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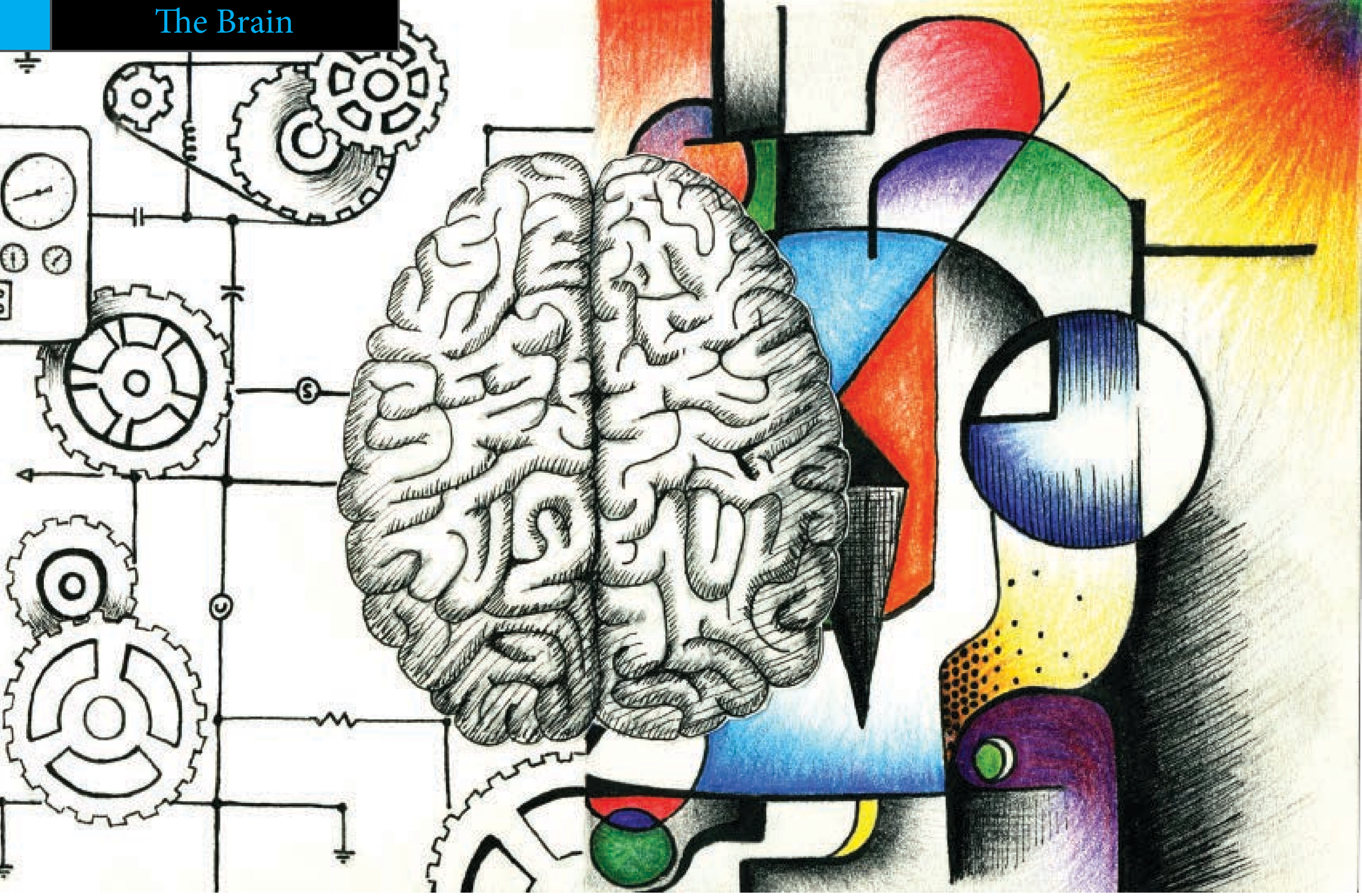

Rigorous Innovation

How Neuroscience Shapes our View of Creativity

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Illustrated by Megan Herrmann

Creative impulse represents one of the more idolized traits in human history. Many societies across the globe prize the skills associated with innovation. As a result, creativity has been a topic of research in philosophy, psychology, and other fields for hundreds of years. More recently, neuroscience has been exploring this in conjunction with the advancements in technological methods associated with studying the brain. While the definition of creativity shifts back and forth over time and between fields of study, neuroscience provides us with a more complex awareness about what happens to our brains when we mold our thoughts into novel designs and works of art.

Researchers have discovered various forms of creativity, each associated with its own mechanism in the brain, although overlaps between them do exist. Some examples include cognitive and emotional creativity, economic innovations, and scientific and technological breakthroughs. Researchers have also looked at artistic creativity, such as visual creativity, like painting and sculptures, and musical creativity. The arts have been the most widely studied form of creativity in neuroscience.

Musical creativity has been a particularly important research theme. Published in 2008, one foundational fMRI study, by Charles Limb and Allen Braun, looked at the differences in brain activation amongst instances in which six professional musicians played improvised notes within in a particular musical scale on the piano, and when those same individuals improvised alterations to a jazz tune. The set of participants who were restricted to use a single scale were expected to produce a lower degree of musical complexity, and therefore, display a lower amount of creativity. On the other hand, the participants working on the improvised jazz were expected to exhibit a higher degree of musical complexity, and therefore a higher amount of creativity.

The results expressed that improvisation of a higher complexity leads to changes in activation of the prefrontal cortex, which is the part of the brain that processes various higher-order forms of thought, including planning, decision-making, and expressing personality. Specifically, they found increased activation of the medial prefrontal cortex (MPFC) and decreased activation in the dorsolateral prefrontal cortex (DLPFC). The MPFC is an area that is important for processing personal history, and in this case, personal musical history, to produce improvised music. The DLPFC is important for strategic planning and problem solving, and so, less activation in this region leads to an increase in the kind of non-goal-oriented mind wandering that is seen when individuals are at rest. Therefore, this pattern of both increased autobiographical memory recall and spontaneous generation of ideas was found to be a key component in musical improvisation.

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Another research team found similar results when they carried out an fMRI study on twelve artists in 2012. In this case, the team examined the neural basis of improvising music in the context of freestyle rap. They found the same kind of relationship between rehearsed and freestyle rap performances that was found in the 2008 piano study. During freestyle rap performances, there was inhibition of the DLPFC and excitation of the MPFC. This pattern of activation did not occur in the brains of individuals reciting rehearsed lyrics. Musical improvisation and its neural connections mimic the kind of multimodal functioning that can be seen in other kinds of creativity.

Early last year, a team of researchers found that engaging in visual creativity tasks gives rise to a similarly nuanced pattern of processing in the brain. The study was conducted at the University of Trento in Italy. It analyzed this interaction by looking at the neural connections in the brains of a group of twelve professional artists and twelve individuals who were not artists, while they were partaking in a visually creative task. During this task, they were asked to imagine what they would create to represent the concept of "landscape" and to think about the materials they would use to create it.

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Each of the participant's brain activation patterns during this task were recorded with fMRI. Then, these recorded patterns were compared to brain activation patterns, which were recorded during a non-creative task, such as visualizing the alphabet, and a task in which the participants were asked to let their minds wander. The visually creative task produced a similar pattern of activation in all of the participants, and this pattern was not present in the other two tasks. This pattern showed a specific interaction between two networks in the brain that had previously been found to oppose each other. These networks, the default mode network and the executive control network, are our processing modes at different levels of mental stress.

The default mode network is our more relaxed form of mental processing, which is active when it is not performing difficult tasks or trying to problem-solve in any way. This network consists of a variety of different structures around the brain, which serve various functions that revolve around emotional memory and visual and sensory perception. In the context of creativity, this network can be thought of as the system in the brain that spontaneously generates ideas. Furthermore, artists can use this system in the initial stages of planning a piece. In contrast to the default mode network, the executive control network is the system in the brain that helps us reach goals by controlling and directing our behavior. This work is thought to mainly occur in the frontal lobe, where the prefrontal cortex lies. One particularly key area in this region is the DLPFC. This system is linked to the second step in the visually creative process, when artists pick which ideas generated from the default mode network are the most essential for their piece.

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The results of this new study provide some evidence that our notions of creativity are misguided or underdeveloped. Creative endeavors involve logical processing in the form of decision-making. As individuals scroll through their mental matrices of ideas, they pinpoint which ones are the most poignant to the piece or concept they hope to create. This discovery of communication between the spontaneous flow of ideas at rest and the rigorous logic involved in rational selection give us a deeper understanding of how creativity works. Additionally, rather than being an inherent trait to certain individuals, this kind of creative neural communication is a skill present in the entire population. Therefore, encouraging adolescents and children to continue practicing their creative skills, regardless of the level of their perceived inherent talent, is an important and worthwhile pursuit. It is also essential in supporting the next generation of artists, musicians, and scientists.