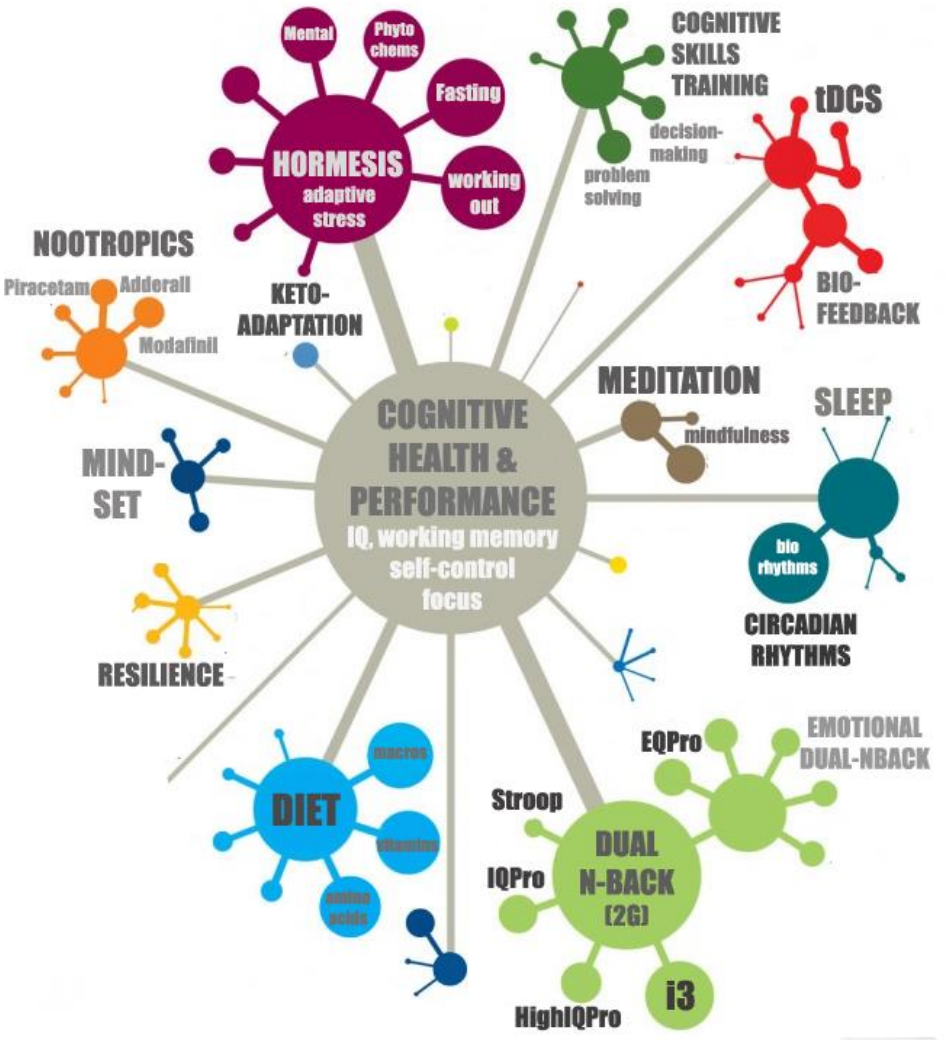
IQMINDWARE
health, resilience, performance



Brain Cross Training

Fasting for Brain Training

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Foreword

My training is in cognitive neuroscience. I earned my doctorate from Carnegie Mellon and the University of Pittsburgh's flagship Center for the Neural Basis of Cognition program. I have since worked as a Lecturer/Assistant Professor at the University of Cambridge's Experimental Psychology Department – the top ranking Psychology Department in the top ranking University in the UK - where the basis of IQ Mindware's training program was devised.

In this series of eBooks I present you with the most effective, evidence-based cognitive interventions within a brain 'cross training' paradigm that combines computerized brain training with other strategies to improve brain health, resilience, performance and creativity.

Enjoy your training!

Mark

Mark Ashton Smith, Ph.D.

Personal Website

IQ Mindware

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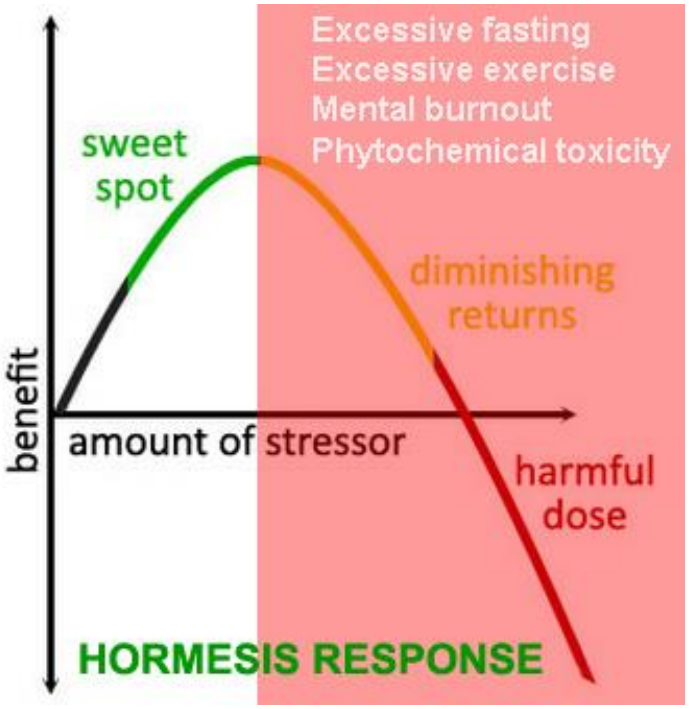
Hormesis and Vitagenes

We have learned that stress – in the right doses and applied at the right times – is highly beneficial for the brain and body – their health, resilience and performance. We can harness it in brain cross-training programs using the **hormesis response**.



Without stress, the vitagenes and adaptive cellular stress responses don't kick into action to build resilience, health and better brain functioning.

In this eBook we will be looking at **fasting** as a brain training strategy. Adopting a fasting routine that puts you in the **hormesis sweet spot** improves **neuroplasticity** for adaptive learning and enhances **cell protection** for a healthy brain.

Combining fasting with effective computerized cognitive training (e.g. IQ Mindware) can result in **hormetic synergies** for enhanced brain benefits.

Fasting in a Cultural Context

"I fast for greater physical and mental efficiency." Plato (428-348 B.C.)

"Instead of using medicine, rather, fast a day." Plutarch (45-120 A.D.)

Fasting has a respected history. Plato and Socrates fasted for physical and mental efficiency. Pythagoras required his students to fast before entering his classes. The Greek physician Hippocrates recognized fasting as an important therapeutic intervention. In the 16th century a famous Swiss physician Paracelsus said, "Fasting is the greatest remedy".

Fasting in spiritual quests is an integral part of the human religious history. All major religions to this day retain fasting as far more than simply a traditional ceremonial act. It remains a fundamental part of the spiritual practice to gain enlightenment as in the Muslim feast of Ramadan and the Jewish fast of Yom Kippur. Fasting was an expected discipline in both the Old and New Testament eras. According to scripture Moses fasted at least two recorded forty-day periods. Jesus fasted forty days and reminded his followers to fast. Yogis practice austerity with their diets and shamans fast during their vision quests.

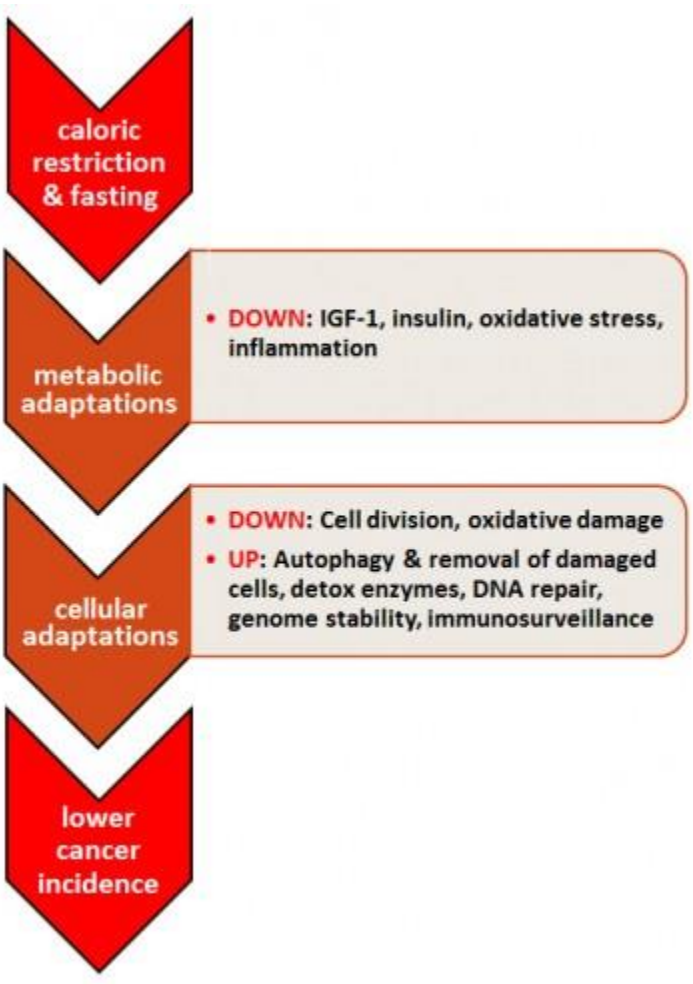
General Health Benefits of Fasting

A hefty body of research shows that caloric restriction (with a maintained balanced diet) results in the following benefits (click on this link for review):

- **Reduced fat mass (weight loss)**
- Increased **insulin sensitivity** and improved **glucose metabolism**
- **Decreases blood pressure**
- Increased **heart rate variability** (HRV) – which has been used as an index of physical and psychosocial health, with lower HRV levels being linked to stress and negative emotions such as anxiety and hostility.
- **Less oxidative damage** during cell metabolism (due to free radicals) to tissues and DNA
- **Less inflammation**
- **Better autophagy** – the detoxification process whereby your cells eliminate waste material and repair themselves)
- **Protection against multiple age-related diseases** including cancers, cardiovascular disease, diabetes, a (amount of blood glucose is too high) and sarcopenia (degenerative loss of skeletal muscle mass)

Anti-Cancer Effects of Fasting

Long-term fasting results in low plasma growth factors and hormones associated with increased risk of cancer. This diagram summarizes the adaptive response to caloric restriction or intermittent fasting that helps fight cancer (review article).



Intermittent Fasting for Brain Health & Performance

Via the same **adaptive cellular stress response** that improves immune function and health reviewed above, practicing intermittent fasting in a way that hits the 'sweet spot' in the **hormesis response** can **promote optimal brain function and resistance to age-related brain diseases.**

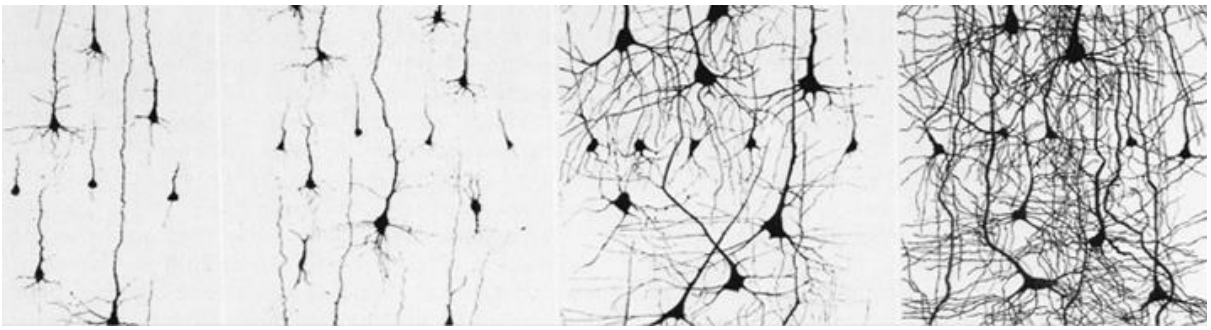
Adopting a diet plan that puts you in the hormesis response sweet spot improves **neuroplasticity** for adaptive learning and **cell protection** for healthy brain cells. Fasting can both strengthen the synapses (communication points between brain cells) via protein enzymes. And it prevents neuron damage via DNA repair and antioxidant enzymes.

We will now look at specific evidence-based brain benefits of caloric restriction. Much of this research can be found in this excellent Cell Metabolism review paper and this Nature Reviews Neuroscience paper.

Improved Neuroplasticity

Neuroplasticity can be defined as structural changes that occur in neural (brain cell) circuits as adaptive responses to environmental challenges. Neuroplasticity is essential for learning and memory, and as the brain ages it tends to become less neuroplastic.

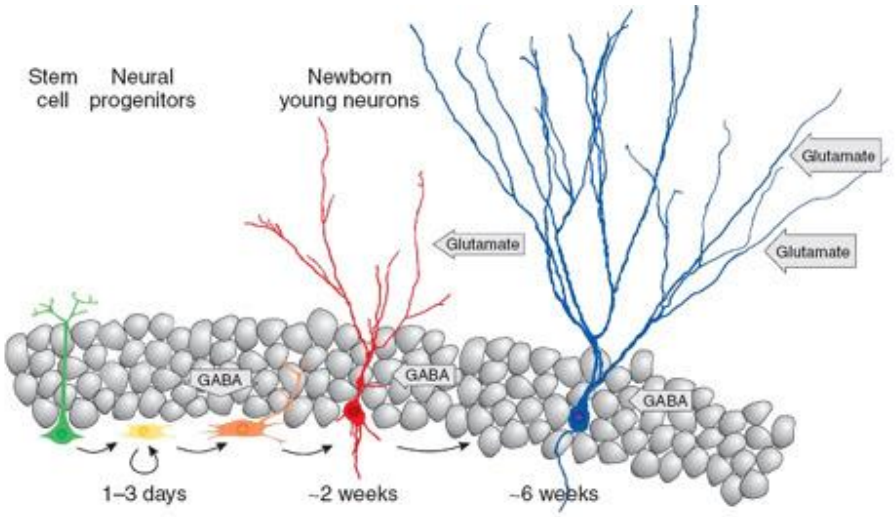
Intermittent fasting promotes neuroplasticity in both synapses (connections between individual neurons) and neural stem cells.



Neurogenenesis: The Growth of New Brain Cells

Neurogenesis is the creation of new brain cells (neurons) from neural stem cells. The new neurons can form synapses with existing neurons, thereby becoming part of a functional neural circuit.

Caloric restriction can increase neurogenesis in rodents by increasing the survival rate of newly created hippocampal cells, thereby **improving learning and memory**.



Improved Gene Regulation

Going without food for even short periods of time switches on a number of repair genes – the 'vitagenes'.

Fasting can result in the expression of neurotrophic factors including the BDNF gene. This protein promotes the survival of nerve cells (neurons) by playing a role in the growth, and maintenance of these cells. It also plays an important role in synapse plasticity which is important for learning and memory.

Ketones: Superfuel and Protection for the Brain

Our biology is adapted for times of food scarcity. During these periods, the main goal of our system is to provide enough glucose to the brain and other tissues. If you are deprived of food where does this glucose come from? Lack of food causes the brain to shift away from using glucose as a fuel to using **ketones**. Ketones are produced when the body burns fat for fuel. Ketones act as a stand in for sugar in the brain. By reducing the body's need for sugar, less protein is required, protecting muscle mass - the protein reservoir that might otherwise be used to power the brain.

- The principal ketone (beta-HBA) is not just a fuel, but a "superfuel" more efficiently producing ATP energy for brain cells than glucose. Ketones are also the preferred fuel for the heart, making that organ operate at around 30% greater efficiency. **Thus fasting can increase your brain and body's energy production**.
- Ketones also protected neuronal cells in tissue culture against exposure to toxins associated with Alzheimer's or Parkinson's.

Both caloric restriction and exercise have been shown to increase the production of ketone bodies, which can enter the brain and protect neurons against injury and disease. For an interesting theory on the benefits of being 'keto-adapted', see the **Appendix**.

Resilience to Stress and Emotion Control

Stress reactivity means being threat reactive. High stress reactivity means a low threshold for threat, and perceived threat triggers a stress response. This can result in stress response disorders, such as fatigue, anxiety and cognitive impairments. Some studies indicate that caloric restriction can help **reduce stress reactivity** – although experimenting with fasting regimes should be done with care if you are already highly stressed – according to the bi-phasic hormesis principle where too much stress has a toxic effect.

- Caloric restriction results in reduced stress reactivity and preservation of volumes of brain structures involved in emotional control including the prefrontal cortex and amygdala.

Heightened susceptibility to stress increases with aging. This is linked to atrophy of the hippocampus (a memory related region of the brain), and age-

related cognitive deficits such as memory loss, as well as increased risk for Alzheimer's disease.

- Long-term caloric restriction results in lower-stress reactivity and increased sizes of the brain regions (e.g. hippocampus) associated with lower stress reactivity.

Keeping Your Brain Young: Neuroplasticity and Brain Function

Numerous studies show that caloric restriction helps maintain brain volume and buffer against loss of memory and other cognitive functions that is associated with loss of neuroplasticity with aging.

- When the caloric intake of fifty normal elderly subjects was reduced by 30% for 3 months, the performance on memory tests improved significantly.

Male-Female Differences for Intermittent Fasting

There are a number of studies indicating that intermittent fasting **shouldn't be practiced during pregnancy** since it alters foetal breathing patterns, foetal heart rate, and may increase gestational diabetes. This is not surprising since metabolic demands are going to be very different during pregnancy.

There may also be more general sex-differences in response to caloric restriction or IF, indicating that women should exercise more caution in their experimentation, being careful not to become overstressed due to fasting. In her 'Paleo for Women' blog, Stefani Ruper has observed:

> *"Many women find that with intermittent fasting comes sleeplessness, anxiety, and irregular periods.... I have also personally experienced metabolic distress as a result of fasting."*

Rat studies on 40% caloric restriction indicate that compared to males, females respond with a heightened stress response, greatly increased spontaneous activity, improved alertness, learning and memory with elevated levels of circulating brain-derived neurotrophic factor. Female rats also stop ovulating

and menstruating. ***This suggests that females may have evolved a greater 'survival mode' response during times of energy scarcity.***

However, these are animal studies, looking at high levels of caloric restriction - not the kind of intermittent fasting that is widely practiced by women who report its benefits. There are only a handful of studies looking specifically at sex differences in the effects of intermittent fasting (IF).

- Intermittent fasting improved insulin sensitivity in men, but not women, and glucose tolerance of fasting women slightly worsened.

- After a regime of intermittent (whole day) fasting women's HDL ('good' cholesterol) improved and their triglycerides remained stable, while men's HDL remained stable and their triglycerides decreased.

- One study looked at fitness biomarkers as a result of a program of cycle training comparing training after an overnight fast with training after a morning meal. Both men and women displayed greater increases in VO2 max and resting muscle glycogen concentration in response to fasted cycling training, but only men showed greater skeletal muscle adaptations. Women had better muscle adaptations when fed.

But these are non-replicated, isolated studies with small numbers of subjects and relatively small effect sizes. They also look at whole day (36 hour) fasting rather than 25% caloric restriction fasting.

It's clear that many biomarkers of improved physical and cognitive health improve in (non-pregnant) women on intermittent fasting programs - as a result of the adaptive cellular stress response. The 5:2 fast, for example, is very popular with women. There may even be greater cognitive benefits for women. But the evidence suggests that there may be a more heightened stress response to calorie deprivation, suggesting that there needs to be more care about not crossing into the 'red' region of the hormesis response where there may be "sleeplessness, anxiety, and irregular periods". Special care should be taken with respect to reproductive health.

Summary

Intermittent fasting (IF) is the most practical way of benefiting from caloric restriction. IF – in the right dose - can trigger a **hormesis response**. As with exercise, this results in general health and immunity benefits, and improved neuroplasticity, gene regulation, neural protection, and stress resistance.

IQ Mindware Apps

If you are interested in finding out more about the IQ Mindware app **HighIQPro** for brain performance and resilience, you can do so at this website.

Combining fasting with effective computerized cognitive training such as HighIQPro can result in a **brain training synergy** for extra benefit.

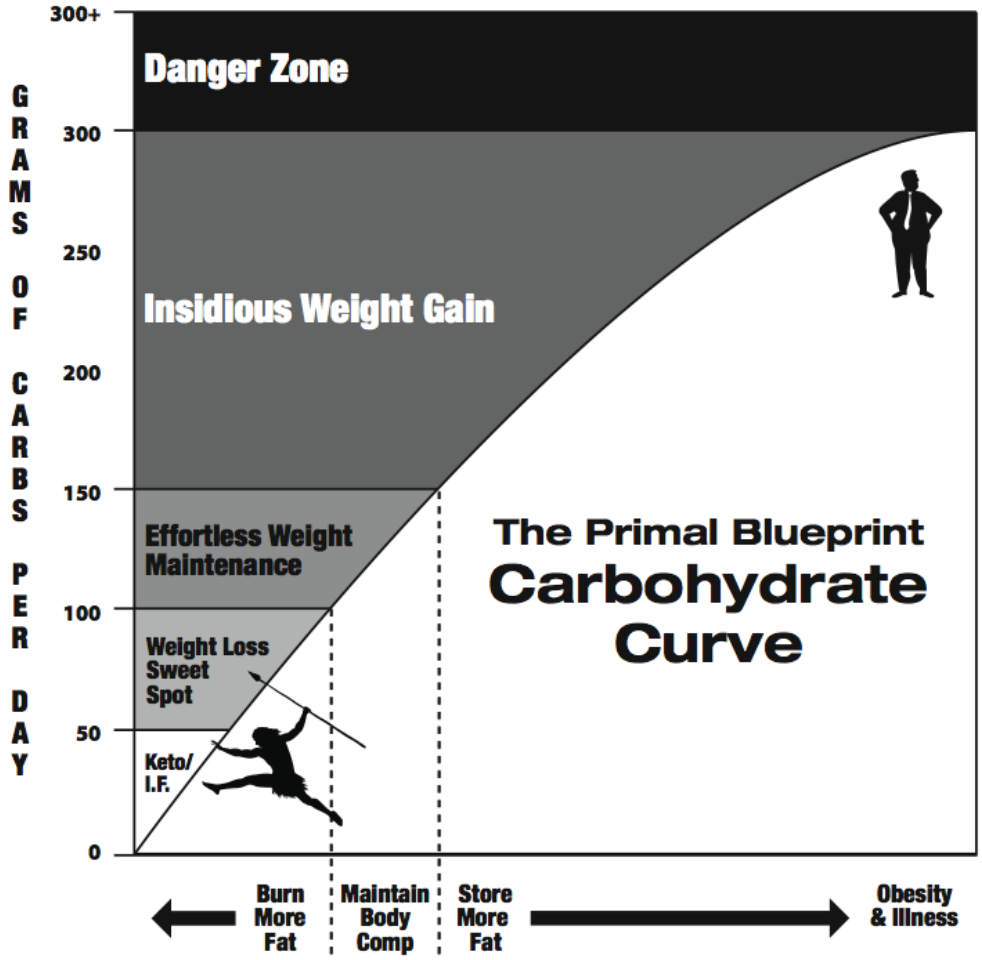
APPENDIX

Keto-Adaptation

According to Mark Sisson and other advocates of the 'keto-diet' we are stuck in a biologically maladaptive 'carb' paradigm that we need to break out, adopting a low carb-eating diet and reprogramming our genes to become 'keto-adapted'.

Sisson argues that in our evolutionary history, the periodic lack of regular access to food and carbohydrates necessitated the adaptation of efficient metabolic processes to store and access body fat, and that **human metabolism is pre-programmed by evolution to be primarily fat-based, not glucose based.**

> *"Our movement patterns were such that we never required large amounts of glucose or that we needed to store very much glycogen.* ***It was predominantly fats, ketones and the minimal infusion of glucose via gluconeogenesis that got us here. Dietary carbs were insignificant.*** *In fact, when you consider how ridiculously small the body's glycogen reservoirs are, you understand that it would have been impossible for us to survive as a species if glucose were truly the "preferred" fuel. The liver, the main back-up glycogen/glucose storage facility for the brain and other glucose-burning organs, can only store about 100 grams of glycogen. Less than a day's worth. Your muscles can only hold another 350-500 grams, barely enough to run for 90 minutes at a reasonable clip, and that glycogen isn't even available to provide fuel for the brain. Meanwhile, we have a virtually unlimited storage capacity for fat (like 100,000 grams or close to a million calories on some people)."* Mark Sisson



Taken from Mark Sisson - [Mark's Daily Apple]

By adopting a low carb diet we can become keto-adapted and more efficient fat-burners – through [gluconeogenesis] and [ketosis] rather than the carbohydrate based use of glucose and glycogen stores.

> *"most typical human movement patterns can be fuelled almost entirely by fats and/or ketones if need be, but can draw on glycogen when energy bursts are required (and which can then be replaced over time). It acknowledges that fat (and cholesterol) are not the proximate cause of heart disease. It acknowledges that fat cells are designed to release stored fatty acids as required, especially during times of scarcity or fasting. It allows for intermittent fasting as a means of accelerating fat loss without sacrificing muscle tissue. It increases insulin sensitivity, modulates energy and mood swings, and allows for a normal and healthy drop in hunger and cravings."*

For more scientifically grounded information on the 'ketogenic diet', have a look at [this comprehensive introduction by Dr. Peter Attia].

Notice. *As a general warning, the ketogenic diet for the general population is scientifically controversial. There are no systematic clinical trials looking at the effect of the ketogenic diet on general health. Dr. Peter Attia represents just one, idiosyncratic, point of view. The evolutionary arguments are also very controversial. Adopting the ketogenic diet is for most people a radical dietary intervention, and may result in unwanted side effects. Experiments with the ketogenic diet, motivated by the intention to burn more ketones, should only be attempted with a gradual, tapering transition from a higher to a lower carbohydrate diet.*