

# THE NEUROSCIENCE OF INNOVATION

How to unlock the six principles of innovative thinking

Fact Sheet



Imagine you're in a jazz club, watching your favorite trio play. In the middle of the set, the bassist starts to jam on stage, coming up with spontaneous riffs that are melodic, harmonic, and moving.

You think, "How innovative and creative." Then, you tell yourself, "They must have a special skill or innate ability for them to be that innovative."

Neuroscience research, though, shows us that innovation is not a special skill—it is not something mystical or magical. Instead, we all have the capacity to be innovative because innovation is grounded in everyday, ordinary mental functioning. Innovative thinking can be learned and developed—with patience and practice.

Developing the ability to innovate is increasingly a source of competitive advantage for businesses. Most organizations are engaged in some journey of transformation to adapt to the new business environment or to increase their performance. Transformation means new ways of thinking, connecting and doing things. It means that leaders and people in business—much like jazz players—must find new, harmonic relationships in expanded ecosystems and reach new heights of performance through novel solutions and business models. By understanding the neuroscience of innovative thinking, organizations can tap into fresh learning and insights that help them transcend the music sheet of business innovation.

## What is innovation?

Innovation can be an outcome (like a new product or a new use for an existing one) or a process (like a new policy or process). Or it can be a way of thinking that is both novel and useful. Innovation might improve efficiency and lower costs—for people and organizations—by increasing speed and productivity. Or it might transform everyday life by introducing products that change our way of doing things.

Often, innovation is seen as something tangible—like a new gadget that kick-starts a revolution. Johannes Gutenberg's printing press. The Kenbak-1, the world's first personal computer. Motorola's brick of a mobile phone, released in 1973. Or, more recently, less tangible tools like digital platform models that bring the dining or moviegoing experience into your home. But innovation doesn't start at the outcome. Rather, innovation begins as an idea—the moment we decide to embrace new ways of thinking and discovering.

Creative insight, the backbone of innovative thinking, can occur both spontaneously and deliberately. Archimedes' "Eureka!" moment in the bathtub is an iconic example of spontaneous creativity. Deliberate creativity, on the other hand, involves methodical problem solving—like a group of scientists using systematic experimentation and testing to invent a new device to aid visual impairments.

## How does innovative thinking happen in our minds?

Both spontaneous and deliberate innovation are underlined by several distinct mechanisms in the brain. By understanding and “activating” these mechanisms, business leaders and professionals in general can expand their ability to generate new ideas and be innovative.

Below, we focus on the six fundamental principles of innovative thinking based on neuroscience research. In substance, these levers help the brain tap into existing—yet dormant—resources, like our full memory, allow for new inner-connections and “what if” possibilities, and learn from others to stimulate new thoughts:

### 1. Making (seemingly unrelated) associations

Creative thinking relies on the ability to make associations between unrelated concepts. When we think creatively, we use various parts of our brain that interpret both the novelty and usefulness of new concepts. We do so first by searching through semantic memory—that is, our long-term memory of common knowledge and facts about the world around us. Semantic memory processing can happen both automatically (think that “aha” moment of spontaneous innovation) and in a controlled manner (making a conscious, intentional effort to sort through thoughts). Automatic associations involve fast connections between unrelated concepts using the association and memory regions of the brain, whereas controlled connections require the additional use of the prefrontal cortex to deliberately search through our distant knowledge while ignoring irrelevant information. While in some cases we might be able to freely and quickly come up with novel ideas by making new associations in a split second, we can also be more intentional by turning down some of the extra noises in our brain and explicitly focusing on finding solutions.

### 2. Mental time travel

A fundamental aspect of human cognition is our ability to reconstruct past events in our minds and project ourselves into the future by imagining alternative scenarios—a process known as mental time travel. We use episodic memories (that is, memories of our past personal experiences) to shift our attention from our immediate environment into our remembered past—or our imagined future. Also called “temporal imagination,” mental time travel enables our minds to imagine across time and space and orient ourselves towards the future. An important neural mechanism that supports mental time travel is the default mode network (DMN), a network of brain areas corresponding to the resting state—or “idling”—of the brain. Brain imaging studies reveal that the default mode network is active when people are engaged in unplanned cognitive activity like mind-wandering or daydreaming, which help us remember the past and imagine the future in an effortless way. This type of spontaneous cognition is a hallmark of imagination and impromptu creativity because it enables people to quieten their mind so they can connect the previously unconnected dots.

### 3. Mental imagery

Mental imagery refers to the ability to create visual representations by retrieving information from our memory—or put more simply, “seeing with the mind’s eye.” One mechanism through which mental imagery is thought to promote imagination and creativity is through the vividness of the mental images that are being recreated. Mental imagery uses the brain regions involved in visual perception—the same regions people who are blind from birth use to produce mental images from mere verbal descriptions. Mental imagery, therefore, is not only for visual tasks—it’s important for artistic, scientific, and verbal creativity. Neuroscience research shows that mental imagery systems in the brain are activated during creativity across different tasks. For example, one neuroimaging study scanned the famous Venezuelan classical music performer, Gabriela Montero, and found that visual imagery regions of her brain were activated while she improvised on a keyboard inside the fMRI machine. So, we can say that creativity is seeing with our mind’s eye.

#### 4. Counterfactual thinking

Counterfactual thinking is a non-lateral way of imagining alternative—and sometimes contrary—ways things might have happened. This way, we can experience alternate realities without actually living through them. Counterfactual thinking supports creativity by allowing people to question and mentally challenge what is given to them. Through counterfactual thinking, we can sail into alternative futures or pasts and ask the questions “what if,” “why,” and “why not.” In the brain, the default mode network, reward circuitry, and the cognitive control areas work together when we are engaged in both spontaneous and more deliberate counterfactual thinking. Interestingly, people with damage to their prefrontal cortices show impairments in spontaneous counterfactual thinking despite still being able to arrive to counterfactuals through deliberate guidance and cues. This shows that even when a person might not be able to easily come up with alternatives to a scenario, they might be guided and taught to imagine alternative possibilities with specific instruction.

#### 5. Imitative learning

It may sound counterintuitive that imitation can beget creativity and originality, but imitation is one of the key mechanisms of human learning. Imitative learning unleashes our ability to learn from collective or cultural wisdom, going beyond the singular perspective. What sets apart humans' ability for imitative learning is that humans imitate others with the understanding that others' actions are intentional and goal-driven. So, when we are imitating another person, we are not just copying their body movements, we also understand the reason behind their choice of actions and how they contribute to the outcome. This way, a complex array of neural mechanisms like visual perception, short-term memory, social cognition, and agency get involved during human imitative learning. Neuroscience research refers to this neural system as the “mirror neuron system”: neurons in this system fire both when we watch others' actions and when we perform the same action. In a way, these neurons “mirror” the other person's neural activity. Scientists argue that the mirror neuron pathways enable us to imitate others by using the same neurons, thus helping us learn more effortlessly, contributing to spontaneous creativity.

#### 6. Empathy

Empathy is our ability to move beyond our own point of view and understand or feel what other people are experiencing. Empathy can have two forms: **emotional and cognitive**. Emotional empathy creates the instant gut reactions and feelings we have when we interact with others; It helps us “feel like” others. Cognitive empathy, on the other hand, relies on our capacity to “know” what others are thinking and feeling. This capacity is also called a Theory of Mind—our capability to understand the ways the minds of others operate. While emotional empathy contributes to spontaneous innovation by sparking novel ideas or gut reactions, cognitive empathy is more crucial for deliberate innovation. In fact, brain imaging research found that **synchronization of the brain areas** related to Theory of Mind among team members enhanced creativity levels in a cooperation-based creativity game. Not only that, but joint activation of these regions also turned two less creative people into a highly creative team. Therefore, empathy in diverse teams seems to be the key to innovation.

#### Six ways to unlock innovative thinking

Based on these neuroscience-based principles, here are six specific, actionable strategies that leaders can use to unlock innovative thinking:

##### 1. Quiet your mind

To make associations between distant knowledge in our brain, it is important to reach a mental quiet by reducing the extra cognitive load on it. This can be achieved by reducing our cognitive load (such as back-to-back meetings and deadlines) or deliberately implementing calming mental training practices, such as mindfulness or meditation, in our routine. Neuroscience research shows that mindfulness practice enhances attention, emotion regulation, and self-awareness in the brain; thus, quietening our minds and preparing the space for novel and creative associations.

##### 2. Have a positive mindset

Mental time travel to a reimagined past or imagined future relies on episodic memory retrieval. Research shows that both having high self-efficacy (belief in our own capacity for performance) and focusing on positive future-oriented thoughts improve mental time-traveling capacity. Therefore, embodying positive emotions and a positive self-image would boost innovative thinking.

### 3. Create the mental space

To create the space for innovation in our minds, we need to have a diverse array of experiences and knowledge conducive to creating novel ideas. One way of creating this space would be trying new things in life and going on new adventures—making sure to use all our senses in experiencing the world, in all its vividness of taste, scents, sound, touch or sight. This type of strategy would enhance our mental imagery.

### 4. Increase your autonomy

Counterfactual thinking helps us experiment with new ideas by questioning existing events or outcomes. Research shows that when people exercise higher autonomy or free will, their counterfactual thinking abilities improve. Whether it is an internal motivation for self-independence, or externally created conditions to exercise free will, autonomy increases both the number and the types of counterfactuals a person can create, enabling more effective learning.

### 5. Observe with intent

Observation is the key for imitative learning. Even from our earliest days in life, we observe others around us to learn how to behave and respond to a complex world surrounding us. However, not all observations are equal. Brain research shows that the intent of the observer shapes the brain pathways that respond to observation. When people observe an action just with the mere intent of recognizing, mostly it is the brain structures related to memory that are activated. However, when people observe actions with the intent of imitation and learning, a wider net of brain regions, including prefrontal regions (like the dorsolateral prefrontal cortex) related to action planning and goal directed behavior, is activated. So, intention setting (observing with the purpose of learning) is a useful cognitive strategy for learning from others for the pursuit of deliberate innovative thinking.

### 6. Collaborate with diverse others

Exposure to different perspectives and backgrounds reduces prejudice and increases empathy. Working in diverse teams not only fosters empathy but also boosts imagination and creativity. Diverse teams innovate and create more effectively. Research from Chinese firms showed that collaboration breadth among employees with diverse technological skills exponentiates the overall innovation performance of the firms.

Neuroscience research also supports these notions, demonstrating that exposure to others' ideas during creative tasks, and collaboration with others to innovate new ideas, improve originality of the outcomes.

## How organizations can foster innovative thinking

Innovation, when implemented well, can bring profit and growth to businesses in a multitude of ways, including improving brand recognition and value, reduced costs and increased productivity. A recent *MIT Sloan Management Review* paper found that businesses that had a higher rate of innovative ideas produced by their employees experienced a larger growth in their profit.

But how can organizations facilitate innovation by fostering innovative thinking among their employees? Here are six actionable recommendations, based on neuroscience mechanisms and strategies.

### 1. Give minds the time to wander

Research found that, to foster innovative thinking, teams should be given open, unstructured time and resources at the initial planning and designing stages. This way, they can let their minds wander, make connections between distant knowledge, and experiment with different thoughts. Loose control and small pockets of research financing that can be accessed without strict bureaucratic processes are often considered to be good managerial practices for promoting innovation and invention at earlier stages of development.

### 2. Invest in employee wellbeing

Organizations can improve mind-wandering and mental time travel by investing and implementing strategies that improve employee wellbeing, increase self-esteem, and build self-efficacy. For example, designating “no meeting days,” providing mindfulness trainings, and offering wellness benefits can be paired with professional growth opportunities. Specific vacation time benefits could also be provided for employees to travel and increase their mental time travel repositories.

### 3. Integrate visualization practices to improve innovation

Mental imagery is a core component of creative thought processes. Research shows that mental imagery can also act as an amplifier of motivation to promote not only engagement in activities but also increase enjoyment of them. Therefore, integrating visualization processes like storyboarding, graphical illustrations or mental imagery exercises (including imagining previous or future tasks, activities or products) as part of the day-to-day work can help improve innovation.

### 4. Count blessings—as well as losses

Upward counterfactual thinking helps us imagine what could have gone possibly better and downward counterfactual thinking helps us think about what could have gone worse. The perfect balance of these two modes could provide leaders and teams with a mental protocol that allows them to increase their return-of-failure without demoralizing themselves or their workforce. Luckily, counterfactual thinking can be improved with instruction and training, and incorporated into the mental routine in the workplace.

### 5. Provide opportunities to observe to jumpstart agile learning

Teams for innovation can look for opportunities for partnerships and networking that will allow for observation internally and externally. For example, shadowing different production or research teams, attending workshops or conferences, conducting regular market and benchmarking analyses would all be examples in an intentional and constructive way.

### 6. Value, promote, and empower differences

Innovation occurs at the nexus of bringing together diverse ideas into new concepts. Innovative teams can search for different inputs and ideas both internally (via the technological diversity within the firm) and externally (via formal or informal collaboration opportunities). Diversity can also be paradoxical, though; it can create misunderstandings and resentments in a highly diverse team. To counter these negative effects, leaders should foster a supportive and inclusive work culture that emphasizes perspective-taking and intercultural competency so that all employees, across all levels, promote innovative thinking and feel empowered.

Innovative thinking is an achievable goal. With the right individual mindsets, organizational environment, and management strategies, innovation can be purposefully cultivated, resulting in more products, better processes, and newer, cutting-edge strategies or concepts.

**Figure 1**  
Unlocking the six principles of innovative thinking



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