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Robot And Human Dancing

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If a robot does "the robot," would it still be called "the robot," or just… dancing?
- Unknown

How And Why Not?

In sciences how-and-why explanations are routine. In biological sciences, these are usually articulated as "proximate" and "ultimate" causation of living processes. Take the hand for example. The proximate is: we have two hands and ten fingers, with which we do this and that. The ultimate explanation is why we have two hands and ten fingers to start with, and why we are prone with them to do this and that, and not something else.

Put it another way, the proximate explanation recognizes that anatomy and emotions are hardwired to engage in certain activities, such as speech and dancing in humans. The ultimate explanation answers the question 'why this particular hardwiring and not some other?'

Viewed this way, human beings are made for music – little children almost immediately pick up the thrill and rapture of music. Music served early humanity as a means of integrating societies and heightening the emotions of the people. Rapture – a joy excessive and sweet, as Spain's great mystic Saint Teresa of Ávila (1515-1582) described it in her 1563-65 diary – can be achieved variously by music, religion, and hallucinogenic drugs (such as psilocybin mushrooms, LSD, and DMT found in the Amazonian religion-enhancer ayahuasca). Neurobiologists have tracked at least some of the peak experience of music to at least one cause: the release of the neurotransmitter molecule dopamine within the striatum of the brain. This, incidentally, is the same biochemical reward system that mediates pleasure in food and sex.

From archaeological evidence of bird bone and ivory flutes dating back more than 30,000 years ago, we infer that music began in Paleolithic times (Stone Age). And because it remains universal in hunter-gatherer societies around the world, it is reasonable to conclude that our loving devotion to it has been hardwired by evolution in the human brain.

Cogito Ergo Sum

Let us backtrack a little and consider consciousness – the state of being awake and aware of one's surrounding. Let us go to the simplest living systems and see how their needs are met. There is no need for consciousness yet in these primitive life forms, but there is already some kind of subjectivity in that the creatures make a distinction between themselves and the rest of the world. We can get a long way from these primitive life forms without having to invoke consciousness. In fact, we can go all the way to plants, and to the most advanced digital age human invention – the robot.

More complex creatures move about and in so doing, interact with one another, creating more complicated problems for themselves and to one another. Mother Nature, through the process of evolution by natural selection, began to come up with more complicated solutions to give her offspring a leg up in the fight for survival. It is living creatures' need to

anticipate threats that leads to the development of the capacity to sample the environment in what we call "sensing," the ability to try out different solutions in what we call "planning," and ultimately the extra capability to do something creative in what we call "intelligence." Consciousness exists primarily to predict the future, helping the bodies attached to them to avoid destruction, and in the case of humans, to think and sometimes do something creative.

Mind Your Consciousness

The "mind" is the element of us, as *H. sapiens*, that enables us to be aware of the world and our experiences, to think, and to feel, that is, the faculty of consciousness and thought. Consciousness refers to awake state, while the mind is a broader term that generally refers to consciousness plus memory and cognition (such autobiographical memory, personal identity, and ability to control one's thought).

A good part of our minds are actually located not just outside our brains, but totally outside our bodies. One of the great evolutionary triumphs that brought our minds to the level of sophistication we humans now enjoy was the ability to absorb more and more information from our environments. According to Daniel Dennett, a philosopher of mind, an even greater evolutionary leap came when we began to off-load information to our environments. He argues that, first through tools, which contain their instruction manuals within them by the nature of their design, and then through language, we have learned to manipulate the outside world in such a way that it serves as an extension of our minds.[1]

Many of these tools we now take for granted. For example, the good old-fashion index card, which is falling out of fashion now because of use of iPads in its stead. The card (or for that matter, an iPad), the symbols and the notes are all, in a sense, a part of my mind. They are also now part of yours (if you have access to the iPad). In addition to allowing each of us access to information too vast to store in our own brain, human's capacity to store information outside our bodies (in books, music scores, photographs, MP3s, and now onto iPads, robots, Youtube, clouds…) allows us to share that information with others, in effect blending our consciousness and allowing for parallel processing, that is, the information has multiplied.[2]

We *Homo Gaudia*

As a species, we have never been entirely satisfied with what nature gave us. We are the apes that shape our environment – *Homo gaudia*.

The advances in science and technology have brought us to the greatest watersheds in several fronts. In fact, in one of the fronts, advances have brought us to the moral dilemma: how much to retrofit the human genotype? The choice will be forced on us because our species has begun to cross the Rubicon in the techno-scientific era. So far, natural selection has brought us to where we are now, but we are about to abandon it in order to direct our own evolution by volitional selection – the process of redesigning our biology and human nature as we wish them to be. No longer will the prevalence of some genes over others be the result of environmental forces, most of which are beyond human control or even understanding, but by design so that we will have designer this and designer that. In designer babies, the genes and their prescribed traits can be what we choose. A few attributes come to mind immediately: how about longer lives, enlarged memory, better vision, less aggressive behavior, superior athletic ability including dance ability?[3,4]

Figure 1. Screen dump of the GUI of the author's laptop. The proxy for the hand is the touchpad on the laptop (instead of a mouse).

In another front we humankind have just passed a huge milestone in technological breakthrough that will affect our own evolution – we are conversing with machines. This is a change much bigger than GUI (graphical user interface, see Figure 1). The promise of GUI and its desktop metaphor was that computers would work as humans do, with desktops and files, and a mouse that was a proxy for the hand. That is, we still have to get our hands dirty (on the keyboards). Now we are somewhere else entirely; we have machines (robots) with AI that can learn, and do what we do. Tomorrow's technology will succeed or fail depending on their ability to learn what we do and help us do it, and very importantly, do better than we can do it so that we do not have to do the chore ourselves![5]

The question now is how much to off-load information to our environment, especially onto a robot? And if the robots can self-learn and self-replicate, the consequence will be unprecedented.

Dreaming of Robots

As baffling as a problem as consciousness is, once we have accepted that we are conscious, why should we need to lie down to sleep and become unconscious for hours at a time every night? In fact, we spend about one third of our lives sleeping!

Our other daily needs are easier to explain: we have to take in fuel / food and water to replenish what we lose as we burn energy doing activities, we have to take shelter so our bodies will not get wrecked by the elements, we have sex to ensure survival of the species. One might question why we are designed to use the kinds of fuel we do, or why we are not impervious to the elements, or why are not individuals immortal (the ultimate part, see section on 'How and Why Not?'), but given the way our bodies are made and the way inheritance happens and that we do die, it is pretty clear why we need food, water, shelter, and sex, and why it is hardwired into our bodies to seek those things out.

But there is no obvious reason why we could not keep going, taking in fuel and sheltering from storms and procreating, without shutting down each night. If we were like cars in Formula One, depending on outside manipulations to repair the damage caused by a day of living, the immobility sleep forces on us would make sense.

But biologically speaking, we carry our pit crew around with us, repairing damage (healing) and re-growing hair, skin, and blood (regenerating) from within. There is no intuitive reason to think our immune system or our bodies' regeneration and repair mechanisms need us to hold still while they work. And yet it turns out that forgetting sleep messes with our ride-along maintenance team. Research has shown that people who get less sleep have compromised immune defenses, and some hormones are produced in greatest amounts when we are asleep.[6]

Until such days when robots could self-repair and self-replicate (and have consciousness), as of the current state of technology, robots are like cars. They need no sleep, except may be during maintenance. Robots are not necessarily made for music, because they still do not listen (react, rather) to music with rapture. At least for now.

Shall We Dance?

It is obvious from the foregoing that we, *H. sapiens*, are a biological product of million years of evolution, many of the biological attributes (sleep, for example) are still not well understood. Robots are a technological product of scientific breakthroughs.

According to the axiom known as Moravec's paradox, many of the (easy) activities that we take for granted, for example vision and motion, are actually very hard for robots. A child can tell the difference between a cat and a dog; to survive, we have to be able to tell danger looming when we see silhouettes of predators, and run for our lives. We can tell, for example, a tiger, under different shades of light ("sensing" in 'How and Why Not?' section). These are easy things for us, but are hard for robots.[7]

In contrast, it is comparatively easy for robots to exhibit adult level performance in intelligent tests. Not surprisingly, Deep Blue beat Kasparov (1997) in chess; and Watson bested Ken Jennings (the world's leading human player in *Jeopardy!*) in 2011, and Da Vinci a great resource in minimally invasive assisted-surgeries. And in May 2017, Alpha Go beat the best Go players in the world!

Thus anything that is very routine – rote-memorization, repetitive and precision work – is being replaced by machines and robots. If this is what dancing is all about, then a robot will outperform any human dancer in repetitions, in precision, in stamina, and in brawn power. Creativity is something that is not immediately replaceable, but there is no guarantee that AI will not reach this stage of development in the future (as we stated above, "tomorrow's technology will succeed or fail depending on their ability to learn what we do and help us do it, and do better than we can do it").

Figure 2. Alpha Robots dancing at a tech show in China. The robots dance with great precision and in synchrony.

We should not be a Luddite but be excited and be looking forward to the coming of robots as a new form of technological breakthroughs. The key is to use robots (just like other technologies) to improve and enhance life. There are of course those who are concerned that robots would overtake us, just like we *H. sapiens* "dominate" over other living organisms because our big brains and opposing thumbs allowed tool-making and the power grip needed to use our tools effectively.

The artificial intelligence (AI) will evolve to the point where robots will truly be our "friends", not in ways that dehumanize us, but in ways that rehumanize us to decrease the trends of the distance between people and connect us with people as well as with robots.

Viewed this way and from a proximate perspective, early generation robots do not have to have feet; they can be on wheels. They do not have to have fingers; they can have clamps. They do not have to have music hardwired; they can have audio sensors… In fact, early robots do not even have to look much like a human if they are designed to be task-specific.

Figure 3. Not all robots look like humans. Here Dash is a robot on wheels, and Dash delivers food, snacks, drinks, and amenities to designated areas. One of Dash's habitats is hotel.

And if we revert to human's tendency to think anthropomorphically, we would love our dancing robots to be humanoids with a high verisimilitude, and dance like *H. sapiens*. Future generations of robots will improve on their features and attributes, until they are human-like, and later surpass their creators. In fact, human-like robots (androids) are already here. At least two teams – Hanson Robotics (U.S.) and Hiroshi Ishiguro Laboratories (Japan) – are working to develop human-like robots. Hanson's Sophia – the team's most advanced android to date – has lifelike skin made from patented silicon and can emulate more than 60 facial expressions. "Gemini" is Latin name for "twins" and is the root for Geminoid – a robot created by Ishiguro in his own likeness. Geminoid has a plastic skull, metal skeleton, and silicon skin.[8]

Figure 4. The human musculoskeletal system. There are 206 bones that provide support and serve as levers for muscles. Some bones provide protection for internal organs, and some are responsible for producing red blood cells. There are long bones, short bones, and flat bones that play a role in movement.

Our musculoskeletal system includes the bones, cartilage, muscles, joints, tendons, and ligaments in a person's body. The robot's system is one of rods, rotors, and hinges. Thus many moves that are easily executed in humans may be a challenge for robots.

Figure 5. The simplest form of a robot dancing is the "stick" dancer in which only the four limbs are moving. A professional dancer can segment her body (and legs) into eight overlaying segments. Thus the next simplest form of a robot dancing is one that has segments in which the overlaying segments can move relative to each other. A most sophisticated robot dancer is a humanoid dancing.

Movement operation involves the use of leverage. A lever is a rigid bar that moves a fixed point when effort, or force, is applied t it. In the body, joints are the fixed point, the bones are the levers, and the effort is muscle contraction.[9] Understanding of human dance movements will help not only improve dancing, but also design of robots.

Figure 6. The authors demonstrating body dynamics, leverage ("pull"), compression ("push") and tricks in human dancing. Some of the moves are easy for robot to execute, but others can be extremely challenging. Balancing and making circular motions are examples that are easy for robots, but twisting while stretching of arms can be challenging. Also, humans can see in different shades, and can tell background noise or applause from music; robots will have a harder time discerning noise from music and may go wild under stroboscopic lights or chiaroscuro lightings!

Dehuman or Rehuman?

Like most technological advances, robots are a "dual-use" technology, that is, with both peaceful and harmful applications. Examples abound. For instance, nuclear fission can power cities; it can also destroy cities, or cause long-term ecological disasters in accidents like in Chernobyl (1986) and Fukushima (2011). Nanotechnology, bioengineering and genetic engineering all hold terrific promise in life-enhancing civilian applications, but all are primed for catastrophic accidents and exploitations in the military (and terrorist use).

This is an irreducible promise versus peril that goes back to the discovery of fire. Fire cooked food but was also used to burn down villages. Similarly, the wheel is used for good and bad and everything in between, including in robots. View it another way. Human beings do everything under the sun from humanitarian to fighting wars and we are going to enhance all of these activities with technologies. Technology is power.

Thus when it comes to dancing with robots, the key is to enhance dancing with this technology. And when it comes to competition, the first thing that comes to mind is "competing against"; but we should really be thinking about "competing with". The idea is not to win by competing against robots, but to compete with robots. Instead of "Dancing with the Stars", we will have "Dancing with the Robots"![10]

Figure 7. A dancer dancing with a robot. The robot functions as a partner, or as a prop (instead of ribbons or hoops, umbrellas, chairs, or mirrors).

The main focuses of "Dancing with Robots" are as follows:

a. To differentiate a human from a robot. A human is a "biological" product and a robot is a "technological" product. Many of the things that humans can do very naturally can be a challenge for robots. For example, a robot may have a hard time discerning music from background noise, applause included.

b. To thus have the dancer(s) and robot(s) augment each other's weaknesses, or amplify each other's strengths. This way, each (in a team) will benefit from the other's peculiar powers: The robot will bring accuracies and precisions in repetitions – if uncreative – moves, while the human would bring intuition and insight

c. To use robots, CREATIVELY. For example, in performances, dancers have used stroboscopic lights for effects, or a fan or a veil, or a ball. Here a dancer may hold a robot in the hand to create a certain effect, such as audio-synchronous blinking robots. Balls, veils, or balls do not move by themselves; robots can do many great stunts! This will add a new dimension to dancing.

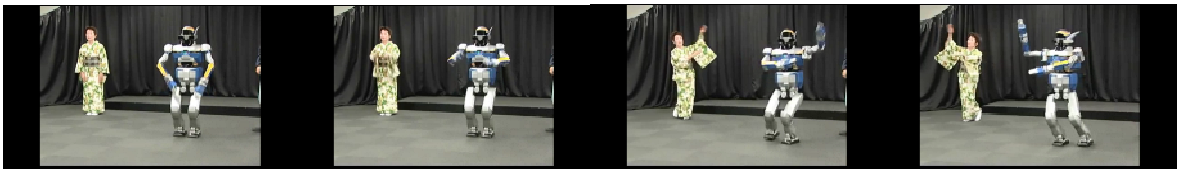

Figure 8. A few snapshots from a video (Humanoid Robot Dancing) of a robot dancing with its human counterpart.[11]

At the end of the day, the whole thing will also help propel robot technologies forward. This is a cross- and trans-disciplinary of humanity (the nuances of body movement, expressiveness and creativity in the arts [and science] of dancing) and robotity (science and technology) articulated through an evolutionary product (*H. sapiens*), versus through a technological product (robots) that is much less versed in these nuances but great in repetitions, accuracies and precisions!

We would have come a full cycle in two ways: we are at a watershed juncture where we are playing with our genotype for volitional evolution, and we are creating a robot that can do things better than we can do the things ourselves. The left hemisphere (science) and the right hemisphere (humanity) of the brain are now merged. The human will do humanitarian work, and the robot will rehumanize humans with robotitarian work.[12]

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