

Outer space and cyber space: meeting ET in the cloud

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Abstract: What justifies the astrobiologist's search for post-biological or machine-intelligence in outer space? Four assumptions borrowed from transhumanism (H+) seem to be at work: (1) it is reasonable to speculate that life on Earth will evolve in the direction of post-biological intelligence; (2) if extraterrestrials have evolved longer than we on Earth, then they will be more scientifically and technologically advanced; (3) superintelligence, computer uploads of brains, and dis-embodied mind belong together; and (4) evolutionary progress is guided by the drive toward increased intelligence. When subjected to critical review, these assumptions prove to be weak. Most importantly, evolutionary biologists do not support the idea that evolution is internally directed toward increased intelligence. Without this assumption, justifying the search for ET more intelligent than earthlings is anaemic. Nevertheless, one can still hope that in the near future we will be communicating with new neighbours in the Milky Way. Can sheer hope inspire science?

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Should we expect an extraterrestrial civilization to be led by the equivalent of a terrestrial transhumanist? If we answer affirmatively and place this on our list of assumptions, we can justify a research programme that looks for post-biological forms of extraterrestrial life. I enthusiastically embrace such an astrobiological research programme. However, before we get started, I would like to get clear on the assumptions with which we launch our project. Well examined assumptions will provide us with increased precision when formulating our research questions.

When we listen to the promises being made by today's transhumanists—that we *Homo sapiens* will take control of our evolutionary future by creating a post-human machine-intelligence—it makes sense to ask: have our neighbours on off-Earth planets already evolved into a post-biological intelligence? With this question in mind, should we ask National Aeronautics and Space Administration (NASA) and the search for extraterrestrial intelligence (SETI) scientists to look off-Earth for the kind of machine-intelligence transhumanists promise here on Earth? Is our terrestrial future already ET's present?

In what follows we will examine four assumptions implied in such questioning: (1) it is reasonable to speculate that life on Earth will evolve in the direction of post-biological intelligence; (2) if extraterrestrials have evolved longer than we on Earth, then they will be more scientifically and technologically

advanced; (3) superintelligence, computer uploads of brains, and dis-embodied mind belong together; and (4) evolutionary progress is guided by the drive toward increased intelligence. We will show that these assumptions provide only an anaemic foundation on which to launch an extraterrestrial research programme. It is my personal hope that terrestrial astrobiologists will soon establish communication with extraterrestrial neighbours in either biological or post-biological form, but this requires a scaffold of hope that cannot be fully supported by our operative assumptions.

Assumption #1: it is reasonable to speculate that life on Earth will evolve in the direction of post-biological intelligence. This assumption is based on a transhumanist promise: our terrestrial post-human descendents will develop a superintelligence that will spread from Earth into outer space. This spread from Earth to space implies a correlate assumption: we terrestrials will avoid destroying ourselves before this can happen. Cambridge astrophysicist Martin Rees gives voice to this complex assumption with its correlate.

Long before the sun finally licks Earth's face clean, a teeming variety of life or its artefacts could have spread far beyond its original planet, provided that we avoid irreversible catastrophe before this process can even commence. They could look forward to a near-infinite future. (Rees, 2003, 189)

Why might Rees forecast disembodied intelligence on another planet? Because transhumanists, who believe evolution is teleologically driven toward increased intelligence, promise post-biological intelligence spreading out from its origin on Earth. Computer magnate Ray Kurzweil formulates the promise: 'The purpose of the universe reflects the same purpose as our lives: to move toward greater intelligence and

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knowledge. . . we will within this century be ready to infuse our Solar System with our intelligence through self-replicating non-biological intelligence. It will then spread out to the rest of the universe' (Kurzweil, 2005, 372). It appears that the transhumanist promise has become the space researcher's assumption.

Assumption #2: If extraterrestrials have evolved longer than we on Earth, then they will be more scientifically and technologically advanced. This implies that ETI will have attained post-biological intelligence before we make contact. Paul Davies gives voice to this assumption.

My conclusion is a startling one. I think it very likely—in fact inevitable—that biological intelligence is only a transitory phenomenon, a fleeting phase in the evolution of intelligence in the universe. If we ever encounter extraterrestrial intelligence, I believe it is overwhelmingly likely to be post-biological in nature, a conclusion that has obvious and far reaching ramifications for SETI. (Davies, 2010, 160)

The astrobiologist should scan the heavens looking for post-biological intelligence, recommends Davies.

How should we think about these first two assumptions? What these two assumptions themselves presuppose is that evolution is progressive. If evolution is progressive and if an extraterrestrial civilization is more highly evolved, then it will advance to post-biological existence. But, we should pause to ask: is evolution progressive or not? The majority of today's evolutionary biologists deny a built-in *telos* or direction to evolution. Davies recognizes this: 'Unfortunately, the popular view of evolution as progress is at best a serious oversimplification, at worst just plain wrong' (Davies, 2010, 68). So far, so good. Yet, in order to pursue the research agenda at hand, it appears that evolutionary progress must still be presupposed. Davies continues, 'Now imagine a technology a *million* or more years in advance of ours: it might well appear miraculous to us' (Davies, 2010, 140). To expect an extraterrestrial civilization to be 'a *million* or more years in advance of ours' is to presuppose that evolution advances over time—that is, evolution is progressive.

The denial of evolutionary progress dominates today's science, as Davies rightly points out. 'Cosmic teleology must be rejected by science—I do not think there is a modern scientist left who still believes in it,' contends Harvard evolutionary theorist Mayr (1991, 131). No built-in teleology leading our cosmos toward increased intelligence exists. When it comes to the evolutionary process within cosmic processes, Mayr's argument relies on randomness without repeatability. The probability of a repeat of Earth's evolutionary history on another planet is so low as to be virtually nil. The evolutionary process would produce a different outcome every time it gets going. Mayr puts it this way: 'At each level of this pathway there were scores, if not hundreds, of branching points and separately evolving phyletic lines, with only a single one in each case forming the ancestral lineage that ultimately gave rise to Man' (Mayr, 1985, 27). The statistics suggest strongly that Earth's evolutionary history is rare if not unique, and we should not expect a repeat on an off-Earth site.

Evolutionary biologist and former president of the AAAS, Francisco J. Ayala, similarly argues that the improbabilities of a repeat of our evolutionary progress are greater than the probabilities of ETI coming into existence. If we 'replay life's tape,' he observes, the improbabilities get multiplied from year to year, from generation to generation, millions and millions of times. 'The resulting improbabilities are of such magnitude that even if there would be millions of universes as large as the universe that we know, the products (improbability of humans \times number of suitable planets) would not cancel out by many orders of magnitude. The improbabilities apply not only to *Homo sapiens*, but also to 'intelligent organisms with which we could communicate'; by this phrase I mean organisms with a brain-like organ that would allow them to think and to communicate, and with senses somewhat like ours (seeing, hearing, touching, smelling, tasting), which would allow them to get information from the environment and to communicate intelligently with other organisms. We have to conclude that humans are alone in the immense universe and that we forever will be alone' (Ayala, 2004, 77; see: Peters, 2011b, 2013b). In sum, the dominant position in evolutionary biology withdraws support for belief in the directionality or teleology needed for predictable progress.

This statistical pessimism is not shared by evolutionary convergence theorists. Cambridge's Simon Conway Morris, for example, contends that 'convergence is ubiquitous: the number of possibilities in evolution in principle is more than astronomical, but the number that actually work is an infinitesimally smaller fraction' (Morris, 2015, 21). In short, we can expect natural selection to lead to a species something like *Homo sapiens*. By implication, Morris narrows the number of paths evolution on an off-Earth site might travel. Yet, this does not translate into affirmation of a built-in entelechy or directionality to either cosmic or biological evolution. Morris is a friend to NASA and SETI, to be sure; but convergence theory falls short of promising that progressive evolution has produced an advanced civilization on an exoplanet.

At this point, we should pause to refine the role of teleology in evolution. Even though it may be the case that pre-human evolution on Earth was not directed by a natural purpose, future evolution might be directed by human purpose. Certainly transhumanists contend that our post-human descendents will be the product of a purpose, which we *Homo sapiens* introduce. Even if our inherited evolutionary history is purposeless, our post-human future may very well be guided by intelligence, our own intelligence at first and the intelligence of our progeny at a later time. This observation adds some iron to the otherwise anaemic set of assumptions we are reviewing here.

Even if natural evolution on Earth or off-Earth is undirected, the sheer scope of the universe and the sheer number of habitable planets enlists happenstance into the service of contact optimism. It is not unreasonable for NASA and SETI researchers to rely upon arguments from large numbers. The cosmos is big, really big. With between 200 and 400 billion stars in the Milky Way, and with one-star-in-ten minimally with orbiting planets, the number of potential Earth-like planets is giant. Even if Mayr and Ayala are right about the statistical

improbability of a repeat of terrestrial evolution, the chances of life beginning and evolving into intelligence still remain reasonable. The 'argument from large numbers' is perhaps the strongest motivation for those who search for beings beyond our planet,' says SETI's Seth Shostak (2011, 32).

What this brief review suggests is clear: space researchers dare not rely on the discipline of evolutionary biology to support the assumptions necessary to search for extraterrestrial intelligence. If terrestrial biologists do not support the idea of progressive evolution, then astrobiologists must say to themselves: even though evolutionary biologists deny progress in evolution, we must still affirm that evolution has progressed toward intelligence somewhere beyond Earth. Despite the lack of evidence, astrobiology must proceed in the extraterrestrial search. I find no fault here, as long as the assumptions are transparent. Transparency implies that we treat the prospect of discovering an evolutionarily advanced extraterrestrial civilization as a hypothesis, not as an apodictic principle (Peters, 2011a, 2011b).

Assumption #3: Superintelligence, computer uploads of brains, and dis-embodied mind belong together. This is another assumption made by today's transhumanists and entertained by speculating astrobiologists. Currently, these three ideas are as intertwined as spaghetti strands in a pasta entree. Should we attempt to disentangle them?

Specifically, the three strands which we may wish to disentangle are (1) superintelligence, (2) non-biological intelligence in a hardware substrate and (3) non-biological intelligence in the equivalent of the Cloud¹. First, by forecasting the upcoming Singularity, transhumanists expect a new and higher level of intelligence to take over and make the move to the post-human². We might ask: even short of the Singularity,

¹ Nick Bostrom distinguishes between *weak superintelligence*, that is, accelerating the human intellect as we know it, and *strong superintelligence*, that is, a qualitative jump in being smart. 'The arrival of superintelligence will clearly deal a heavy blow to anthropocentric world views. ... Creating superintelligence may be the last invention humans will ever make' (Bostrom, 2014a, 8). 'Uploading... is the process of transferring an intellect from a biological brain to a computer. ... An upload would have a virtual (simulated) body... [we would] rent bodies in order to work in or explore physical reality' (Bostrom, 2014a, 9–10). What needs distinguishing here is the relationship between biological bodies, uploads of intelligence into non-biological computers, and complete disembodiment. Might the disembodied internet someday just 'wake up'? Could the Internet become something more than just the backbone of a loosely integrated collective superintelligence—something more like a virtual skull housing an emerging unified super-intellect? (Bostrom, 2014b, 49). Bostrom describes many paths to superintelligence, of which the internet is only one. If extraterrestrial intelligence has arrived at a more highly advanced internet, would intelligent beings communicate with us or would their superintelligent internet itself communicate with us?

² 'Uploading a human brain means scanning all of its salient details and then re-instantiating those details into a suitably powerful computational substrate. This process would capture a person's entire personality, memory, skills and history' (Kurzweil, 2005, 198–99). 'We will within this century be ready to infuse our solar system with our intelligence through self-replicating non-biological intelligence. It will then spread out to the rest of the universe' (Kurzweil, 2005, 372). How could non-biological intelligence spread if it is not released from the time and space of computer hardware? The Cloud?

might today's human beings with today's level of intelligence be capable of transcending our biological substrate? Suppose a genius transhumanist in a Cambridge laboratory uploads the first brain prior to the Singularity? If we today can envision a post-biological intelligence, why does it require a post-biological intelligence to make it happen?

After pursuing this question, then, I recommend we distinguish between two non-biological platforms: computer hardware and cyber space. If extraterrestrial intelligence sits like software in an Apple computer in an office on Gliese 581 g, then it is no more likely to connect with us than it would if housed within a biological organism. Even if the interstellar UPS would travel at light speed, the delivery time would be too lengthy for meaningful contact.

If, however, extraterrestrial intelligence exists in cyber space, then this will increase the likelihood that we terrestrials might make contact. Without having to travel physically—either in our biological bodies or hardware bodies—interstellar communication might become easier. We will meet our space neighbours on line, so to speak. With SETI's help, the Royal Society could become the first to set up an interstellar dating service.

Davies astutely recommends that, 'in contemplating the activities of a super-intelligence it pays to clear your mind of all preconceptions' (Davies, 2010, 144). Good advice. However, in order to clear our minds, it might help to specify just what preconceptions we are bringing to this contemplation.

Assumption #4: Evolutionary progress is guided by the drive toward increased intelligence. Short of transhumanist intelligence amplification (IA) let alone the vision of the Singularity, more prosaic advances in artificial intelligence (AI) presume naively that the sole guiding value of the enterprise is increased intelligence. But, we must ask critically: should intelligence sit on top of our values hierarchy? No, is my answer. Love is more valuable than intelligence and, further, intelligence should be pressed into the service of love.

Intelligence alone, says Stuart Russell of the faculty of the University of California at Berkeley and a member of the Centre for the Study of Existential Risk at Cambridge University in the UK, should be pressed into the service of some higher value, some integrated objective. Uncontrolled supra-human intelligence could lead to human extinction; yet, no plans or regulations yet exist while the experimentation proceeds. 'To those who say, well, we may never get to human-level or superintelligent AI, I would reply: It's like driving straight toward a cliff and saying, 'Let's hope I run out of gas'' (Cited in Bohannon, 2015, 252). In short, the pursuit of intelligence alone without social controls and without accompanying values puts the human race at risk. Or, to say it another way, should intelligence sit atop our list of social values and become the goal toward which our civilization aspires?

Yes, say the transhumanists. When it comes to the transhumanists, we encounter a full-fledged ideology complete with worldview and value system. For our generation to pursue the invention of superintelligence, accordingly, would fulfil a destiny assigned to us by an evolutionary entelechy. Tacitly if not overtly, the highest value—the *summum bonum*—on the transhumanist scale of values is intelligence. Would this

necessarily be the case for extraterrestrials as well? A problem arises here, because Christians along with adherents to many other religious traditions do not place intelligence on the top of their values list. Rather, what sits on top is love.

Love is but an epiphenomenon of the neocortex, according to Ray Kurzweil; love evolved so that children would be taken care of in the human home (Kurzweil, 2012, 120). Yet, for the believer in a gracious God, love is more than merely evolutionarily adaptive. It becomes apotheosized. 1 John 4:7: 'Beloved, let us love one another, because love is from God; everyone who loves is born of God and knows God.' Love trumps intelligence, theologically speaking (Peters, 2013a). Might we find a values conflict between intelligence and love?

Here is how the assumption regarding intelligence as the *summum bonum* plays out in the construction of a full-fledged worldview. The *Transhumanist Manifesto* offers a 'totalized philosophical system' with a three level worldview: a metaphysical level, a psychological level, and an ethical level (Young, 2006, 87). At the metaphysical or cosmological level, the transhumanist perceives our world in a 'process of evolutionary complexification toward evermore complex structures, forms, and operations.' At the psychological level, transhumanists believe we human beings are 'imbued with the innate Will to Evolve—an instinctive drive to expand abilities in pursuit of ever-increasing survivability and well-being.' These two lead to the ethical level, where 'we should seek to foster our innate Will to Evolve, by continually striving to expand our abilities throughout life. By acting in harmony with the essential nature of the evolutionary process—complexification—we may discover a new sense of purpose, direction, and meaning to life, and come to feel ourselves *at home in the world once more*' (Young, 2006, 19, italics in original). Simon Young plans to replace 'Darwinian Evolution with Designer Evolution—from slavery to the selfish genes to conscious self-rule by the human mind' (Young, 2006, 207). Making intelligence the *summum bonum* is justified by the transhumanist because it is allegedly built into nature's evolutionary *telos*. But, if evolutionary biologists are correct in declaring the absence of teleology in our inherited evolution, then the warrant for belief in intelligence evaporates like mist in sunshine. If the pursuit of increased intelligence becomes the elected future goal of *Homo sapiens*, then it will become an arbitrary value without physical or metaphysical warrant.

It is this onionskin evolutionary framework that provides the flimsy basis for valuing disembodied intelligence. Despite its fragile foundation, transhumanism self-identifies as an inspiring liberation movement. Whereas in the past we have been prisoners of our biology, in the future we will become liberated. Our liberation will come from increased intelligence, an intelligence that itself will find a way to remove itself from our deteriorating bodies and establish a much more secure substrate for endurance. Our mental lives in the future may take place within a computer or on the internet. What we have previously known as *Homo sapiens* will be replaced by *Homo cyberneticus*. 'As humanism freed us from the chains of superstition, let transhumanism free us from our biological chains' (Young, 2006, 32, italics in original).

Once freed from the limits of our inherited bodies, the expansion of human intelligence would be limited only by the size of our universe. What the transhumanist foresees is a cosmic imbuing of matter with consciousness. 'Liberated from biological slavery, an immortalized species, *Homo cyberneticus*, will set out for the stars. Conscious life will gradually spread throughout the galaxy...until finally, in the unimaginably distant future, the whole universe has come alive, awakened to its own nature—a cosmic mind become conscious of itself as a living entity—omniscient, omnipotent, omnipresent' (Young, 2006, 44). The entire universe will be converted into an 'extended thinking entity,' writes Moravec (1988, 116).

Can the astrobiological weather reporter forecast that a cyber cloud emitted by Gliese 581 g is approaching a similar cloud emitted from Earth? When the two clouds converge, can we expect lightning and thunder? Will the clouds compete or converge?

The mood of transhumanism is aggressively Promethean. Here is the promise: we humans will arrest from the gods (or from nature) the principles and resources we need to take our destiny into our own hands. With a wave of the philosophical hand we will expel the old fatalisms, the naysayers, the Luddites. 'Bio-fatalism will increasingly be replaced by techno-can-do-ism—the belief in the power of the new technology to free us from the limitations of our bodies and minds. ... In the twenty-first century, the belief in the Fall of Man will be replaced by the belief in his inevitable transcendence—through Superbiology' (Young, 2006, 20). The torch of Prometheus will lead us into the new world of transhumanism. 'Let us cast aside cowardice and seize the torch of Prometheus with both hands' (Young, 2006, 40).

With this ideology at work here on planet Earth, it is reasonable to ask: might one or more extrasolar civilizations have been led in the past by extraterrestrial transhumanists, so that we will soon meet their progeny in cyber space? Is there sound reason for assuming that Promethean techno-can-do-ism has preceded us on an exoplanet? Is such a future what we should value here on Earth?

This is what a worldview looks like when it revolves around intelligence. But, we must acknowledge that intelligence is morally ambiguous. It takes the highest intelligence we have known yet on Earth to design and detonate a nuclear weapon. Similarly, it takes this same high level of intelligence to create a hospital and to advance the medical frontier. Into whose service will intelligence be placed? Suppose we would ask intelligence to serve as a means to a loving end? What then?

Tübingen theologian Jürgen Moltmann lifts up a vision parallel to, but different from, that of the transhumanist. If in our era of biomedical progress human existence is no longer oriented toward mere survival, then we are ready to reorient our lives around a new purpose, namely, fulfillment. Darwinian values that may have supported survival of the fittest will need replacing by values that promote cooperation and social harmony. 'The change in human interests evoked by biomedical progress can be described as a transition from the struggle for existence to striving for fulfillment,' writes Moltmann. 'The principle of self-preservation against others can be transformed into the principle of self-fulfillment in the other. Systems of

aggression can be overcome by systems of co-operation' (Moltmann, 1979, 147). In short, we can imagine a post-survivalist mindset—either on Earth or on another planet—that is oriented toward love, toward a harmonious society, toward a benevolent community.

When we speculate about a more advanced extraterrestrial civilization, must we limit our scale of measurement only to advances in intelligence? Might we anticipate that one or another of our extraterrestrial societies have oriented itself around a different *summum bonum*, such as love?

Conclusion

We have just examined four transhumanist assumptions borrowed by some astrobiologists: (1) it is reasonable to speculate that life on Earth will evolve in the direction of post-biological intelligence; (2) if extraterrestrials have evolved longer than we on Earth, then they will be more scientifically and technologically advanced; (3) superintelligence, computer uploads of brains, and dis-embodied mind belong together; and (4) evolutionary progress is guided by the drive toward increased intelligence. We have shown that these assumptions provide only a flimsy foundation on which to launch an extraterrestrial research programme. It certainly is my hope that terrestrial astrobiologists will soon establish communication with extraterrestrial civilizations in either biological or post-biological form, but this requires a scaffold of hope that cannot be empirically supported by current assumptions. Can rickety hope still inspire solid science?

When we speculate about our extraterrestrial neighbours, we cannot help but project imaginatively to off-Earth sites what we have known on Earth. Such imaginative speculation leads to the formulation of hypotheses and eventually research agendas. Like preparing the launch pad for a rocket's blast off, double checking our assumptions will help secure a successful flight.

References

- Ayala, F.J. (2004). The Evolution of Life on Earth and the Uniqueness of Humankind. In *Perché esiste qualcosa invece di nulla? (Why There Is*

- Something rather than Nothing?)*, ed. Moriggi, S. & Sindoni, E., pp. 57–77. ITACALibri, Castel Bolognese, Italy.
- Bohannon, J. (2015). Fears of an AI pioneer: an interview with Stuart Russell. *Science* 349(6245), 252.
- Bostrom, N. (2014a). Introduction—The Transhumanist FAQ: A General Introduction. In *Transhumanism and the Body: The World Religions Speak*, ed. Mercer, C. & Mather, D.F., pp. 1–17. Macmillan Palgrave, New York.
- Bostrom, N. (2014b). *Superintelligence: Paths, Dangers, Strategies*. Oxford University Press, Oxford.
- Davies, P. (2010). *The Eerie Silence: Renewing Our Search for Alien Intelligence*. Houghton, Mifflin, Harcourt, Boston.
- Kurzweil, R. (2005). *The Singularity is Near: When Humans Transcend Biology*. Penguin, New York.
- Kurzweil, R. (2012). *How to Create a Mind: The Secret of Human Thought Revealed*. Viking, New York.
- Mayr, E. (1985). The probability of extraterrestrial life. In *Extraterrestrials: Science and Alien Intelligence*, ed. Regis, E. Jr., pp. 23–30. Cambridge University Press, Cambridge, UK.
- Mayr, E. (1991). The Ideological Resistance to Darwin's Theory of Natural Selection. *Proceedings of the American Philosophical Society*, 135.
- Moltmann, J. (1979). *The Future of Creation*, tr., Margaret Kohl. Fortress Press, Minneapolis.
- Moravec, H. (1988). *Mind Children: The Future of Robot and Human Intelligence*. Harvard University Press, Cambridge, MA.
- Morris, S.C. (2015). *The Runes of Evolution: How the Universe Became Self-Aware*. Templeton Press, West Conshohocken, PA.
- Peters, T. (2011a). The implications of the discovery of extra-terrestrial life for religion. *R. Soc. Phil. Trans. A* 369(1936), 644–655.
- Peters, T. (2011b). Transhumanism and the Promethean Future: Will Technological Progress Get Us There? In *H+ Transhumanism and Its Critics*, ed. Hansell, G.R. & Grassie, W., ch. 10, pp. 147–175. Metanexus, Philadelphia.
- Peters, T. (2013a). Astroethics: engaging extraterrestrial intelligent life-forms. In *Encountering Life in the Universe*, ed. Impey, C., Spitz, A. & Stoeger, W., pp. 200–221. University of Arizona Press, Tucson.
- Peters, T. (2013b). Astrotheology. In *The Routledge Companion to Modern Christian Thought*, ed. Meister, C. & Beilby, J., ch. 72, pp. 838–853. Routledge, London and New York.
- Rees, M. (2003). *Our Final Hour*. Basic Books, New York.
- Shostak, S. (2011). Are we alone? Estimating the prevalence of extraterrestrial intelligence. In *Civilizations Beyond Earth: Extraterrestrial Life and Society*, ed. Vakoeh, D.A. & Harrison, A.A., pp. 31–42. Bergbahn Books, New York and Oxford.
- Young, S. (2006). *Designer Evolution: A Transhumanist Manifesto*. Prometheus Books, Amherst, NY.