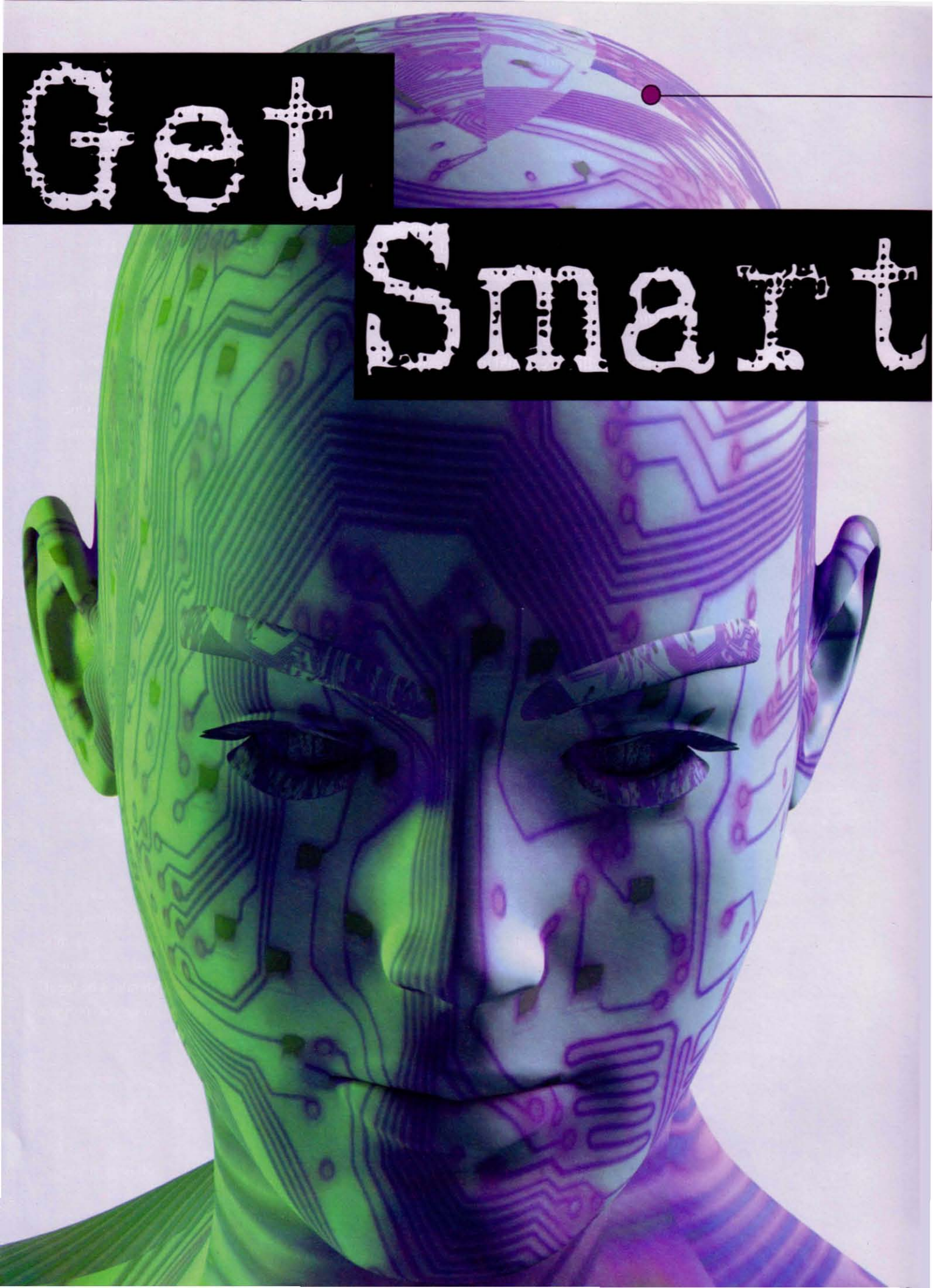
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Smart

The evolution of intelligence hasn't reached its pinnacle. In fact, it may just be getting started.

By Richard Yonck

For billions of years, life and its attendant intelligences have been slowly evolving—changing, adapting, accumulating abilities that have only recently resulted in the human mind. This evolution of intelligence has been a long and slow journey, full of twists and turns, strange divergences, and many dead ends. But while it may be tempting for us to believe we've reached some sort of culmination, the reality is this journey is far from over. In fact, it may have only just begun.

The evolution of intelligence has directly paralleled the evolution of life itself—from single-cell organisms with motility and the ability to locate light or food to multi-celled colonies that eventually developed rudimentary neural nets to animals with separate brain regions to primates capable of complex symbolic communication, long-term planning, and self-reflection. Each stage builds on the triumphs and developments of its predecessors.

But in relatively recent times, a new type of evolutionary process began to emerge. Just as genes came to be the primary medium by which life propagated, memes started to evolve a world of concepts and ideas. A term coined by biologist Richard Dawkins in his book *The Selfish Gene*, memes were conceived as informational units analogous to genes. Though not as broadly accepted as genetic evolution, memetic evolution seems to share many similar features and properties. Through memetic evolution, ideas develop and are transmitted, withering or prospering according to their viability under the conditions in which they exist. Over time, memes have led to the development of our tools and inventions, societies, and institutions. Perhaps most importantly, just like genes, these memes are yielding progeny that are themselves becoming increasingly intelligent.

Intelligent? If we broaden our definition, yes. Just as the first single-celled life had its own rudimentary intelligence, our early machines are laying the foundation for what will likely become a broad array of machine intelligences. And it's happening very rapidly. Much of our day-to-day experience with artificial intelligence involves what is known as "weak AI," which generally entails processing and problem solving within a very limited domain, such as the auto-complete function on a cell phone. But little by little, we're getting closer to creating "strong AI," artificial general intelligences (AGIs) capable of operating across a broad range of general and specialized knowledge, just as humans do. A very critical milestone will occur when such an intelligence succeeds at improving itself through self-modification. (Significant work is already being done with self-improving hardware and evolutionary algorithms.) Once this occurs, that intelligence is going to get a little faster, a little smarter, and so on. With each iteration coming ever more rapidly, a super-intelligence—or, more probably, super-intelligences—will emerge.

This is an important point when considering the future of intelligence. The domain of potential types of super-intelligence is quite large. There is no reason to think only one of these will be realized. In the coming decades, we may witness myriad of different intelligences, from monolithic super-computers to distributed intelligences such as an intelligent Internet or a digital Gaia of networked, embedded microprocessors.

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Other possibilities involve the modification of human intelligence. While many people may find this idea unappealing, the fact is that humans have been modifying their intelligence with tools for a long time. Reading

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and writing allow us to record, retrieve, and transmit far more knowledge than we could ever recall unaided. Search engines and the Internet provide almost instant access to vast exabytes of data. Given recent advances in brain-computer interfaces (BCIs), is the off-loading of a variety of mental tasks so farfetched? Sometimes referred to as an exocortex, this external housing of parts of our memory and processing would offer many competitive advantages given the increased capacity and speed. Of course, intelligence amplification (IA) needn't be limited to tying in with a computer network. Advances in the fields of biotechnology and nanotechnology may one day result in significant augmentations to our up-to-then fixed biology.

How would such augmentation affect how we measure and gauge intelligence? What would it mean for high IQ societies such as Mensa? Sure, we could say that tests are only valid when taken in an un-augmented state, but what happens when we get to the point where such augmentation is so prevalent or so intimately embedded that it can't simply be turned off? Would augmentation be the neurological equivalent of steroid use, or would this somehow be different? If the modifications are achieved through genetic engineering or other biotech advances, would they have a different validity than increases in intelligence achieved by other methods, such as by interfacing with computer technology? Is the distinction important? Finally, at what point does technological enhancement cross over to become an evolutionary leap?

Are super-intelligences and the Human 2.0 inevitable even though they pose considerable potential risks? Given the speed of recent advances, it would seem likely. While many might want to take the Luddite approach and try to ban such research, this would only serve to drive the work underground where it can't be properly monitored and regulated. That would probably be the best way to create a negative super-intelligence scenario. In trying to control future AIs, ideas like a version of Asimov's *Three Laws of Robotics* have been discussed, as well as possible fail-safes. Interestingly, some scientists have suggested that augmented human intelligence may be the best way of meeting the potential threats that could arise from a machine super-intelligence.

The domain of sapient entities may one day encompass not only humans, but trans-humans, machine intelligences, augmented animals, distributed networks, group minds, even uploaded personalities. If so, our definition of what is intelligent and sentient would need to change, along with the legal and social institutions under which we'd coexist. There can be little doubt that it would be a very strange and different world—a world in which new forms of intelligence appear much more rapidly than has ever occurred in the past.

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