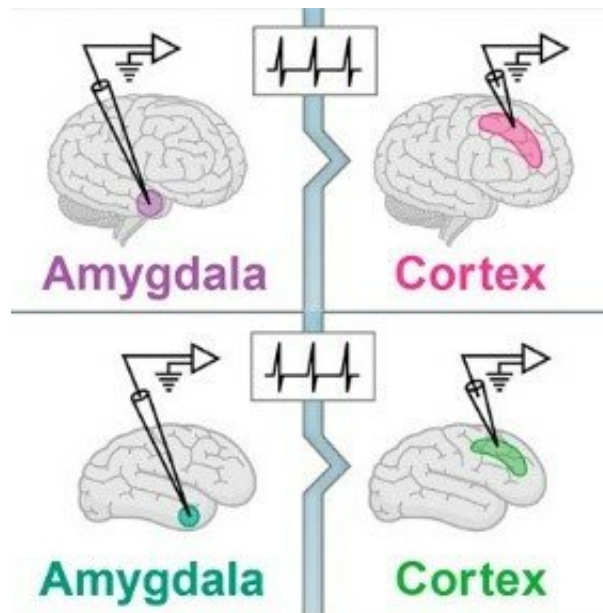


# The price we pay for our advanced brains may be a greater tendency to disorders

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The tradeoff in human brains (top) and monkey brains (bottom). The more evolutionarily advanced, the more efficient and the less robust each area proved to be Credit: Weizmann Institute of Science

Prof. Rony Paz of the Weizmann Institute of Science suggests that our brains are like modern washing machines—evolved to have the latest sophisticated programming, but more vulnerable to breakdown and prone to develop costly disorders. He and a group of researchers recently conducted experiments comparing the efficiency of the neural code in non-human and human primates, and found that as the neural code gets

more efficient, the robustness that prevents errors is reduced. Their findings, which recently appeared in *Cell*, may help to explain why disorders as ADHD, anxiety, depression, PTSD and even autism are common in humans.

Paz, in the Institute's Neurobiology Department, says that anatomical differences between humans and other primates have been described—particularly our large [prefrontal cortex](#) and its extended number of neurons. But differences in the [neural code](#)—the "software," in contrast with the "hardware" (the physical structure)—have not been explored.

Raviv Pryluk, a research student in Paz's group, devised a way to test and compare the efficiency of the neural code in several regions of the brain. "We defined efficient communication as that which uses the least amount of energy to transmit the maximal information—to pass on as complicated message as possible with the fewest 'words'," says Pryluk.

The researchers recorded the electric activity of single neurons both in humans and in [macaque monkeys](#) in two regions: the prefrontal cortex, where higher functions like decision-making and rational thinking occur, and the amygdala, a more evolutionarily ancient region that is responsible for the basic "fight-or-flight" survival functions, as well as emotions. Paz and his group worked in collaboration with Prof. Itzhak Fried of Sourasky Medical Center in Tel Aviv and UCLA Medical School in Los Angeles.

Patients with pharmacologically intractable epilepsy come to Fried for diagnostic electrode implants, which provide a rare opportunity to record the electric activity of single neurons in the human brain. Also participating in this research were Dr. Hagar Gelbard-Sagiv of Tel Aviv University and Dr. Yoav Kfir, at that time a research student in Paz's group.

The findings of this research provided support for the "washing machine" theory of brain evolution: The neural code in the more evolved prefrontal cortex is more efficient than the amygdala, both in humans and monkeys. And the neural code of both areas in the human brain was more efficient than its monkey counterpart. But the higher the efficiency of a particular neural code, the less it was robust to errors. Paz likens the amygdala to a washing machine drum: "It's not highly sophisticated, but it is less likely to fail—which is important to animals' survival," he says, adding, "The lower resistance of the human amygdala to errors may play a role in exaggerated survival-like responses in inappropriate contexts, such as those we see in PTSD and other anxiety disorders."

Pryluk says, "Evolution works with trade-offs. There may be a zero-sum game between efficiency and robustness, and our complex, multidimensional brains have gained one at the price of the other."

Fried says, "Comparing single-cell recordings from human and monkey brains is a large step toward answering the question of what makes the human brain unique."

Paz adds, "Why, on the one hand, do humans have such superior learning, cognitive and adaptive abilities and, on the other, this tendency to anxiety, depression and other mental disorders? We have shown that these may be two sides of the same coin."

Provided by Weizmann Institute of Science

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