthesia, the surgeon producing a screwdriver, his muscles straining behind the screen

37 p. 176, Lawrence A. Shapiro, *Embodied Cognition*, 2011

38 Image source: https://tt.tennis-warehouse.com, retrieved on August 23, 2019

39 Ria Higler, explaining where one must have eyes, while giving dance class on September 23, 2019

40 https://en.wikipedia.org/wiki/

Moravec%27s_paradox, retrieved on August 23, 2019

41 p. 93, Moshe Feldenkrais, *Embodied Wisdom: the Collected Papers of Moshe Feldenkrais*, 2010

42 Proprioception, also referred to as kinaesthesia, is the sense of relative positions of body segments in relation to other body segments.

43 Edwin Guthrie, *The Psychology of Human Learning*, 1935

44 https://en.wikipedia.org/wiki/Germ_theory_of_disease retrieved on September 17, 2019

45 An elaboration is beyond the scope of this text, but Buckminister Fuller has written plenty on structures that have more in common with organic ones than those of the industrial revolution

46 Merriam-Webster Dictionary

47 Havas et al., *Cosmetic use of botulinum toxin-A affects processing of emotional language*, 2009

48 p. 135, Lawrence A. Shapiro, *Embodied Cognition*, 2011

49 p. 94, Moshe Feldenkrais, *Embodied Wisdom: the Collected Papers of Moshe Feldenkrais*, 2010

50 The standard model of the autonomous nervous system divides it into two branches, sympathetic and parasympathetic, popularly known as fight & flight and rest & digest respectively. Neither of these are controlled by will. The polyvagal theory divides the ANS into three branches, Ventral (for social engagement), Dorsal (passive defense), and

Sympathetic (active defense). Consecutively, this puts (genuine) facial expressions into a category similar to heart rate or digestion, that is: out of conscious control. Stephen W. Porges, *The Polyvagal Theory*, 2011

51 p. 213, Lawrence A. Shapiro, *Embodied Cognition*, 2011

52 Gaga methodology, as described by Ohad Naharin in multiple interviews

53 Image source: Laura Erlauer, *The Brain-compatible Classroom: Using what We Know about Learning to Improve Teaching*, 2003

54 Pauline Oliveros, *Deep Listening: A Composer's Sound Practice*, 2005

55 Gerald H. Pollack, *Cells, Gels and the Engines of Life*, 2001

56 In physics, work is the product of force and displacement. Work transfers energy from one place to another, or one form to another.

57 p. 113, Gerald H. Pollack, *Cells, Gels and the Engines of Life*, 2001

58 The virus, can be describes as a self-replicating chemical. It doesn't possess what we would normally call sentience. Yet it adapts to stay alive and multiply. What gives?

59 p. 129, Gerald H. Pollack, *Cells, Gels and the Engines of Life*, 2001

60 *Frieze* no. 204

61 Jenny Holzer, 1996

62 D.G. Dutton, A.P. Aron, *Some evidence for heightened sexual attraction under conditions of*

high anxiety, Journal of Personality and Social Psychology, 1974

63 p. 100, Bessel van der Kolk, *The Body Keeps the Score*, 2014

64 p. 246, ibid

65 p. 98, ibid

66 Rachel Yehuda, Amy Lehmer, *Intergenerational transmission of trauma effects: putative role of epigenetic mechanisms*, 2018

67 Brian G. Dias, Kerry J. Ressler, *Parental olfactory experience influences behavior and neural structure in subsequent generations*, Nature Neuroscience, 2014

68 Rachel Yehuda, Amy Lehmer, *Intergenerational transmission of trauma effects: putative role of epigenetic mechanisms*, 2018

69 p. 265, Bessel van der Kolk, *The body keeps the score*, 2014

70 Donald Winnicott, *Fear of Breakdown*, International Review of Psycho-Analysis, 1974

71 p. 83, Ida Rolf, *Rolfing and Physical Reality*, 1990

72 Image source: Andreas Vesalius, *De Humani Corporis Fabrica*, 1543

73 Image source: Getty Images, depicting Camilo Villegas

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Thesis Mentor
Isabel Cordeiro

Proofreading
Laura Vocat

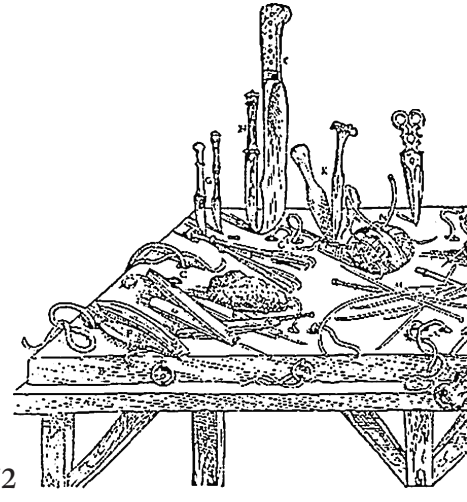
Graphic Design
Cleo Tsw

Printing made possible by
Miguel Hervas Gomez
Rietveld Bookbinding
Workshop

Special thanks to
Angelo Custodio
Moa Holgersson

BA thesis by
Nell Schwan

VAV 2020
Gerrit Rietveld Academie



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