nature café REPORT

Building a better brain

Karolinska Institutet — the Swedish medical university — in collaboration with Nature Café discusses some of the latest research in brain science, creativity and cognition

Nature Café is a unique forum organized by NPG Nature Asia-Pacific that allows registrants to the natureasia.com Japanese website and Nature subscribers in Japan to meet with Nature staff and other international scientific experts to discuss some of the hottest current topics in science. The sixth Nature Café forum on 'The Smart Brain at Work' was held on 16 October 2010 at the Embassy of Sweden in Tokyo and featured several guest speakers from Karolinska Institutet the internationally renowned medical university in Sweden.

The Café was opened with an address by His Excellency Stefan Noreén, Ambassador of Sweden to Japan. Following this, Professor Harriet Wallberg-Henriksson, president of Karolinska Institutet, gave an introduction to the history and work of the university, which this year celebrated its 200th anniversary.

Flexible brains are kids' stuff

The scientific discussion was moderated by Yukiko Motomura, deputy director of Science and Environment News at Mainichi Newspapers, a major Japanese news organization. Motomura introduced the first speaker Martin Ingvar, a professor of Integrative Medicine and dean of research at the Karolinska Institutet. In his presentation on 'The adapting brain', Ingvar focussed on the remarkable ability of the brain to develop in response to external and social cues over two distinct stages in its development — the flexibility phase and the stability phase.

"The brain is generally coded to adapt to the natural environment and society, and the hard-wired automatic behaviour and learning provide faster reaction and better prediction in order to save on the limited computational ability of the brain," explained Ingvar. "A child's brain is very adaptive but that carries a computational cost. In the adult brain, there is about half the number of synapses, and the brain becomes stable and adapts more by implementation of already encoded programs."

The brain is made up of four layers that handle different aspects of the cognitive process: automaticity, emotional reaction, feeling and thoughts reflection. The appropriate layer is used to compensate for the limited computational capacity of the brain. However, automation of some of the behaviour can interfere with accurate judgement. Ingvar gave an example of an experiment in which the test subject is shown a video of a person pronouncing the consonant 'd' and given the audio of the spoken consonant 'b' at the same time. Remarkably in this test, it was found that despite audio stimuli to the contrary the subject hears the 'd' sound. Ingvar then invited the audience to take the test for themselves, which raised eyebrows as participants experienced the workings of the visual pathway gaining the upper hand over the auditory pathway such that they were literally unable to believe their ears.

Ingvar also touched on the learning of language. "People who can read and write a language have a developed corpus callosum. As illustrated in this example, the brain can change its morphology in response to external pressure." The flexibility of the brain is important for being creative, but "stress can reduce plasticity" he concluded.

Music moves minds

In the second part of the presentation, Fredrik Ullén, professor of cognitive neuroscience at Karolinska Institutet, who in addition to being a researcher is also a professional concert pianist, spoke about the association of creativity with music and with schizophrenia.

In his talk on 'The creating brain', Ullén described an experiment using a special piano keyboard designed to be played by a subject inside the cavity of a functional magnetic resonance imaging scanner. In the experiment, a group of eighteen professional classical pianists were shown sheet music of a simple melody and asked to improvise on the tune by adding decoration such as grace notes while the activity in their brain was being monitored. Ullén found strong activity in the dorsolateral prefrontal cortex and other parts of the prefrontal cortex responsible for planning complex cognitive behaviour, as well as in the premotor area. The study revealed a particularly strong correlation between activity in the pre-supplementary motor area and the complexity of the improvisation.

Following this, Ullén presented some of his findings concerning the long-discussed relationship between schizophrenia and creativity. In the brain of schizophrenia patients, it is known that the levels of dopamine D2 receptor — variants of which have been linked to creativity and divergent thinking — in the thalamus are lower than in normal brains. The thalamus is a symmetrical structure at the top of the cerebral cortex which relays sensation, spatial sense and motor signals and regulates consciousness, sleep and alertness. Ullén showed that increased creativity in healthy patients is similarly associated with low D2 receptor density in the thalamus, suggesting a biological common denominator between symptoms of schizophrenia and creativity in healthy individuals. "There are many creative people among the relatives of schizophrenia patients," concluded Ullén.

Old heads can get wiser

Nature Café is, more than anything, an interactive experience. The audience at the sixth Nature Café joined in a vigorous question and answer session with many of the questions focusing on how to continue brain development into old age.

"The cognitive function can be improved by a certain level of training," said Ingvar, "but language acquisition is said to have its peak at the age of ten." For example, mathematical discoveries tend to be made by younger scientists. "Achievements in fields that require vast amounts of factual knowledge, however, seem to be made by older scholars," said Ullén. Despite these observations, neither Ullén nor Ingvar rejected the idea of doing something to stimulate the brain. "Music and physical activity are beneficial for the brain, but also enjoyable in themselves," said Ullén. "What's important is your initiative in participating in, concentrating on and enjoying the activities." Ingvar also advised a proactive approach to brain training — up to a point. "Reading, solving puzzles and having friends are the protective means for the improvement of memory and against dementia, but the resting mode is also necessary," he said. ■

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