



IT'S ALL IN THE MIND

Creativity, innovation and the brain - it's a heady mix, as neurophysiologist **Prof Marcello Costa** explains and one that thrives on sharing.

Creativity and innovation are some of the most remarkable properties of the human brain. Although we still know little of the brain processes underlying these unique functions, there is a consensus that they are well embodied in the normal functions of the brain.

This short commentary is a personal view of how creativity and innovation in our modern society can be discussed profitably from a neu-

rosience perspective.

Concept of the brain

The brain is a gigantic collection of neurons: sensory neurons (which continuously monitor changes in the internal and external environment), motor neurons (which translate sensory information into action by controlling muscle cells), and an enormous number of "in between" neurons called interneurons, which

are responsible for the evolutionary growth of the brain. The enormous power of our minds is due to the rich architecture and functioning of millions of interneurons.

Mental functions are carried out by brain neural circuits, in particular by those involved in memory, language and cognition.

Brain imaging has given an insight of where and when something happens in the brain correlated to specific mental functions.

As a result, most previous ideas on the localisation of certain functions, based on experimental lesions in animals or spontaneous diseases or accidental lesions in humans, have been confirmed and refined.

Two major brain functions

Rationality and creativity have often been seen as contrasting human abilities.

However, few will argue that the human brain has given the human species new advantages over most others. Such advantage is based on the remarkable ability of the brain to detect stable patterns in the world on one hand, and to detect novelty or salient features, making new functional connections between apparently unrelated events in the world, on the other.

Essential for survival and increasingly advantageous for species is the appearance in evolution of goal-directed behaviours. Goal-directed behaviours emerge from the ability to predict, which in turns depends on a robust detection of patterns in the world.

This enables the brain to construct models of the world on which to base decisions. Human rationality is based indeed on goal-directed actions¹.

Creativity on the other hand is not necessarily goal-oriented. It may represent the exploratory part of our brain, able to imagine situations before they eventuate. Imagination is a form of free-modelling of reality without having to enact it every time.

This gives enormous advantage of no-cost trial and errors. A balance between rationality and creativity in early humans may have given them the ability to cope with increasingly varied environments, and enabled humans to settle successfully in most environments on Earth.

Creativity and reward

Both art and science are characterised by innovation and discovery. They are interpretative activities - they are both about meaning and they both use models and metaphors to make the invisible visible, to provide some sort of explanation.

While the artist is generally acknowledged to generate a sense of beauty and wonder, science is also strongly based on a sense of beauty (harmony). The French mathematician and philosopher Henri Poincaré stated that

"The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful."

Beauty is probably the way the self-reward of cognitive creative activities is achieved. One of the best examples of the role of imagination in creativity is visual imagery in art².

Research shows that there may be specific parts of the brain where novelty and imagination take place. These are areas of the brain located at greater distance from sensory or motor neurons in a common "neural space", a kind of distributed space where learning and attention can take place, ie high level cognitive functions. Such a place is probably the posterior parietal cortex³.

This abstract space, where imagination lives, is what many modern philosophers of mind

regard as a metaphoric "stage theatre of mind".

A classical metaphor for consciousness has been a "bright spot" cast by a spotlight on the stage of a dark theater that represents the integration of multiple sensory inputs into a single conscious experience, followed by its distribution to a vast unconscious audience. In the cognitive field, such a theater stage is called a "global workspace", and implies both convergence of input and divergent dissemination of the integrated content⁴.

Within this global workspace strategies of selecting salient events are based on some reward system.

Successful strategies are usually associated with some reward system that favours certain strategies over others. The rewards the brain processes are beginning to be better understood⁵.

Cognitive and motivation incentives (satisfaction is an internal reward for certain achievements) appear to involve neocortical structures in the frontal and parietal lobes.

The nature of the neural operations associated with cognitive incentives is unknown but plausible and testable models are being proposed.

Lesion experiments have raised the possibility that the release of the neurotransmitter dopamine encodes a measure of the incentive value of a contemplated behavioural act⁶.

Cooperation diversity and innovation

Much of human endeavour is shared through communication. The discovery of mirror neurons provided the first convincing physiological evidence for a direct matching between action perception and action execution⁷.

Such neural processes are probably the basis of awareness of the self and others and lie at the basis of human intentional cooperation.

Human cultural diversity arises from two main processes. One is the drive to secede from larger groups whenever possible, to better control some advantageous resource; this is what probably gives rise to the geographical patterns of diversity.

Social and behavioural processes, on the other hand, maintain cooperation within groups and create cultural identity and coherence based on communication.

Putting these processes together, a picture emerges of humans as a highly social and group-focused species⁸. The traits for the emergence of cultures thus appear to play against the selection for excessive diversity and innovation. We do live in an increasingly global culture.

This is due to the spread of the common languages of science, technology and economy. These, for the first time, are capable of unifying the entire human species under one potential common culture (globalisation).

In parallel to the need to develop a global cohesive identity, it is important to preserve some degree of creativity, novelty and innovation.

Indeed, social processes have emerged for the recognition of and reward for creativity. Most organisations endeavour to foster innovation, as their ability to grow depends on creativity and novelty. Despite expectations, studies over the past decades show that monetary incentives or deadline pressures do not guarantee optimisation of creativity and innovation. People are most creative when they care about their work and they are stretching their skills⁹.

This research shows that creativity often requires long incubation periods and protection from distractions.

This work also demonstrates that the most creative teams are those that have the confidence to share and debate ideas. But when people compete for recognition, they stop sharing information.

Creativity was shown also to suffer greatly during a downsizing of team structures and infrastructures - an important lesson for many senior managers too often attracted by processes of "rationalisation".

The lesson from the neurosciences

Both parts of the human brain, the individual and the social, are involved everyday in creativity and innovation. The process of creativity thus can be regarded as an essential component of the brain adaptation of humans to their environment.

Better knowledge of this brain process will lead to better decisions of how best to take advantage of this remarkable human characteristic. ■

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