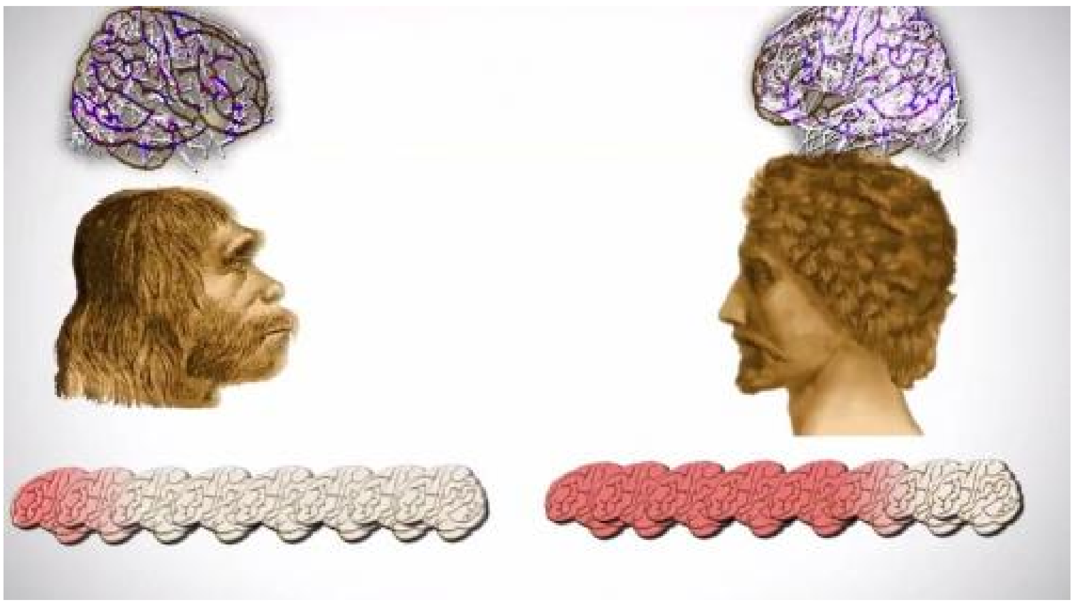
Medical Xpress

Glucose war between brain and brawn—the hidden battle in children that made us human

November 20 2014, by Dr. John Skoyles



The *Proceedings of the National Academy of Sciences* recently published a paper that showed a close link between the slow growth of children and the high glucose consumption of their brains. The proposed explanation: by saving on energy that would be spent on growth, children could devote more glucose to their brains. This week the Proceedings published a response which suggested an alternative theory: that slow growth is part of a package of adaptations to prevent skeletal muscle competing against the brain for plasma glucose.

Background to this science is that one of the most important biological things about us is nearly impossible to research—the metabolism of the brain in children. The brain of the child can be pictured in exquisite detail with MRI scans, but what is metabolically going on in it? Scientists can take a peek with radioactive tracers but ethics limits that to the very few occasions in which such a look is justified by medical need.

The limited research that has been done reveals a brain quite unlike that of the adult or infant. Its energy guzzling—the cerebral cortex using twice the glucose that it did use in its first year after birth or that it will use in its twenties. The explanation is that the young child doubles the component of the brain that burns the most energy—the synapses that connect neurons. That doubling is called exuberance—that excess allows the brain to prune down its connections during development to those that best enable the wiring required for adult cognition. This refinement is a key part of neuromaturation.

And it creates a big physiological problem. A five-year-old has nearly the same volume of gray matter as an adult but only a body a third of its size. That results in nearly half of every bit of food going to fuel its energy demanding brain—in adults it is nearer a tenth.

The original paper in *PNAS* by Kuzawa and colleagues showed that the peak of the young brain's percentage energy demand closely matched the peak slow down in the child's body growth. The inference they make is—that the body slows growth down so energy that would be allocated to making extra tissue get used by the brain.

But is this the explanation? The response published by John Skoyles at University College London suggests a more complex situation. First, the amount of energy saved by not growing extra tissue is small compared to the extra needs of the young brain. Second, there is a more determinative factor—the conflict between the brain and skeletal muscle for glucose—staying small could be part of a package of adaptations that prevent skeletal muscle outcompeting the young brain for glucose.

Even in adults with their far bigger bodies that are much better able to match glucose needs and its generation, sustained intense exertion can result in drops in the glucose carried in the blood sufficient to cause hypoglycemia. If such exercise related hypoglycemia was to occur in children it could be disastrous. That is because brains of children suffer impairment with much smaller drops in glucose levels than adults—and, of course, their brains are also using more—and undergoing neuromaturation.

Fortunately, children are not at risk. Simply children do not engage in the sustained and intense exertion which in adults causes skeletal muscle to utilize glucose. Not that children do not engage in exercise—they do, in fact, they engage in much more low and moderate exercise than adolescents and adults but when muscles do this they do not, as when they do sustained intense activity, use glucose.

Could slow growth be another factor stopping skeletal muscle battling with the brain for glucose? A child's body is not only small but contains a fraction of the skeletal muscle in an adult. This situation favourable to the brain is thanks to limited body growth. So slow growth might have less to do with saving energy as to the child putting a break on the amount of skeletal muscle that could compete against the brain for glucose.

This issue may seem arcane but it could revolutionize how we understand human uniqueness. The reason is that one of the unexpected findings upon Neanderthals is that they grew up faster than modern humans. If slow growth links to energy expensive neuromaturation this suggests that in spite of Neanderthals having brains of similar size to us, the high energy period neuromaturation they underwent might have been shorter in duration. That suggests a radical new understanding of what makes us human.

We have large brains and our capacity for complex cognition links to this. But this may not be the only factor in our extraordinary capacity for cognition—large brains may also need their network connections to be intensively refined if there is to be a full taking advantage of its potential for advanced neural information processing. If so human evolution might contain a presently overlooked stage—after human brains evolved to be big, one such large brained human species—our own—evolved a specially long duration of energy expensive neuromaturation. This enabled us uniquely to exploit potentials in such large brains that were not taken advantage of by equally large brained Neanderthals.

Is there any evidence for this enhanced neuromaturation account of our species? In the video, Dr John Skoyles, suggests there is. We have global shaped brains, while Neanderthals had more elongated ones. That difference in shape arises just as children enter their energy expensive neuromaturation. Could there be a connection? There is.

Much of the connection refinement during neuromaturation concerns reducing communication delays between separated areas of the brain. Brain shape here matters: the more global a brain, the less will be the maximum distance between separated brain areas. This raises the possibility that human brains but not Neanderthal brains have been selected to reduce cross brain communication delays—just what would be expected if human but not Neanderthal ones had been under a selection to fully extract the potential that would otherwise be hidden in large brains unless prolonged neuromaturation allowed a full refinement of its connectivity.

What is exciting here is that while this puts together very different areas of research, they all provide opportunities for research to test and explore the role of expensive neuromaturation in human origins. The sum is much larger than the individual parts. Even the big problem of examining metabolism in the young brain looks as if might be solved—new imaging technologies on the horizon could allow it to be as easy as MRI scans are today.

Not only do the ideas here suggest a new era in understanding human origins and our biological uniqueness but the video abstract gives a taste of science in the future. Its a new breed of science communication—video explanation using the latest graphic developments in software to create compelling infographics. Einstein looks out of a car into a side mirror to see the blind spot of science—the hidden metabolic world of the juvenile brain—we indeed see himself as a child enter a scanner—all done to the energetic string orchestra beat of Scott Joplin's Maple Leaf Rag.

More information: Skoyles JR "Skeletal muscle-induced hypoglycemia risk, not life history energy trade-off, links high child brain glucose use to slow body growth" *PNAS* 2014 111 (46) E4909; DOI: 10.1073/pnas.1417468111

Provided by University College London

Citation: Glucose war between brain and brawn—the hidden battle in children that made us human (2014, November 20) retrieved 16 May 2024 from https://medicalxpress.com/news/2014-11-glucose-war-brain-brawnthe-hidden.html