Food for thought, er, well... Study finds brain wolfs energy to stop thinking

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Ever wonder why it's such an effort to forget about work while on vacation or to silence that annoying song that's playing over and over in your head?

Mathematicians at Case Western Reserve University may have part of the answer.

They've found that just as thinking burns energy, stopping a thought burns energy - like stopping a truck on a downhill slope.

"Maybe this explains why it is so tiring to relax and think about nothing," said Daniela Calvetti, professor of mathematics, and one of the authors of a new brain study. Their work is published in an advanced online publication of *Journal of* Cerebral Blood Flow *& Metabolism*.

Opening up the brain for detailed monitoring isn't practical. So, to understand energy usage, Calvetti teamed with Erkki Somersalo, professor of mathematics, and Rossana Occhipinti, who used this work to help earn a PhD in math last year and is now a postdoctoral researcher in the department of physiology and biophysics at the Case Western Reserve School of Medicine. They developed equations and statistics and built a computer model of brain metabolism.

The computer simulations for this study were obtained by using Metabolica, a software package that Calvetti and Somersalo have designed to study complex metabolic systems. The software produces a

numeric rendering of the pathways linking excitatory neurons that transmit thought or inhibitory neurons that put on the brakes with star-like brain cells called astrocytes. Astrocytes cater essential chemicals and functions to both kinds of neurons.

To stop a thought, the brain uses inhibitory neurons to prevent excitatory neurons from passing information from one to another.

"The inhibitory neurons are like a priest saying, 'Don't do it,'" Calvetti said. The "priest neurons" block information by releasing gamma aminobutyric acid, commonly called GABA, which counteracts the effect of the neurotransmitter glutamate by excitatory neurons.

Glutamate opens the synaptic gates. GABA holds the gates closed.

"The astrocytes, which are the Cinderellas of the brain, consume large amounts of oxygen mopping up and recycling the GABA and the glutamate, which is a neurotoxin," Somersalo said.

More oxygen requires more blood flow, although the connection between cerebral metabolism and hemodynamics is not fully understood yet.

All together, "It's a surprising expense to keep inhibition on," he said.

The group plans to more closely compare energy use of excitatory and inhibitory neurons by running simultaneous simulations of both processes.

The researchers are plumbing basic science but their goal is to help solve human problems.

Brain disease or damaging conditions are often difficult to diagnose until

advanced stages. Most brain maladies, however, are linked to energy metabolism and understanding what is the norm may enable doctors to detect problems earlier.

The toll inhibition takes may, in particular, be relevant to neurodegenerative diseases. "And that is truly exciting" Calvetti said.

More information: The paper can be found at: www.nature.com/jcbfm/journal/v … l/jcbfm2010107a.html

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