



ETHICS OF PERCEPTION AND NANOCOGNITION (NANOROBOT-AIDED COGNITION)

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Melanie Swan illustrates the ethics of perception, nanocognition and nanorobot-aided cognition toward a more internally aware, connected, expressive, expansive and freer life as beings in the technological era, developing an ethics of immanence.

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One of the most interesting geographics in nanospaces is the mind.

The ethics of perception in nanorobotics¹ contemplates the idea of having onboard nanorobots in our brains to aid the cognitive activities like perception, and explores what kinds of ethics modules or moral principals might be appropriate for how we want cognitive nanorobots to guide our perception. Philosophy, social science and nanotechnology have not previously considered these topics because we have not yet considered the idea of nanorobots or that of the ethics of perception. This is partly because having only one unalterable means of perception meant that we failed to question the ethics of our existing perception. To some degree we have failed to notice that there is an inherent ethics in everything: people, societies and technologies. These existing ethics models have principles and effects that have not always

¹ Nanorobot/Nanobot - a hypothetical very small (nanoscale) self-propelled machine, especially one that has some degree of autonomy and can reproduce. Retrieved from <http://www.oxforddictionaries.com/definition/english/nanobot>.

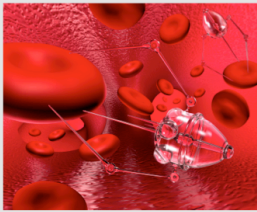
been deliberately thought out and examined and we will investigate this now in the context of nanorobot-aided cognition.

My background is in quantitative risk modeling and genomics, and more recently in art and philosophy. I will discuss what nanocognitive robots are, the geoethics of cognitive nanorobots, specific issues of cognition including perception and memory, models of ethics, killer apps of cognitive robots, and an ethics of cognitive nanorobots.

What are cognitive nanorobots? Cognitive nanorobots are an extension of the idea of medical nanorobots. Medical nanorobots are a familiar concept, one elucidated at the United Therapeutics Nanomedicine Conferences². Medical nanorobots span the continuum from nanoparticles in current pharmaceutical use that disgorge cargo in cellular destinations per simple on-board logic instructions, to the more elaborate conceptualization of many species of future medical nanorobots such as respirocytes (hypothetical, microscopic, artificial red blood cells), clotocytes (clotting cells), vasculoids (nanomedical devices to replace human blood) and microbovres (artificial mechanical phagocytes) that could perform a variety of biophysical cleanup, maintenance and augmentation functions in the body. In the most basic sense cognitive nanorobots are the analog to medical nanorobots: nanorobots deployed in the specific context of facilitating, aiding and improving the processes of cognition, like perception and memory; a sort of neuro-prosthetics on a nanotechnological scale. In some sense cognition is just another biological function, a process to manage and ameliorate. Robert Freitas³, in his nanomedicine textbook, has already begun to explore the issue of nanorobot biocompatibility with neural cells and outlined the different levels of concern and response for them: mechanical, biophysiological, immunological, cytological, and biochemical. The key point is that cognitive nanorobots are analogous to medical nanorobots.

What are Cognitive Nanorobots?

- Analog to Medical Nanorobots
- Cognition is just another...
 - Biological function
 - ‘Pathology’ to ameliorate
- Biocompatibility of medical nanorobots with neural cells¹
 - Mechanical
 - Physiological
 - Immunological
 - Cytological
 - Biochemical



¹Freitas, R.Jr. Nanomedicine, Volume IIA: Biocompatibility. 15.3.6.5 Biocompatibility with Neural Cells. <http://www.nanomedicine.com/NMIIA/15.3.6.5.htm>


² United Therapeutics Conference. <http://www.unithertechnologyconference.com/conferenceagenda.php>.

³ Freitas, R., Jr. (2003). *Nanomedicine, Vol. IIA: Biocompatibility*. Texas: Landes Bioscience.

There are different levels of geoethical concerns related to the risk and benefit of managing nanotechnology across geographic spaces that could arise with cognitive nanorobots. The first level of concerns includes those similar to any kind of nanotechnology, that there must be appropriate manufacturing and disposal processes, a means of monitoring compliance with widely agreed upon industry norms, security authentication and virus protection protocols, requisite functionality, and accessibility to the technology across the digital divide. There are other concerns since cognitive nanorobots are neural prosthetics where the geoethical environment of concern is the human mind. Not only is *in situ* safety a concern with neural prosthetics, but also the possibility of Level Two concerns that cognitive nanorobots transform and edit human cognitive processes for the worse and make edits to human value systems that could include re-valuing or de-valuing geoethical and environmental concerns. From this geoethical frame let's next consider perception.

Geoethics of Cognitive Nanorobots

- Level I Geoethical Concerns
 - Manufacturing and disposal
 - Neural prosthesis
 - Functionality
 - Accessibility (digital divide)
 - Security and mind viruses
 - Authentication
- Level II Geoethical Concerns
 - Transformation, editing of human cognitive processes
 - Edits could include environmental axiology (re-valorization)



To see how we might begin to develop an ethics of perception and nanocognition, we need to understand more specifically how cognition works. One place to turn is the work of Henri Bergson⁴, a French philosopher living 1859 to 1941 and writing in the early 1900s. Although we might easily dismiss Bergson in our shiny, modern era of real-time fMRIs⁵, neocortical column simulation, and spike-timing calculations, Bergson's theories of perception and memory still stand as some of the most comprehensive and potentially accurate accounts of the phenomena. Bergson was a polymath, known for anticipating quantum mechanics thirty years ahead of its discovery, partially by noticing that time is asymmetric. He was trained as a

⁴ Bergson, H. (Translation 2010). *Matter and Memory*. New York: Digireads.com Publishing. ISBN: 1-4209-3780-4.

⁵ fMRI - Functional magnetic resonance imaging. <http://psychcentral.com/lib/what-is-functional-magnetic-resonance-imaging-fmri/0001056>.

mathematician and brought an extensive ongoing knowledge of then contemporary physics and psychology regarding both normal brain activity like reading, and pathologies like aphasia and brain lesions to bear in generating his theories.

Bergson's theory of perception and memory involves the interaction of mind and body in independence from each other as integral parts of a dynamic process. Memory is not a weaker form of perception as Kant⁶, Locke⁷ and others saw it. One important concept Bergson uses throughout his work is that of doubling. This is the notion of two dimensions of phenomena occurring simultaneously, the quantitative and the qualitative. We have the objective, quantifiable, measurable experience of the external world together with our subjective, qualitative, immeasurable internal experience, doubling the curves of time, intensity, states, memory, self and consciousness.

Bergson focused on time, distinguishing the difference between objective, external clock-time and the inner experience of time, which he called duration. This is the subjective sense of waiting for a train or time passing more quickly when you are having fun. Time is important to consider because we overly spatialize the world. It is easy to see space; we divide and segment the world in terms of space. Further, we think of time in terms of space, in blocks of hours or days on a calendar, for example. However, it was critical to Bergson that we tune into the subjective experience of time to exercise our free will. We are more disposed to freedom and free will when we choose spontaneous action and this happens when we are oriented toward the qualitative aspects of the internal experience and see time as the dynamic overlap between states. After addressing free will and determinism, Bergson then takes up another philosophical challenge, mind-body dualism.

To investigate the inner workings of the mind and body Bergson proposes a detailed account of perception and memory proposing that they are interactive processes of the mind and body. Counter to Kant, he suggests that images of external objects are not a function of our own brain structure, rather they are outside the body and they exist externally as part of objects. The body does not create representations and store them in some part of the brain, rather the body selects images and materializes them when triggered by a stimulus. Perception and memory are a dynamical process of the body and mind as pictured here in the diagram of the memory cone. The memory cone extends from Point S, that of stimulus; perception, images and action are on the plane of existence to the other end, and the slice A/B is pure memory, the virtual. The energies of the mind move both up and down between the various tiers of the memory cone in a dynamical circuit, mixing idea and image, mind and matter.

⁶ Kant, I. (1781, Translated 2007) *Critique of Pure Reason*. England: Penguin Books Ltd.

⁷ Locke, J. British Philosopher. <http://plato.stanford.edu/entries/locke/#LocWor>.

Perception and Memory

- Topic: mind/body dualism
- Perception and memory are an interactive process of the body and mind
- Time and movement
- Privilege time as space, how/when (not where) memory is stored
- Exercise: memory retrieval

Pure memory is virtual; it cannot be physically localized. Memory does not exist until it is actualized through interaction with perception. To ask “where” memories are stored is to miss the point that memory is a dynamical, on-demand process. It is more relevant to ask “how” memory is stored, or re-created on-demand.

To understand this better let’s try an example. Try to retrieve a memory yourself, any memory. What happens? Our awareness is pulled back from this present moment, and we place ourselves in the past. We try to localize the particular moment like the trial and error action of focusing a camera. Notice that memory flow is a process, not a state. So by de-privileging space and the idea that memory is stored somewhere, Bergson comes to articulate that mind/body dualism is not an either/or but a larger frame of a dynamical process.

The next step in developing an ethics of perception is to review the thinking on ethics. There are three models in Western philosophy. Historically the notion of ethics has been applied negatively as opposed to affirmatively, meaning having a judging, circumscribing stance as opposed to an empowering stance towards behavior. The focus has been on evaluating behavior as opposed to empowering behavior through principles. What is nice is that ethics is one field related to cognition and social behavior where research and experimental results are improving our understanding of the underlying phenomena. There have been three historical paradigms: Act-based, Agent-based, and Situational ethics. The classic models are Act-based; Kant’s Categorical Imperative, where certain actions are always right or wrong, and Utilitarianism where utility is maximized. We then came into the Agent-based ethics of Virtue ethics and Dispositionism thinking that the traits of the individual might be predictive of behavior. But now we have a new paradigm for understanding ethics: Situationism. This is a more systemic view that situational context determines behavior.

Process Philosopher Ethics

- Bergson
 - Direct contact with the real, true duration
- Heidegger
 - A conscious authentic life
 - Dwell meaningfully as human
implacement, being 'in' place, as an
extension of identity
- Foucault
 - Power: omnipresent micropower relations,
biopower and self-disciplinary power
- Deleuze
 - Thinking and life, plane of immanence
 - Non-fascist life, desiring-production

Since our project is developing an ethics of perception, we need to connect perception and ethics. Again, we can look to philosophers for this. With Bergson we saw that the prescription for freedom and the exercise of free will is afforded by tuning into subjective experience. For Bergson, a futurist ethics that supports continued freedom would be ethics models that focus awareness onto subjective experience and facilitate dynamism in cognition. Heidegger⁸, too, has some useful precepts for futurist ethics. He says that to realize the true meaningfulness of our being we need to consciously live in authenticity. When we get the wake-up call from the conscience, as he details in *Being and Time*, we have a choice of whether to live authentically, and we should choose to do so. In another essay, *Building Dwelling Thinking*⁹, Heidegger continues to explore the idea dwelling meaningfully as human in-placement, being 'in' place as an extension of our identity.

Likewise, Foucault¹⁰ has some important and accessible points for a futurist ethics. He would like us to be constantly aware of the micro-power relations present in any interaction. Deleuze and Guattari¹¹ continue to pose ideas of top-down bio-power and bottom-up self-disciplinary power as they exhort us to eliminate micro-fascism everywhere in our behavior and caution that we should not try to recreate existing power structures in our new trans-human and futurist spaces like Second Life. Deleuze and Guattari further describe a futurist ethics that sees

⁸ Heidegger, M. (1962) *Being and Time*. New York: Harper & Row.

⁹ Heidegger, M. (1971) *Poetry, Language, Thought*. New York: Harper & Row.

¹⁰ Foucault, M. (1980). *Power/Knowledge*. New York: Pantheon Books.

¹¹ Deleuze, G. & Guattari, F. (1983, Dec.). *Anti-Oedipus: Capitalism and Schizophrenia*. Minnesota: University of Minnesota Press.

humans on a plane of immanence, a plane of pure possibility that comes from within us. We do not need to transcend anything external, we can make our lives from within. Part of the way to do this is through desiring-production, becoming more closely in touch with our desires (biological and otherwise) as a productive force. Group ethics in a societal sense then becomes a less veiled and more honest negotiation between individual desires as opposed to the repression of the productive force of desire. Now this affirmative perspective of a futurist ethics can be interpreted into the context of an ethics of perception.

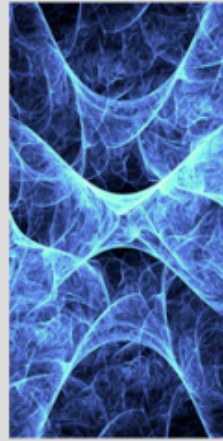
One of the core realizations we will start to have is that ethics and perception become something of choice, a module of selectable parameters just like any kind of technology feature. We can imagine picking an 'ethics buffer' or 'perceptual interface'.

Immediately, a hard philosophical problem arises as to whether ethics interfaces are even feasible since how would it be possible to have objective reality as an input? This issue may be skirted initially with standard Newtonian physics as the basis for perceptual interfaces, but the philosophical issue remains of a provable external reality. Another issue that emerges with the possibility of changing our perceptual apparatus is an awareness of the many ways in which we are currently biased due to evolution and sociality. Likewise our perceptual interfaces could reduce these built-in biases. The ability to choose different kinds of perceptual realities suggests considering an Ethics of Reality directly. It is imaginable that a transhumanist viewpoint could be constructed that it is unethical to experience raw reality because it is inhumane, unproductive, or perceptually harmful.

One of the most fun parts of thinking about cognitive nanorobotics is imagining the killer apps that we might have. The first and most obvious is bias reduction, helping to identify and reduce the many cognitive biases of humans including loss aversion, over-confidence, confirmation and hindsight biases. A second killer app is memory management, both accessing the right memories at the right time and suppressing other memories at other times. The third and fifth killer apps go together, the ability to elicit and optimize value systems and desires. The fourth killer app is perceptual augmentation using cognitive nanorobots in some of the ways Bergson and the other philosophers suggested to amplify subjective experience.

Killer Apps of Cognitive Nanorobotics

1. Bias reduction
2. Memory management
3. Value system elicitation and optimization
4. Perceptual enhancement
 - Different 'objective' realities
 - See time, see movement in time and space
 - Notice subjective experience
5. Desire elicitation and modification




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An obvious issue that arises with ethics is the trade-off between individual freedom and group cohesion. One point to make in this context is that just as technology paradigms change (Ray Kurzweil¹² urges us to invent where the technology is going, not where it is now), so too the social paradigms, although more slowly. We need to anticipate this in our futurist ethics. As an example, consider how considerably our thinking has shifted over time regarding slavery, women's rights and sexuality. A second point is the social trend toward greater self-awareness, disclosure, destigmatization and taboo removal. Over time we become more willing to share information about ourselves because there are value propositions in place for sharing information that diminish risk. Depending on the country and environment, some of the areas that are now uncomfortable for information-sharing include medical records, mental health, sexual orientation and gender identification, but this could change. In the case of genomics, individuals who have felt comfortable sharing their own information has helped to greatly de-stigmatize pathology.

¹² Kurzweil, R. (2005). *The Singularity Is Near*. New York: Penguin Group.

Individual / Group Ethics



- Trend of self-awareness, disclosure, destigmatization, taboo removal

Medicine (genomics), behavior (QS), personal/professional life blending, sexual orientation, gender identification

Neurodiversity: mental health, mental performance

Desires

Time → now →

- Group ethics models
 - Old: okay unless harms others, ‘do unto others’
 - New: Negotiation per disclosure, automated mediation through anonymous disclosure

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The next wave of information-sharing trend could include mental health and performance data, and later desires in the sense of being more productively connected to our inner-most desires and more happily realizing them, editing them, and collaboratively sharing them with others. In the futurist ethics of society, group ethics models that are familiar to us now like personal freedoms that do not harm others, and ‘doing unto others as we would ourselves,’ could evolve into more complex configurations in ongoing negotiations and disclosures, including facilitated automatically and autonomously by our cognitive nanorobots.

In concluding on the Geoethics of Cognitive Nanorobots, first we should explicitly consider the development of machine ethics modules in our technology. These ethics modules deployed in cognitive nanorobots as perceptual aids may start with some version of Asimov’s Laws of Robotics¹³ as an algorithmic baseline, but would also meet other dimensions that draw in elements of subjective experience such that we can be more internally aware, connected, expressive and freer as beings. We look to an ethics of perception to enhance subjective experience and elicit and optimize our personal values and desires. Technology progresses and so too do social models, therefore a futurist ethics should take into account the progression of ethics paradigms, moving from the limiting from the Ethics 1.0 of judging behavior against principles to the immanence Ethics 2.0 of creating a life that is affirmatory and expansive.

¹³ Asimov, I. (Mar, 1942). Runaround. *Astounding Science Fiction*, 132pp. New York: Street and Smith. ISFDB Title Record # 44191 <http://www.isfdb.org/cgi-bin/title.cgi?44191>.

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