The supremely intelligent rat-cyborg

7 March 2016, by Emilie Reas

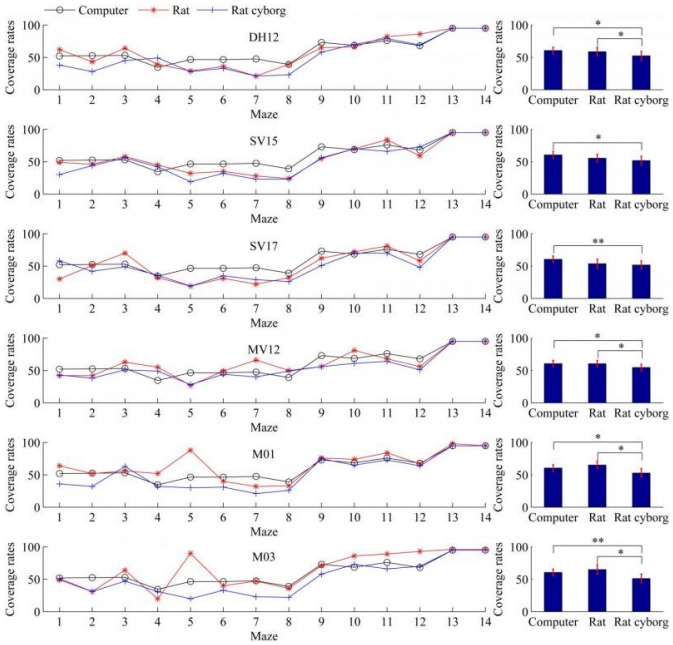
When Deep Blue battled the reigning human chess champion the world held its breath. Who was smarter … man or machine? A human victory would confirm the superiority of human intelligence, while a victory for Deep Blue would offer great promise for the potential applications of artificial intelligence to benefit mankind. And with the defeat of Garry Kasparov by an algorithm, the debate heated over what constitutes intelligence and whether computers can possess it. But perhaps the answer to the man-versus-machine debate isn't so black and white. Perhaps both synthetic and biological systems have unique, complementary strengths that, when merged, could yield an optimally functioning "brain" – a supremely intelligent cyborg, if you will. In their new *PLOS ONE* paper, Yipeng Yu and colleagues tested this possibility, comparing the problem-solving abilities of rats, computers and rat-computer "cyborgs."

Maze-solving rats, computers and cyborgs

Six rats were trained over the course of a week to run a series of unique mazes. The rats were implanted with microelectrodes in their somatosensory cortex and medial forebrain bundle , which releases dopamine to the nucleus accumbens and is a key node of the brain's reward system. They were enticed to reach the maze target by the fragrance of peanut butter, a sip of water (they were mildly dehydrated) and stimulation of the medial forebrain bundle once they solved the puzzle. After training, the researchers tested the rats on 14 new mazes, monitoring their paths, strategies and time spent solving the mazes.

To compare the performance of the rats to that of a computer, the research team developed a maze-solving algorithm implementing left-hand and right-hand wall-following rules. This algorithm completed the same 14 mazes run by the rats.

Rat cyborgs integrated the computational powers of organic and artificial intelligence systems. Rats completed the same set of mazes, but this time with the assistance of the computer algorithm. By stimulating the rats' left and right somatosensory cortex to prompt them to move left or right, the algorithm intervened when the rats needed help, directing them to traverse unique paths and avoid dead ends and loops.



Rat cyborgs covered fewer maze locations than rats or computers. Credit: Yu et al., 2016

Intelligent cyborgs

Performance of the rats, computer and rat-cyborgs were compared by evaluating how many times they visited the same location (steps), how many locations they visited, and total time spent to reach the target. Although the cyborgs and computers took roughly the same number of steps, the cyborgs took fewer than the rats, a sign of more efficient problem solving. Furthermore, the cyborgs visited fewer locations than computers or rats (see Figure), and took less time than the rats to solve the mazes. Across the various maze layouts, the number of steps and locations covered were strongly correlated between the types of beings (rats and cyborgs, rats and computer, cyborgs and computer). Thus, a maze that was challenging for a rat was similarly challenging for the computer and the rat's cyborg counterpart.

The ethics of a human cyborg

These findings from Yu and colleagues suggest that optimal intelligence may not reside exclusively in man or machine, but in the integration of the two. By harnessing the speed and logic of artificial computing systems, we may be able to augment the already remarkable cognitive abilities of biological neural systems, including the human brain. The prospect of computer-assisted human intelligence raises obvious concerns over the safety and ethics of their application. Are there conditions under which a human "cyborg" could put humans at risk? Is altering human behavior with a machine tantamount to "playing god" and a dangerous overreach of our powers?

Despite these concerns, such computer-assisted intelligent systems are already available and in surprisingly wide-spread use. Human brain-computer interface has been in use for decades, helping to restore vision, movement and communication in impaired individuals. Although your brain may not be directly wired to a computer, it's likely that you often function as a human cyborg on a daily basis. Many of us rely on a GPS to augment our navigation abilities while driving, on a word-processor's spell-checker to enhance our writing, or on a digital planner to organize a busy schedule. Few would argue that these daily uses of computer assistance are unethical. But where does one draw the line between harmless lifestyle enhancement and dangerous mind-control? Yu and colleague's findings suggest that, at least for now, we need not fear overtake by super-smart robots; perhaps instead it's time to embrace the computing abilities of machines as complementary – and beneficial – to our own natural powers of intelligence.

More information: Yipeng Yu et al. Intelligence-Augmented Rat Cyborgs in Maze Solving, *PLOS ONE* (2016). DOI: 10.1371/journal.pone.0147754

Carles Grau et al. Conscious Brain-to-Brain Communication in Humans Using Non-Invasive Technologies, *PLoS ONE* (2014). DOI: 10.1371/journal.pone.0105225