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**Natural-Born Cyborgs:  
Minds, Technologies,  
and the Future of  
Human Intelligence**

*ANDY CLARK*

**OXFORD UNIVERSITY PRESS**

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*For Mike Scaife, 1948–2001*

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## **NATURAL-BORN CYBORGS**

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The human skin is an artificial boundary: the world wanders into it, and the self wanders out of it, traffic is two-way and constant.

—Bernard Wolfe, *Limbo*

We're here to go.

—William S. Burroughs, *Dead City Radio*

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# Introduction

## The Naked Cyborg

My body is an electronic virgin. I incorporate no silicon chips, no retinal or cochlear implants, no pacemaker. I don't even wear glasses (though I do wear clothes), but I am slowly becoming more and more a cyborg. So are you. Pretty soon, and still without the need for wires, surgery, or bodily alterations, we shall all be kin to the Terminator, to Eve 8, to Cable . . . just fill in your favorite fictional cyborg. Perhaps we already are. For we shall be cyborgs not in the merely superficial sense of combining flesh and wires but in the more profound sense of being human-technology symbionts: thinking and reasoning systems whose minds and selves are spread across biological brain and nonbiological circuitry. This book is the story of that transition and of its roots in some of the most basic and characteristic facts about human nature. For human beings, I want to convince you, are *natural-born* cyborgs.

This may sound like futuristic mumbo-jumbo, and I happily confess that I wrote the preceding paragraph with an eye to catching your attention, even if only by the somewhat dangerous route of courting your immediate disapproval! But I do believe that it is the plain and literal truth. I believe, to be clear, that it is above all a *SCIENTIFIC* truth, a reflection of some deep and important facts about (a whiff of paradox here?) our special, and distinctively *HUMAN*, nature. Certainly I don't think this tendency

toward cognitive hybridization is a modern development. Rather, it is an aspect of our humanity, which is as basic and ancient as the use of speech and which has been extending its territory ever since. We see some of the “cognitive fossil trail” of the cyborg trait in the historical procession of potent cognitive technologies that begins with speech and counting, morphs first into written text and numerals, then into early printing (without moveable typefaces), on to the revolutions of moveable typefaces and the printing press, and most recently to the digital encodings that bring text, sound, and image into a uniform and widely transmissible format. Such technologies, once up and running in the various appliances and institutions that surround us, do far more than merely allow for the external storage and transmission of ideas. They constitute, I want to say, a cascade of “mindware upgrades”: cognitive upheavals in which the effective architecture of the human mind is altered and transformed.

It was about five years ago that I first realized we were, at least in that specific sense, all cyborgs. At that time I was busy directing a new interdisciplinary program in philosophy, neuroscience, and psychology at Washington University in St. Louis. The realization wasn’t painful; it was, oddly, reassuring. A lot of things now seemed to fall into place: why we humans are so deeply different from the other animals, while being, quite demonstrably, not so very different in our neural and bodily resources; why it was so hard to build a decent thinking robot; why the recent loss of my laptop had hit me like a sudden and somewhat vicious type of (hopefully transient) brain damage.

I’d encountered the idea that we were all cyborgs once or twice before, but usually in writings on gender or in postmodernist (or post postmodernist) studies of text. What struck me in July 1997 was that this kind of story was the literal and scientific truth. The human mind, if it is to be the physical organ of human reason, simply cannot be seen as bound and restricted by the biological skinbag. In fact, it has *never been* thus restricted and bound, at least not since the first meaningful words were uttered on some ancestral plain. But this ancient seepage has been gathering momentum with the advent of texts, PCs, coevolving software agents, and user-adaptive home and office devices. The mind is just less and less in the head.

If we do not always see this, or if the idea seems outlandish or absurd, that is because we are in the grip of a simple prejudice: the prejudice that

whatever matters about *my* mind must depend solely on what goes on inside my own biological skin-bag, inside the ancient fortress of skin and skull. This fortress has been built to be breached; it is a structure whose virtue lies in part in its capacity to delicately gear its activities in order to collaborate with external, nonbiological sources of order to better solve the problems of survival and reproduction. It is because we are so prone to think that the mental action is all, or nearly all, on the inside, that we have developed sciences and images of the mind that are, in a fundamental sense, inadequate to their self-proclaimed target. So it is actually important to begin to see ourselves aright—it matters for our science, our morals, and our sense of self.

What, then, is the role of the biological brain, of those few pounds of squishy matter in your skull? The squishy matter is great at some things. It is expert at recognizing patterns, at perception, and at controlling physical actions, but it is not so well designed (as we'll see) for complex planning and long, intricate, derivations of consequences. It is, to put it bluntly, bad at logic and good at Frisbee. It is both our triumph and our burden, however, to have created a world so smart that it allows brains like ours to go where no animal brains have gone before. The story I want to tell is the story of that triumph, and of what it means for our understanding of ourselves: dumb thinkers in a smart world, or smart thinkers whose boundaries are simply not those of skin and skull?

The cyborg is a potent cultural icon of the late twentieth century. It conjures images of human-machine hybrids and the physical merging of flesh and electronic circuitry. My goal is to hijack that image and to reshape it, revealing it as a disguised vision of (oddly) our own biological nature. For what is special about human brains, and what best explains the distinctive features of human intelligence, is precisely their ability to enter into deep and complex relationships with nonbiological constructs, props, and aids. This ability, however, does not depend on physical wire-and-implant mergers, so much as on our openness to information-processing mergers. Such mergers may be consummated without the intrusion of silicon and wire into flesh and blood, as anyone who has felt himself thinking *via* the act of writing already knows. The familiar theme of “man the toolmaker” is thus taken one crucial step farther. Many of our tools are not just external props and aids, but they are deep and integral parts of the problem-solving systems we now



identify as human intelligence. Such tools are best conceived as proper parts of the computational apparatus that constitutes our minds.

The point is best made by the series of extended concrete examples that I develop in this book. Consider, as a truly simplistic cameo, the process of using pen and paper to multiply large numbers.<sup>1</sup> The brain learns to make the most of its capacity for simple pattern completion ( $4 \times 4 = 16$ ,  $2 \times 7 = 14$ , etc.) by acting in concert with pen and paper, storing the intermediate results outside the brain, then repeating the simple pattern completion process until the larger problem is solved. The brain thus dovetails its operation to the external symbolic resource. The reliable presence of such resources may become so deeply factored in that the biological brain alone is rendered unable to do the larger sums.

Some educationalists fear this consequence, but I shall celebrate it as the natural upshot of that which makes us such potent problem-solving systems. It is because our brains, more than those of any other animal on the planet, are primed to seek and consummate such intimate relations with nonbiological resources that we end up as bright and as capable of abstract thought as we are. It is because we are natural-born cyborgs, forever ready to merge our mental activities with the operations of pen, paper, and electronics, that we are able to understand the world as we do. There has been much written about our imminent “post-human” future, but if I am right, this is a dangerous and mistaken image. The very things that sometimes seem most post-human, the deepest and most profound of our potential biotechnological mergers, will reflect nothing so much as their thoroughly human source.

My cat Lolo is not a natural-born cyborg. This is so despite the fact that Lolo (unlike myself) actually does incorporate a small silicon chip. The chip is implanted below the skin of his neck and encodes a unique identifying bar code. The chip can be read by devices common in veterinarians’ offices and animal shelters; it identifies me as Lolo’s owner so we can be reunited if he is ever lost. The presence of this implanted device makes no difference to the shape of Lolo’s mental life or the range of projects and endeavors he undertakes. Lolo currently shows no signs of cat-machine symbiosis, and for that I am grateful. By contrast it is our special character, as human beings, to be forever driven to create, co-opt, annex, and exploit nonbiological props and scaffoldings. We have been designed, by Mother Nature, to exploit deep neural plasticity in order to become one with our

best and most reliable tools. Minds like ours were made for mergers. Tools-R-U, and always have been.

New waves of user-sensitive technology will bring this age-old process to a climax, as our minds and identities become ever more deeply enmeshed in a nonbiological matrix of machines, tools, props, codes, and semi-intelligent daily objects. We humans have always been adept at dovetailing our minds and skills to the shape of our current tools and aids. But when those tools and aids start dovetailing back—when our technologies actively, automatically, and continually tailor themselves to us just as we do to them—then the line between tool and user becomes flimsy indeed. Such technologies will be less like tools and more like part of the mental apparatus of the person. They will remain tools in only the thin and ultimately paradoxical sense in which my own unconsciously operating neural structures (my hippocampus, my posterior parietal cortex) are tools. I do not really “use” my brain. There is no user quite so ephemeral. Rather, the operation of the brain makes me who and what I am. So too with these new waves of sensitive, interactive technologies. As our worlds become smarter and get to know us better and better, it becomes harder and harder to say where the world stops and the person begins.

Mind-expanding technologies come in a surprising variety of forms. They include the best of our old technologies: pen, paper, the pocket watch, the artist’s sketchpad, and the old-time mathematician’s slide rule. They include all the potent, portable machinery linking the user to an increasingly responsive world wide web. Very soon, they will include the gradual smartening-up and interconnection of the many everyday objects that populate our homes and offices.

However, this is not primarily a book about new technology. Rather, it is about us, about our sense of self, and about the nature of the human mind. It targets the complex, conflicted, and remarkably ill-understood relationship between biology, nature, culture, and technology. More a work of science-sensitive philosophy than a futurist manifesto, my goal is not to guess at what we might soon become but to better appreciate what we already are: *creatures whose minds are special precisely because they are tailor-made for multiple mergers and coalitions.*

All this adds important complexity to recent evolutionary psychological accounts that emphasize our ancestral environments.<sup>2</sup> We must take very

seriously the profound effects of a plastic evolutionary overlay that yields a constantly moving target, an extended cognitive system whose constancy lies mainly in its continual openness to change. Even granting that the biological innovations that got this ball rolling may have consisted only in some small tweaks to an ancestral repertoire, the upshot of this subtle alteration is now a sudden, massive leap in the space of mind design. Our cognitive machinery is now intrinsically geared to self-transformation, artifact-based expansion, and a snowballing/bootstrapping process of computational and representational growth.

The line between biological self and technological world was, in fact, never very firm. Plasticity and multiplicity are our true constants, and new technologies merely dramatize our oldest puzzles (prosthetics and telepresence are just walking sticks and shouting, cyberspace is just one more place to be). Human intellectual history is, in large part, the tale of this fragile and always unstable frontier. The story I tell overlaps some familiar territory, touching on our skills as language-users, toolmakers, and tool-users. But it ends by challenging much of what we think we know about who we are, what we are, and even where we are. It ought to start, perhaps, somewhere on some dusty ancestral savanna, but join me instead on a contemporary city street, abuzz with the insistent trill of a hundred cell phones. . . .

## **Wired**

Brighton main street, hub of a once-sleepy English seaside town lately transformed into a hi-tech haven and club-culture capital. This used to be my town, but it has changed. The shops tell a new story. I walk slowly, taking stock. I count one cell phone shop, one Starbucks, another cell phone shop, a hardware store, *another* cell phone shop, a clothes store, another coffee shop (this one offering full internet access), *yet another* cell phone shop . . .

The toll steadily mounts. Brighton, in my ten-year absence in the United States, has converted itself into a town that seems to sell nothing but coffee and cell phones. The center of town is now home to no fewer than fifty shops dedicated entirely to the selling of cell phones and their contracts. Then there are the various superstores that offer these phones alongside a variety

of other goods. This is quite astonishing. For a relatively small town (around 250,000) this is surely a massive load. Yet business looks good and no wonder: everywhere I turn there are people with phone to ear, or punching in text messages using the fluent two-thumbbed touch typing that is the badge of the younger users. Some, with fancier handsets, are using the phone to surf the web. This town is wired.

Not only is it wired. Half the people aren't entirely where they seem to be. I spent last Christmas in the company of a young professional whose phone was hardly ever out of his hands. He wasn't using the phone to speak but was constantly sending or receiving small text messages from his lover. Those thumbs were flying. Here was someone living a divided life: here in the room with us, but with a significant part of him strung out in almost constant, low-bandwidth (but apparently highly satisfying) contact with his distant friend.

The phone of the flying thumbs was a Nokia. Thanks in large part to Nokia (the firm, based in the Finnish town of the same name) the Finns emerged as early heavy-hitters in the European cell phone league. In 1999, 67 percent of the Finnish population owned and used cell phones compared to 28 percent in the United States. And these are not wimpy devices. Nokia is a pioneer of Wireless Application Protocol (WAP) technology, which supports fluent interfacing between the phone and the internet. Top of the line Finnish phones have for many years opened in the middle to reveal a small keyboard and screen supporting full fax, web, and e-mail capability. But it is not the potency of the technology so much as the pregnancy of the slang that really draws me to Finland. Finnish youngsters have dubbed the cell phone "kanny," which means extension of the hand.<sup>3</sup> The mobile is thus both something you use (as you use your hands to write) and something that is part of you. It is like a prosthetic limb over which you wield full and flexible control, and on which you eventually come to automatically rely in formulating and carrying out your daily goals and projects. Just as you take for granted your ability to use your vocal cords to speak to someone in the room beside you, you may take for granted your ability to use your thumbs-plus-mobile to send text to a distant lover. The phone really did seem to be part of the man, and the Finnish slang captures the mood.

I am surprised, but I shouldn't be. As a working cognitive scientist, the more I have learned about the brain and the mind, the more convinced I

have become that the everyday notions of “minds” and “persons” pick out deeply plastic, open-ended systems—systems fully capable of including nonbiological props and aids as quite literally parts of themselves. No wonder the cell phone shops were full. These people were not just investing in new toys; they were buying *mindware upgrades*, electronic prostheses capable of extending and transforming their personal reach, thought, and vision.

Upgrades, as we all know, can be mixed blessings. Every new capacity brings new limits and demands. We may, for example, start to spread ourselves too thin, reconfiguring our work and social worlds in new and not necessarily better ways. Certainly, I felt more than a tad jealous of my friend’s constant low-bandwidth info-dribble. It took some of him away from those he was physically beside. Later on, we’ll take a closer look at some of these pros and cons in our cyborg future.

Brighton main street, then, is just one more sign of the times. As technology becomes portable, pervasive, reliable, flexible, and increasingly personalized, so our tools become more and more a part of who and what we are. With WAP-enhanced cell and access to our own personalized versions of the web in hand we see farther, organize better, know more. The temporary disability caused by a dead battery is unnerving. It seems we just aren’t ourselves today. (The loss of my laptop, as I mentioned earlier, underlined this in a painfully personal way. I was left dazed, confused, and visibly enfeebled—the victim of the cyborg equivalent of a mild stroke.) So I, of all people, really *shouldn’t* have been surprised. It is our natural proclivity for tool-based extension, and profound and repeated self-transformation, that explains how we humans can be *so very special* while at the same time being not so very different, biologically speaking, from the other animals with whom we share both the planet and most of our genes. What makes us distinctively human is our capacity to continually restructure and rebuild our own mental circuitry, courtesy of an empowering web of culture, education, technology, and artifacts. Minds like ours are complex, messy, contested, permeable, and constantly up for grabs. The neural difference that makes all this possible is probably not very large, but its effects are beyond measure.

Don’t believe it yet? Or don’t think it matters anyway? Both are fair and proper responses. I began deliberately with a technology—the cell phone—which is at once familiar yet insufficiently fluid and user-responsive to make

(as yet) the strongest possible kind of case. And I have rehearsed none of the interlocking evidence (some philosophical, some psychological, some neuroscientific), which actually led me to embrace such a strong thesis in the first place.

Before the day is done, however, I hope to convince you at least of this: that the old puzzle, the mind-body problem, really involves a hidden third party. It is the mind-body-*scaffolding* problem. It is the problem of understanding how human thought and reason is born out of looping interactions between material brains, material bodies, and complex cultural and technological environments. We create these supportive environments, but they create us too. We exist, as the thinking things we are, only thanks to a baffling dance of brains, bodies, and cultural and technological scaffolding. Understanding this evolutionarily novel arrangement is crucial for our science, our morals, and our self-image both as persons and as a species.

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## Cyborgs Unplugged

### Rats in Space

The year is 1960. The pulse of space travel beats insistently within the temples of research and power, and the journal *Astronautics* publishes the paper that gave the term “cyborg” to the world.<sup>1</sup> The paper, titled “Cyborgs and Space,” was based on a talk, “Drugs, Space and Cybernetics,” presented that May to the Air Force School of Aviation Medicine in San Antonio, Texas. The authors were Manfred Clynes and Nathan Kline, both working for the Dynamic Simulation Laboratory (of which Kline was director) at Rockland State Hospital, New York. What Clynes and Kline proposed was simply a nice piece of lateral thinking. Instead of trying to provide artificial, earth-like environments for the human exploration of space, why not alter the humans so as to better cope with the new and alien demands? “Space travel,” the authors wrote, “challenges mankind not only technologically, but also spiritually, in that it invites man to take an active part in his own biological evolution.”<sup>2</sup> Why not, in short, reengineer the humans to fit the stars?

In 1960, of course, genetic engineering was just a gleam in science fiction’s prescient eye. And these authors were not dreamers, just creative scientists engaged in matters of national (and international) importance. They were scientists, moreover, working and thinking on the crest of two major waves of innovative research: work in computing and electronic data-processing,<sup>3</sup> and work on cybernetics<sup>4</sup>—the science of control and communication in



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