Honey and Homo sapiens

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Is Honey a Smart Sugar?

Did honey make the human brain larger, and later smaller and smarter — Homo sapiens?

Yes, surprising as it may seem to physicians, nutritionists, dieticians and most bio-scientists and health professionals, there is growing evidence that honey was critical, firstly in the growth and later in the contraction and improved energy efficiency of the human brain, and therefore for our advanced cognition, communication, and language, compared to other animal species.

Over a period of around 3 million years, the brains of our ancestors more than doubled in size, and then sometime in the last 200,000 years we promoted our neurological processing to an extraordinary new level, rapidly developing advanced cognition, social communication, language, tool making, problem solving, and later farming, civilisation, technology, science, art, music, literature, and poetry.

We associate this explosion of human intellectual capacity with the increasing size of the human brain, relative to body size. This view may only be partially correct. Over the last 10,000 years, a period during which our species achieved its most significant intellectual advancements, the human brain has shrunk by around 10%. This surprising and perhaps shocking statistic was first advanced in 1988 by Maciej Henneberg in the journal Human Biology and published by Wayne State University, and his findings have been confirmed since by numerous researchers.

In an upright bipedal species, there is a physical limit to the growth potential of the human brain, which, if its previous growth trajectory continued, would become simply too large to exit the birth canal. Furthermore, its increasing weight would potentially impair the locomotive ability to hunt and gather the food and energy resources required for survival. Therefore, a brain that was smaller and smarter would have offered an evolutionary advantageous strategy. There is evidence that this is exactly what occurred. Albert Einstein's brain was preserved and studied after he died, and his brain was found to be smaller than average. However, closer examination found that Einstein had a higher ratio of glial cells in the brain to neurons than other brains. Glial cells are the key energy regulating cells in the human brain, and house the pumping mechanism that transfers energy from body into brain, and this would suggest that his cerebral energy processing capacity was above average.

Sugars and the Shrinking Brain: Not so Smart.

However, there may also be another influence that is shrinking the human brain, and in this case, wholly negative. In the latter quarter of the 20th century and in the first two decades of the 21st century the human brain has been rapidly shrinking, not in this case resulting from increased energy processing, rather quite the opposite, due to chronic energy deprivation. This period is associated with increased consumption of refined sugars and carbohydrates. From the 1970s the health establishments around the world, in America, Europe and the United Kingdom adopted the erroneous view that fats were responsible for the exponential growth in metabolic (energy deregulation) non-transmissible diseases, and that refined carbohydrates and sugars were not. Fats were removed from processed foods and sugars were added. The diseases that

resulted are autism, obesity, diabetes type 2 and Alzheimer's disease. It was precisely this change in the human diet, facilitated by governments under the influence of the food/sugar lobby, that caused this increase in these diseases, and which now constitute one third of the population of humans globally. If it seems unlikely that this colossal increase in diseases of prolonged brain energy deprivation may constitute the significant cause of these conditions, it is not — the human brain is an internal combustion engine, it consumes energy (a combustible and inflammable fuel — glucose sugar), creates heat, and performs work and as with any such engine, mechanical or biological, oversupply of energy disconnects or disables the fuel pump.

It really is as simple as that. The fuel pump of the human brain is an enzyme known as glutamine synthetase, its gene is more than 400 million years old, and it converts toxic glutamate into benign glutamine, in a cycle known as the glutamate/glutamine cycle. Each turn of the cycle pumps a glucose molecule from the brain's blood vessels (capillaries) into the glial cells that house the pump, and from the glia the energy is transferred into neurones, the work horses of the human brain. Each of the excess sugar driven major energy deregulation (metabolic) diseases that are destroying human cognition, autism, obesity, diabetes type 2, and Alzheimer's disease are associated with impaired glutamate/glutamine cycling, and with suppression of glutamine synthetase, the enzyme of cognition, communication, and language. Congenital deficiency of this enzyme is incompatible with life, impairment of this enzyme is incompatible with a full sentient life.

The Original Affluent Society.

The "original affluent society" was a phrase coined in 1966 by the anthropologist Marshall Sahlins, who challenged the notion that our hunter-gatherer ancestors lived frugal and food/energy deprived lives, always on the brink of starvation. Basing his ideas on the work of many anthropologists who studied modern surviving groups, such as the !Kung of southern Africa, Shalins claimed that our ancestors enjoyed a wide and nutritionally diverse diet, and their dietary needs were met from abundant availability of fauna and flora. He also stated that such groups could satisfy their material requirements by working around fifteen to twenty hours weekly. Their lives may have been short and often violent (up to 55 years lifespan), with high infant mortality, but they were largely robust and healthy — findings that are confirmed by modern scientific paleopathology. This view confirms that such groups easily satisfied the first condition of all life — that of energy homeostasis (balance) whereby energy expenditure meets energy income. Since there groups were small and nomadic, any animal derived infections (zoonoses — such as Covid19) may have wiped out a group, but there would quickly be no more hosts available, and the infection would dissipate.

Energy and the Human Brain.

The human brain is one of the highest consumers of energy in nature — it constitutes around 2% of the human body by weight, but this greedy organ consumes 20–25% of the energy consumed. The period of its growth may have extended over some millions of years compared to our primate ancestors, but sometime during the last 200,000 years there was a dramatic leap in cognition, social communication, and language, resulting in anatomically and intellectually modern humans — homo sapiens.

What may have been the spark that in such a short timespan triggered this exponential increase in mental capacity?

The most frequent and popular idea that may explain the expansion of the human brain is that promoted by Richard Wrangham at Harvard University, who offers a theory known at the "cooking hypothesis", which states that meat-eating and the discovery of controllable fire is the key. Eating meat would certainly provide a varied and nutritionally diverse diet, but certainly not the energy required to fuel the growing brain. Furthermore, the brain burns the sugar hydrocarbon glucose, and not protein from meat. Only during starvation does the brain burn proteins, which are degraded and converted to glucose in the liver. Also, the contraction of the gut which occurred in this period would not have offered the energy divided claimed — the gut uses proteins for fuel and not glucose, and therefore no additional glucose energy would have provisioned the brain.

Therefore, the question must be posed: from whence came the concentrated and controlled energy that both provisioned the growing brain, improved its function as it more recently contracted and became more efficient, and thereby enabled the development of cognition, social communication, and language that we describe as uniquely human?

Any such fuel source would have to fulfil three conditions. It would have to been available in a concentrated form, accessible to our hunter-gatherer ancestors, would have to have a cohort of glucose regulating nutrients to avoid overwhelming the regulatory mechanisms that prevent flooding the brain with glucose — a combustible and inflammable fuel, and perhaps most significantly have had the capacity to activate the genes that engineered the dramatic cognitive advance that resulted in the species Homo sapiens.

We have a wonderful window into the diet of ancient hunter-gatherers from around 750,000 years ago at the Gesher Benot Ya'aqov site in Israel, in a paper published the journal Science in 2004. The team led by Yoel Melamed found evidence of fire use and remains of meat and a wide variety of plant sources of energy and nutrition, including nuts, fruits, seeds, and underground plant storage organs. This excellent study suggests that Shalin's hypothesis of the First Affluent Society may have been close to the mark. However, although carbohydrate sources of glucose were clearly present in the findings, none of these could account for the kind of highly concentrated and controlled fuel supply that would kick start the kind of genetic leap that transformed the developing human brain into the advanced energy consuming and cognitive organ we associate with our modern species.

Where, if anywhere, may have our ancestors found a readily accessible, sustainable, storable, and renewable source of combustible and cognitive energy, that includes its own regulatory principles, that could fund and genetically catalyse the exponential growth and neurodevelopment of the human brain?

Honey and the Evolution of the Hungry Human Brain.

Honey was and is still today the most energy dense food found in nature. Honey is the only fuel known to man that was widely available during the period of expansion of the human brain relative to our earlier hominid species, which fulfils all these categories, and is available today available on shelves in supermarkets and food outlets around the world, or indeed direct from the hive, via your local beekeeper.

Is Honey Genetically Fecund?

This question was brilliantly answered in an historic paper by Gene Robinson and Marsha M Wheeler at the University of Illinois, published in the journal Scientific Reports in July 2014. They were examining the possibility that domesticated honeybee nutrition, including sucrose and high fructose corn syrup may not have been wholly beneficial to bee health. They found that honey upgraded hundreds of genes compared to both sucrose and high fructose corn syrup, a finding that beautifully confirms the genetic fecundity of honey compared to these refined sugars.

This poses the question; would the consumption of honey compared to sucrose and HFCS drive differential gene expression in humans?

To pose the question is to answer it. A team led by Gene Robinson published a paper in the Proceedings of the National Academy of Sciences in July 2017 that answered that very question: they found a suite of genes shared by humans and social honeybees that indicated molecular mechanism and were autism spectrum disorder-related in both species. Social behaviour is genetically modulated in many animal species, including humans and insects. If differential gene expression is modulated by diet, and diet may influence cognitive genes, we have window into the potential explanation of why modern sugar dense foods and drinks negatively affect cognitive gene expression in the last half-century when autism incidence exploded across the world.

In 2011 Alyssa Crittenden at the University of Nebraska published a brilliant study in the journal Food and Foodways that should have revolutionised the discussions on the evolution of human consciousness, cognition, communication, and language across the scientific world, but did not. The study was entitled: **The Importance of Honey Consumption in Human Evolution**. Professor Crittenden stated:

"…..*The consumption of honey and bee larvae likely provided significant amounts of energy, supplementing meat and plant foods. The ability to find and exploit beehives using stone tools may have been an innovation that allowed early Homo to nutritionally out-compete other species and may have provided critical energy to fuel the enlarging hominin brain…."*

Alyssa Crittenden is a medical, nutritional, and evolutionary anthropologist at the University of Nebraska, who studies the relationship of human behaviour to environment, focusing on evolution of human diet, human ecology, nutrition transition, evolution of childhood, and maternal and infant health. Professor Crittenden conducted much of her research over a fifteen-year timespan in collaboration with the Hadza of Tanzania in East Africa, one of the few remaining hunter-gatherer populations in the world. Alyssa Crittenden is currently Associate Professor and Graduate Coordinator in the Department of Anthropology ad Co-Director of the Nutrition and Reproduction Laboratory at the University of Nebraska Las Vegas.

In her wonderful study Crittenden focuses on the Late Pleistocene, a period that extends from around 150,000 years to 10,000 years ago. The foods that evolutionary scientists focused on included mainly meats, and the various type of plant foods that the Yoel Melamud team found in Israel. This period also coincides with the development of sophisticated stone tools which would have improved hunting and foraging, and would also have enabled early humans to reach and break into honeybee nests and secure both honey and protein rich bee larvae. In tropical zones honey production depends on rainfall and in wet years honey production is continuous. Honey was (and is) the only natural energy dense food source available to man, that may fuel the expensive human brain. That evolutionary biologists and metabolic scientists have avoided

citing the role of honey in the evolution of human nutrition and its influence on cerebral energy supply and neurodevelopment is a quite shocking indictment of that community. Alyssa Crittenden's seminal work has been overlooked, with a tiny number of citations in the decade that followed its publication (48).

Numerous examples of rock art that depicts honey, honeybees, and honey hunting during the Upper Paleolithic period (40,000–8000 years ago) are found in Spain, India, Australia, and Southern Africa are cited in the paper. This neglect of honey is a classic example of evolutionary biologists, anthropologists and archaeologists blinded by prejudices that enable them to miss obvious indications of early human behaviour, culture, and ecology. These artistic presentations could only have been invested in if they represented a vitally important aspect of evolutionary human survival ecology.

Professor Crittenden quotes from a wide range of studies showing the vital role of honey in surviving hunter-gatherer groups around the world. One example referenced is that of the Efe foragers of the Ituri Forest in the Democratic Republic of Congo. During the honey collecting season the Efe rely almost entirely on honey, brood, and pollen. Quoting research from Ichikawa (1981) and Turnbull (1976) Crittenden states that the average amount of honey and brood collected per person is 3.32 kilograms, and the average consumed per person per day is 0.62 kilograms of honey (dry weight), which is 1,900 calories per day (Ichikawa 1981) and honey contributes 70 percent of the diet by weight and 80 percent of the calories (Ichikawa 1981; Terashima 1988). These are astonishing figures compared to modern sugar consuming humans, and they point to the potential of this highly concentrated and metabolically controlled fuel supply for the growing brain as exactly the energy provision that with its genetic potential could have been the critical evolutionary agency that promoted the advanced cognition that took place in that rich intellectual birth-period of prehistory. Indeed, since there is no other food source available that may have done so (then and now), we must regard honey as the driving energy source, and genetically competent agency of the cognitively advanced species Homo sapiens.

Brain Organoids and Zeb2: A Clue?

Brain organoids are collections of stem cells that are grown in a rotating bioreactor (as opposed to a petri dish) and that develop the cells into a kind of model micro-brain that is amenable to study and research into the factors that promote growth and development. In a study published in the journal Cell in March 2021, a group of scientists from Cambridge University in the UK and Duke University in the USA studied cerebral organoids composed of pluripotent neural stem cells (cells that develop into brain cells) sourced from humans and primates, and they discovered what may be the key factor in expansion. Human brain organoids expand to a greater degree compared to primate brain organoids, and they do so via a delayed transition phase. The authors identified Zeb2 — a protein transition factor that is a multifunctional transitional regulator expressed in the nervous system during early foetal development, and in particular during neurogenesis and gliogenesis. Zeb2 directs the formation, migration, and specification of brain cells, and in specific cerebral regions, including the neocortex and hippocampus, areas of the human brain that are directly associated with advanced cognition. Mutations in the Zeb2 gene result in neurodegeneration.

The Sugar and Honey Generated Foetus: Is there a Difference?

The first condition of all life is energy homeostasis (balance). No organism, from the smallest bacterium to the amoeba, to insects, birds, fish, mice, wolves, deer, bears, primates, elephants, and whales may survive if that function is impaired or absent. The human species, Homo sapiens in recent times, seems to the only species that has lost the ability. The four neurodegenerative diseases that are destroying human cognition beginning in foetus, and continuing throughout life are autism, obesity, diabetes type 2 and Alzheimer's disease. Each of these are excess sugar driven conditions and the different expressions simply reflect the timing, degree, and duration of the sugar assault on the provision of energy to the brain. All of the degenerate manifestations are downstream from there — impaired cognition, communication and language in autism, reductions in cerebral volume in obesity and diabetes, and dementia in Alzheimer's disease.

Refined Sugars and Autism: A No-Go Area of Scientific Research.

Michael Stern at the University of Texas was the first to point to excess circulating sugars as the major influence on the growing incidence of autism, in a paper published in October 2011 in the journal Frontiers in Cellular Endocrinology entitled *Insulin Signalling and Autism*. Professor Stern pointed to the increased risk of autism in gestational diabetes and showed that excess circulating glucose would increase the production of foetal insulin. Insulin regulates glutamine synthetase and downgrading this critical enzyme is associated with autism. Indeed, congenital glutamine synthetase deficiency is incompatible with life, impaired glutamine synthetase function is incompatible with full sentient life.

Hear No Sugar, Speak No Sugar, See No Sugar.

We have known from 1980, when Norbert Freinkel published his Fuel Induced Teratogenesis Hypothesis, that excess circulating maternal sugars are potentially teratogenic. In February 2018 Michael Stern's research was brilliantly conformed in a historic study at the University of Warwick in England, by Naila Rabbani and her team. They found that sugar damaged proteins (known as advanced glycation end products — AGEs) are more than 90% diagnostic for autism. This was an astonishing breakthrough and meant that for the first time in the history of this disease a simple blood test could confirm its presence. There are more than 94,000 studies in autism listed in the Pubmed Index, indicating that the autism scientific community includes many thousands of researchers. From 27,000 accesses, this lovely and deeply informative study has drawn a paltry 38 citations, indicating a global reluctance to challenge the food/sugar lobby on this vital question.

Zeb2 and Refined Sugars.

If Zeb2 is the master regulator of cerebral and nervous system development, would excess circulating maternal sugars negatively influence this key transcription factor? The answer was unexpectedly provided in March 2019, when a study appeared in the journal Biomed Research International which examined the role of the plant Coreopsis tinctoria Nutt, a plant commonly found in Canada, the Americas and China, on the amelioration of diabetic kidney disease (nephropathy). The authors conclude: *"….This protective effect may be achieved …..through the miR-192 and its target gene ZEB2…."*

This study confirms that the master transitional factor that regulates brain and nervous system development is suppressed in diabetes, and which may be subject to amelioration. Apart from its hypoglycaemic (glucose lowering) effect, this plant exerts potent antioxidant and anti-

inflammatory actions, each of which are also key positive influences in honey metabolism. It may be stated that much of the cognitive damage inflicted on the human brain in recent decades is via exactly these twin toxic mechanisms. The human brain's fuel pump glutamine synthetase is highly vulnerable to oxidation, and this in turn mobilises immune system signalling in microglia — the brain's immune cells, a major neurodegenerative pathway, if overactivated by sugars. Refined sugars possess none of the vital antioxidant and anti-inflammatory neuroprotective principles that honey is richly endowed with.

Is Honey Anti-Diabetic?

Omotayo O. Erejuwa at the School of Medical Sciences at the University of Sains, Kelantan, Malaysia and his team have made a major contribution to our understanding of honey science in a paper published in the International Journal of Biological Sciences in July 2012. The study was entitled: *Honey — A Novel Antidiabetic Agent.* In this historic study the authors detail positive influences of honey in the gastrointestinal tract, in the liver, on the regulatory pancreas, the kidney, and in the circulation, wherein honey controls blood glucose concentration, compared to refined sugars. This iconic study, which stimulated more and confirmatory research, represents the beginning of a new understanding of why honey may be the critical fuel provision of the human brain during its initial phase of growth, and later when the brain entered a period of improved reduction of size and improved efficiency.

Honey Consciousness.

The four metabolic (energy) and non-transmissible diseases that are destroying human cognition are autism, obesity, diabetes type 2, and Alzheimer's disease. These now constitute one third of the human population and are growing rapidly in incidence. Autism is the most devastating, whereby infants are emerging from the womb in large numbers with impaired cognition, communication, and language. Autism was around 1 in 10,000 in 1980, is now 2 in 100, and doubling every 5 years, in line with the increased consumption of refined sugars and carbohydrates. At this rate our species, Homo sapiens will no longer be cognitively competent before the end of the 21st century. If the human population altered its allegiance from processed and refined sugar in food and drinks in favour of honey, would this catastrophic decline in human cognition halt or even reverse?

Yes, there is potent evidence that this ancient and beatific food created by honeybees may do just that.

Honey is the accessible, controlled, genetically prolific, and regulated fuel supply that provisioned the growth and the improved efficiency of the human brain. Honey may reverse the current decline in human cognition, only if the health establishments world-wide would acknowledge its evolutionary and positive influence on human cognition.

If modern sugar enslaved humans developed honey consciousness, and switched sweet allegiance from refined sugars to honey, we may reverse the decline in human cognition that is developing rapidly across the world.

We, Homo sapiens, can develop a smaller and smarter brain, but we must firstly free our intellectual and information neurotechnological internal combustion engine and cerebral organ from degenerative sugar-shrinkage, and replace these toxic sterile fuels that degrade it, with

honey facilitated genetically fertile fuels and nutritional nourishment enjoyed by our hunter-gatherer ancestors.