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Science's 'Most Beautiful Theories'

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By Sharon Begley

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NEW YORK (Reuters) Jan 16 - From Darwinian evolution to the idea that personality is largely shaped by chance, the favorite theories of the world's most eminent thinkers are as eclectic as science itself.

Every January, John Brockman, the impresario and literary agent who presides over the online salon Edge.org, asks his circle of scientists, digerati and humanities scholars to tackle one question.

In previous years, they have included "how is the Internet changing the way you think?" and "what is the most important invention in the last 2,000 years?"

This year, he posed the open-ended question "what is your favorite deep, elegant or beautiful explanation?"

The responses, released at midnight on Sunday, provide a crash course in science both well known and far out-of-the-box, as admired by the likes of Astronomer Royal Martin Rees, physicist Freeman Dyson and evolutionary biologist Richard Dawkins.

Several of the nearly 200 scholars nominated what are arguably the two most powerful scientific theories ever developed. "Darwin's natural selection wins hands down," argues Dawkins, emeritus professor at Oxford University.

"Never in the field of human comprehension were so many facts explained by assuming so few," he says of the theory that encompasses everything about life, based on the idea of natural selection operating on random genetic mutations.

Einstein's theory of relativity, which explains gravity as the curvature of space, also gets a few nods.

As theoretical physicist Steve Giddings of the University of California, Santa Barbara, writes, "This central idea has shaped our ideas of modern cosmology (and) given us the image of the expanding universe."

General relativity explains black holes, the bending of light and "even offers a possible explanation of the origin of our Universe - as quantum tunneling from 'nothing,'" he writes.

Many of the nominated ideas, however, won't be found in science courses taught in high school or even college.

Terrence Sejnowski, a computational neuroscientist at the Salk Institute, extols the discovery that the conscious, deliberative mind is not the author of important decisions such as what work people do and who they marry. Instead, he writes, "an ancient brain system called the basal ganglia, brain circuits that consciousness cannot access," pull the strings.

Running on the neurochemical dopamine, they predict how rewarding a choice will be - if I pick this apartment, how happy will I be? - "evaluate the current state of the entire cortex and inform the brain about the best course of action," explains Sejnowski. Only later do people construct an explanation of their choices, he said in an interview, convincing themselves incorrectly that volition and logic were responsible.

To neuroscientist Robert Sapolsky of Stanford University, the most beautiful idea is emergence, in which complex phenomena almost magically come into being from extremely simple components.

For instance, a human being arises from a few thousand genes. The intelligence of an ant colony - labor specialization, intricate underground nests - emerges from the seemingly senseless behavior of thousands of individual ants.

"Critically, there's no blueprint or central source of command," says Sapolsky. Each individual ant has a simple algorithm for interacting with the environment, "and out of this emerges a highly efficient colony."

Among other tricks, the colony has solved the notorious Traveling Salesman problem, or the challenge of stopping at a long list of destinations by the shortest route possible.

THE OTHER PAVLOVIAN EFFECT

Stephen Kosslyn, director of the Center for Advanced Study in the Behavioral Sciences at Stanford, is most impressed by Pavlovian conditioning, in which a neutral stimulus such as a sound comes to be associated with a reward, such as food, producing a response, such as salivation.

That much is familiar. Less well known is that Pavlovian conditioning might account for placebo effects. After people have used analgesics such as ibuprofen or aspirin many times, the drugs begin to have effects before their active ingredients kick in.

From previous experience, the mere act of taking the pill has become like Pavlov's bell was for his dogs, causing them to salivate: the "conditioned stimulus" of merely seeing the pill "triggers the pain-relieving processes invoked by the medicine itself," explains Kosslyn.

Science theories that explain puzzling human behavior or the inner workings of the universe were also particular favorites of the Edge contributors:

- Psychologist Alison Gopnik of the University of California, Berkeley, is partial to one that accounts for why teenagers are so restless, reckless and emotional. Two brain systems, an emotional motivational system and a cognitive control system, have fallen out of sync, she explains.

The control system that inhibits impulses and allows you to delay gratification kicks in later than it did in past generations, but the motivational system is kicking in earlier and earlier.

The result: "A striking number of young adults who are enormously smart and knowledgeable but directionless, who are enthusiastic and exuberant but unable to commit to a particular work or a particular love until well into their twenties or thirties."

MOST EMAILED

BEAUTIFUL IDEAS

- Neurobiologist Sam Barondes of the University of California, San Francisco, nominates the idea that personality is largely shaped by chance. One serendipitous force is which parental genes happen to be in the egg and sperm that produced the child.

"But there is also chance in how neurodevelopmental processes unfold - a little virus here, an intrauterine event there, and you have chance all over the place," he said in an interview. Another toss of the dice: how a parent will respond to a child's genetic disposition to be outgoing, neurotic, open to new experience and the like, either reinforcing the innate tendencies or countering them.



The role of chance in creating differences between people has moral consequences, says Barondes, "promoting understanding and compassion for the wide range of people with whom we share our lives."

- Timothy Wilson nominates the idea that "people become what they do." While people's behavior arises from their character - someone returns a lost wallet because she is honest - "the reverse also holds," says the University of Virginia psychologist. If we return a lost wallet, our assessment of how honest we are rises through what he calls "self-inference." One implication of this phenomenon: "We should all heed Kurt Vonnegut's advice," Wilson says: "We are what we pretend to be, so we must be careful about what we pretend to be."

- Psychologist David Myers of Hope College finds "group polarization" a beautiful idea, since it explains how interacting with others tends to amplify people's initial views. In particular, discussing issues with like-minded peers - increasingly the norm in the United States, where red states attract conservatives and blue states attract liberals - push people toward extremes. "The surprising thing is that the group as a whole becomes more extreme than its pre-discussion average," he said in an interview.

- Martin Rees, professor of cosmology and astrophysics at the University of Cambridge, nominates the "astonishing concept" that what we consider the universe "could be hugely more extensive" than what astronomers observe.

If true, the known cosmos may instead "be a tiny part of the aftermath of 'our' big bang, which is itself just one bang among a perhaps-infinite ensemble," Rees writes. Even more intriguing is that different physics might prevail in these different universes, so that "some of what we call 'laws of nature' may ... be local bylaws."

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