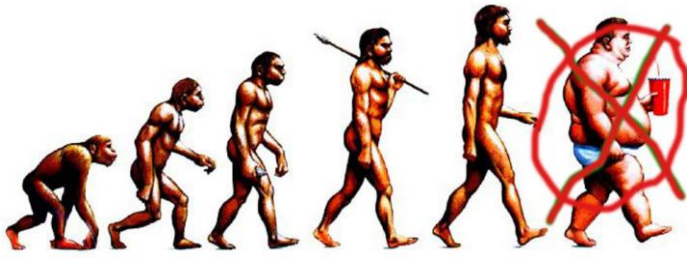
IQMindware
neuroplasticity software

BRAIN CROSS TRAINING

Caloric Restriction
& Intermittent Fasting



Mark Ashton Smith Ph.D
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CONTENTS

Fasting in a Cultural Context	3
General Health Benefits of Fasting	4
CR & Intermittent Fasting for Brain Health & Performance	9
What Fasting Diet?	13
Self Quantifying the Effects of Fasting	21
Personal Recommendations – Mark Ashton Smith, Ph.D	22
APPENDIX 1 - Mark Sisson's Theory of Keto-Adaptation	25
APPENDIX 2 - Daytime Insomnia Symptom Scale (DISS)	28

This eBook is an introduction to **intermittent fasting** – a powerful **brain cross training** strategy that we recommend you combine with your software-based cognitive brain training for maximum brain health and performance benefits.

As explained in my **Brain Cross Training** eBook, by means of activating the **adaptive cellular stress response** we can substantially improve overall health, immunity and brain functioning. One effective way of doing this is through **caloric restriction** - reducing the amount you eat. A popular form of caloric restriction is **intermittent fasting** in which you cycle (e.g. on alternating days) between eating freely, and fasting or reducing calorie intake to e.g. 20%. Specific programs will be detailed below.

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 renowned Greek physician Hippocrates recognized therapeutic fasting as of primary importance in disease. In the 16th century a famous Swiss physician Paracelsus said, "Fasting is the greatest remedy".

Indeed the utility of 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 fast 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 growing body of research shows that caloric restriction (with a maintained balanced diet) results in the following benefits:

- **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)

Extending Lifespan

Data from numerous animal studies conducted over decades show that restricted calories (by 25-55%) with adequate micronutrients compared to 'free-for-all' eating can dramatically extend maximal life span and retard aging – in some studies by up to 65%. In human terms that would be an extension of life expectancy from around 80 years to 130 years! . Mice and rats put on a low-calorie, nutrient-rich diet live far longer – and the same is true of monkeys.

Caloric restriction (70% of normal intake) with maintained nutrition in monkeys protects against multiple age-related disorders. In the Wisconsin study of lifelong caloric restriction in monkeys, over 20 years monkeys whose diets were not restricted were nearly three times more likely to have died than those whose calories

were counted. In the photos, the monkey on the two monkeys are the same age; the one on the left has not been calorie restricted, the one on the right is aging very well on a 30% restricted calorie diet.

> "They don't just live longer, they are healthier. They actually aged biologically slower. Their hair has gone gray less quickly. Their hormones have stayed at their youthful profile and their immune function has stayed good." **Dr. Susan Roberts**

A similar study is currently being conducted with humans – the Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy (CALERIE) involving more than 130 people who have been cutting their calories by 25% for a number of years now. **Typically females consume 1500 Cal/day rather than 2000, and males consume 1875 Cal/day rather than 2500**. So far down the line, the biomarkers in this study have been consistent with the animal studies:

> "I didn't think calorie restriction worked in humans until I started working with people who'd been doing it for years. They are among the healthiest people I've ever known. Their heart function is similar to people 15 years younger, they have very low levels of inflammation and very few get cancer." **Dr. John Holloszy, M.D., lead CALERIE investigator**

> "... subjects have cholesterol around 160, blood pressure around 100 over 60, high HDL, low triglycerides and very low levels of inflammation. ... here we have such a powerful intervention that is basically cleaning out the arteries." **Dr. Luigi Fontana & Dr. Susan Roberts, Washington University and Tufts University investigators for the NIH- funded CALERIE Study**

Animal Protein

The life-extending effects of restricted diets found in other animals based on the adaptive cellular stress response is in large part due to the resulting **lower levels of IGF-1 – a growth factor**. It is known that higher levels of plasma IGF-1 lead to more accelerated ageing and age-related diseases such as cancer, while low levels are protective. Luigi Fontana and colleagues found that caloric restriction (while maintaining nutrition) in human volunteers ***did not*** result in lowered IGF-1 levels. But humans tend to have high protein diets – well in excess of the recommended amount of protein of 0.8 grams per kg of body weight per day (e.g. 46 grams for the average US female and 56 grams for the average US male). Fontella found that reducing protein intake from an average of 1.67 g / kg / day to 0.95 g / kg / day for just 3 weeks in people practicing caloric restriction resulted in a **reduction in IGF-1 by over 20%**.

Animal Protein Recommendation

Reducing the amount of animal protein we eat to 10% of calories consumed reduces risk factors for prostate, breast, and colon cancers, and neurodegenerative diseases. A 2014 University of Southern California study looking at the diets of more than 6000 people found that for 50-65 year olds a diet high in animal protein (more than 20% of daily calories) was associated with a 75% increase in overall mortality and a four-fold increase in the risk of dying from cancer.

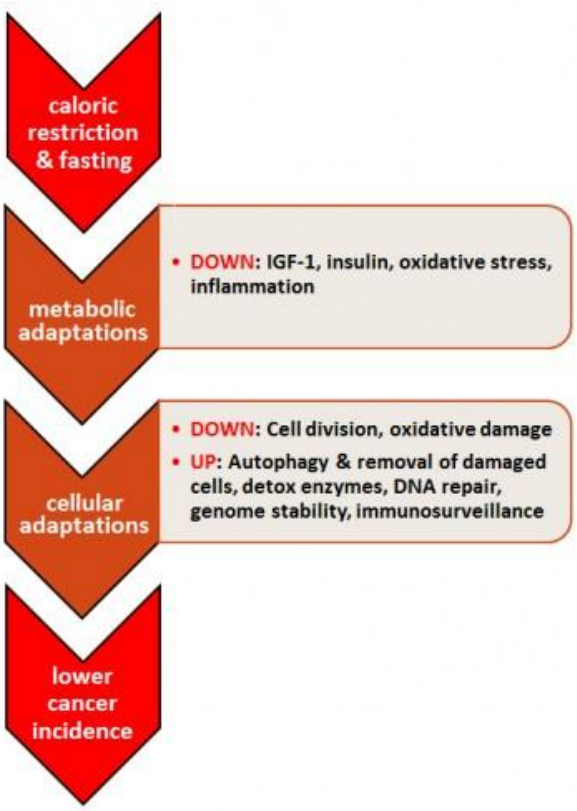
That is as big a risk factor as smoking. **This link was mostly eliminated when the protein source was plant based.** This study also found that for over 65s, a higher protein diet was linked to ***reduced*** cancer and overall mortality. More protein is beneficial in older age.

Based on this research we can recommend a 10-15% primarily plant based protein intake up to one's mid 60s, increasing to 20% in later years. For athletes, for example, more protein intake is to be expected.

Sources of non-animal protein can be found here.

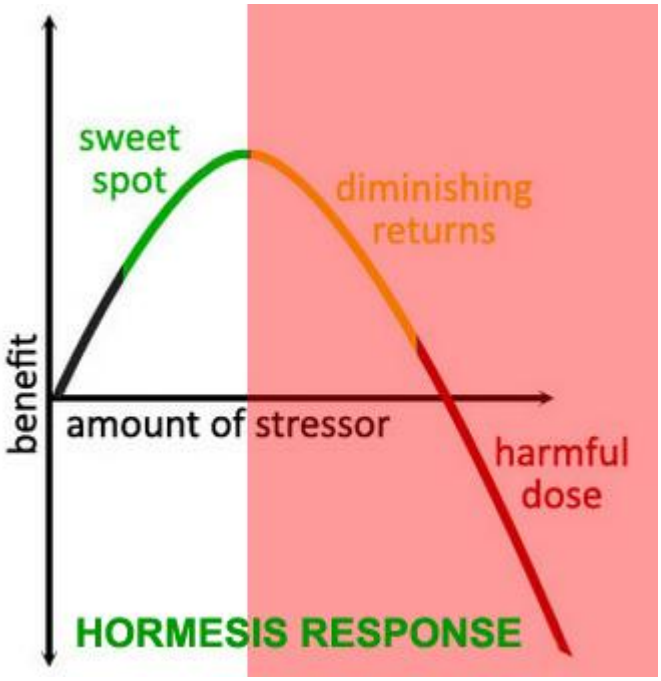
Anti-Cancer Effects of Caloric Restriction & Fasting

Long-term low protein fasting is associated with low plasma growth factors and hormones that are linked to an increased risk of cancer. This diagram summarizes the adaptive response to caloric restriction or intermittent fasting that helps fight cancer (adapted from this review article).



CR & Intermittent Fasting for Brain Health & Performance

Via the same adaptive cellular stress response that improves immune function, health and longevity reviewed above, practicing caloric restriction or 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.**



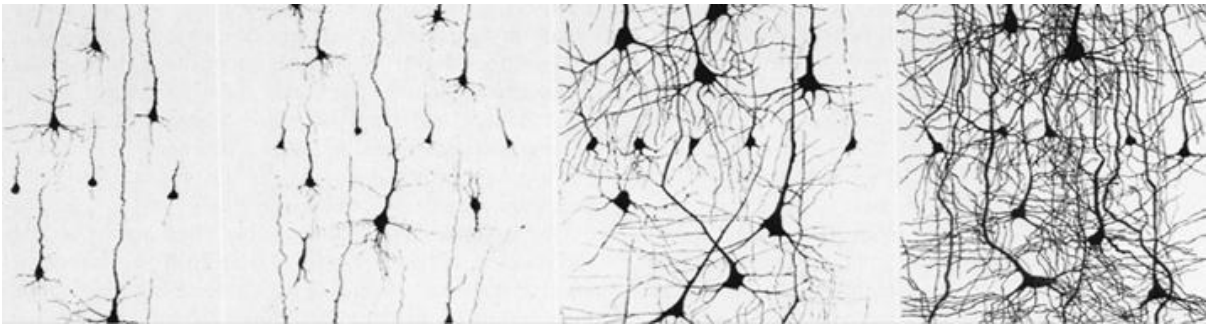
Adopting a diet plan that puts you in the **hormesis 'sweet spot'** improves **neuroplasticity** for adaptive learning and **cell protection** for healthy brain cells. Fasting can both strengthens the synapses (communication points between brain cells) via protein enzymes and improves neuron stress resistance via DNA repair enzymes, 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.

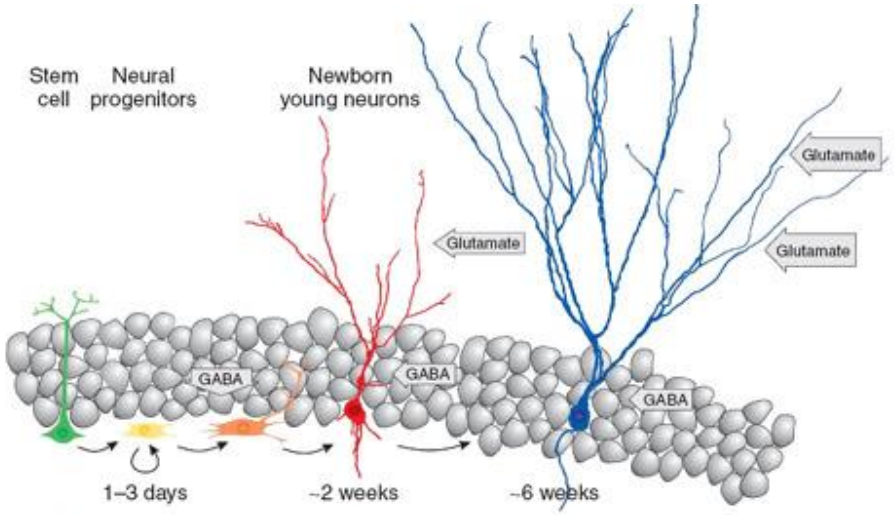
Intermittent fasting promotes neuroplasticity in both synapses (connections between individual neurons) and neural stem cells.



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 so-called 'vitagenes'.

Fasting can induce 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're not eating 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 Appendix 1.

Resilience to Stress and Emotional 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.

- Caloric restriction results in reduced stress reactivity and preservation of volumes of brain structures involved in emotional control including the prefrontal cortex and amygdala – as targeted by the brain training application **EQPro**.

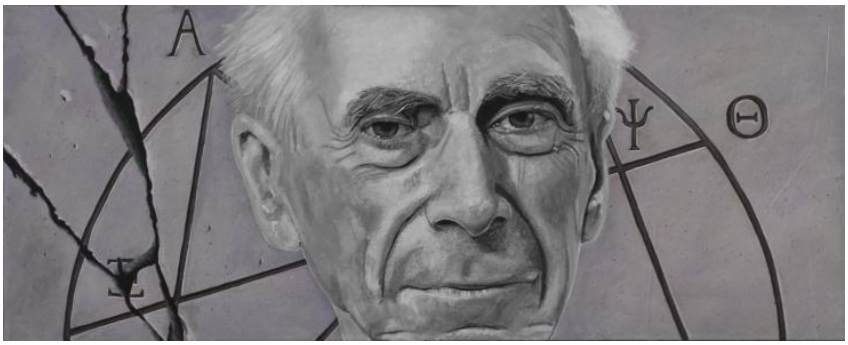
Heightened susceptibility to stress increases with aging. This is linked to atrophy of the hippocampus (a memory related region of the brain), and age-related cognitive deficits such as memory loss, as well as increased risk for Alzheimer's disease.

- 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.



What Fasting Diet?

25% Caloric Restriction (CR) Diet

Most of the animal studies on caloric restriction reviewed above have involved **cutting daily calorie intake by 25%**, while ensuring that the diet has the recommended micronutrients. (The evidence strongly suggests the same benefits accrue with intermittent fasting – although fewer studies have been done with this kind of diet). With CR diets, calories are reduced but essential nutrients are maintained. This is the diet adopted by individuals in the CALERIE study. And this is what CRON (Calorie Restriction with Optimal Nutrition) dieters are doing in their thousands.

A good starting point to get you underway with a CR diet if you find it appealing is this - the Painless Calorie Restriction for People Who Love to Eat. The information on this site follows CALERIE guidelines, such as:

- Sticking to the most nutrient-dense foods like fruits, vegetables, whole grains, and legumes--although the CALERIE study is not vegan or vegetarian.
- Eating foods that are filling, appealing, low in calories, and nutrient-rich.
- Eating lots of fiber--at least 50 grams a day without counting grams or even trying. Fiber is key to keeping satisfied and full - and it likely activates the satiety receptors in the lower intestine.

In addition, it is important to reduce the amount of animal protein.

- Reducing animal proteins (meat, fish, yoghurt, eggs and milk) to 10% of calories eaten or less reduces risk factors for prostate, breast, and colon cancers, and neurodegenerative diseases.

A 1500 Calorie Day

Macros in Numbers

To calculate your required calorie intake, you can use this online calculator. Simply multiply your recommended Calories (to maintain current weight) by 0.75.

To get your macro breakdown, feed this diet-restricted number into this calculator, setting your protein intake to no more than 10% if you consume animal proteins. For instance, 55% carbohydrates, 10% proteins, and 35% fats. The exact carb-fat ratio is something you could experiment with. The research does not have a clear recommendation here. See Appendix 1 for a more radical low carb diet plan.

If you consume mainly vegetable proteins and want a higher protein diet a 55/15/30 or 50/20/30 ratio may be preferred. **Higher protein intake is recommended if you are over 65 or high a highly active lifestyle.**

Intermittent Fasting (IF)

Many would find a CR diet unrealistic to maintain over the long term – particularly for individuals pursuing active lifestyles with high energy demands.

Research shows that the same health giving and brain enhancing genetic pathways and biochemical responses activated by constant caloric restriction are similarly engaged by intermittent fasting, even for relatively short periods of time.

This review and this review (scroll down to paper) strongly indicate that "the reported beneficial health effects from caloric restriction... **can be mimicked by alternating periods of short term fasting with periods of refeeding, without deliberately altering the total caloric intake**."

One of the most comprehensive recent reviews of the benefits of caloric restriction concludes:

> "Incorporation of intermittent energetic challenges into our daily and weekly schedules should be a guiding principle for achieving optimal brain health. a prescription of CR and regular exercise will improve the health and longevity of the brain and body. Individuals who are overweight and sedentary must reduce their energy intake and engage in regular vigorous exercise in order to improve their brain health and reduce their risk for neurodegenerative disorders. Those of normal weight can expect to optimize the performance of their brain by CR and exercise."

Intermittent fasting is more similar to the availability-scarcity cycles of our evolutionary past. As with exercise and mental effort, by periodically **triggering the adaptive cellular stress response we can benefit from the hormesis response** (see above).

There are three popular varieties of intermittent fasting:

Alternate Day Fasting (ADF)

This requires **eating what you want one day, then cutting down to a quarter of your normal calories the next**. This amounts to around 500 Cal / day for women and 600 Cal / day for men.

Intriguingly, the research indicates that it might not matter much what proportion of fat you eat on non-fast days – although studies are limited. Dr Krista Varady of the University of Illinois at Chicago carried out an eight-week trial comparing two groups of overweight patients on ADF. She observed:

> "If you were sticking to your fast days, then in terms of cardiovascular disease risk, it didn't seem to matter if you were eating a high-fat or low-fat diet on your feed (non-fast) days."

5:2 Diet

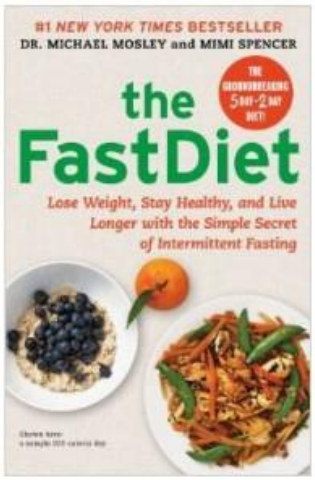
This is a less intensive and often more practical version of ADF. **Five days a week you eat normally and then for two days a week what you do is you cut down to a quarter of your normal calories as in ADF**.

The 5:2 diet has been popularized by the Michael Mosley in the BBC Horizon program Eat, Fast and Live Longer (also given a BBC feature here). The feature is well worth a watch for an introduction to the science between restricted diet and intermittent fasting.

Michael Mosley having his health assessed before starting his 5:2 intermittent fasting diet. Click for video.

Recipes for 500-600 Calorie Intermittent Fasting

Michael Mosley's book The Fast Diet is recommended if you want a practical plan for adopting alternate day fasting or the 5:2 diet. You can download it in an instant to your Kindle. Examples of the fasting day diets are:

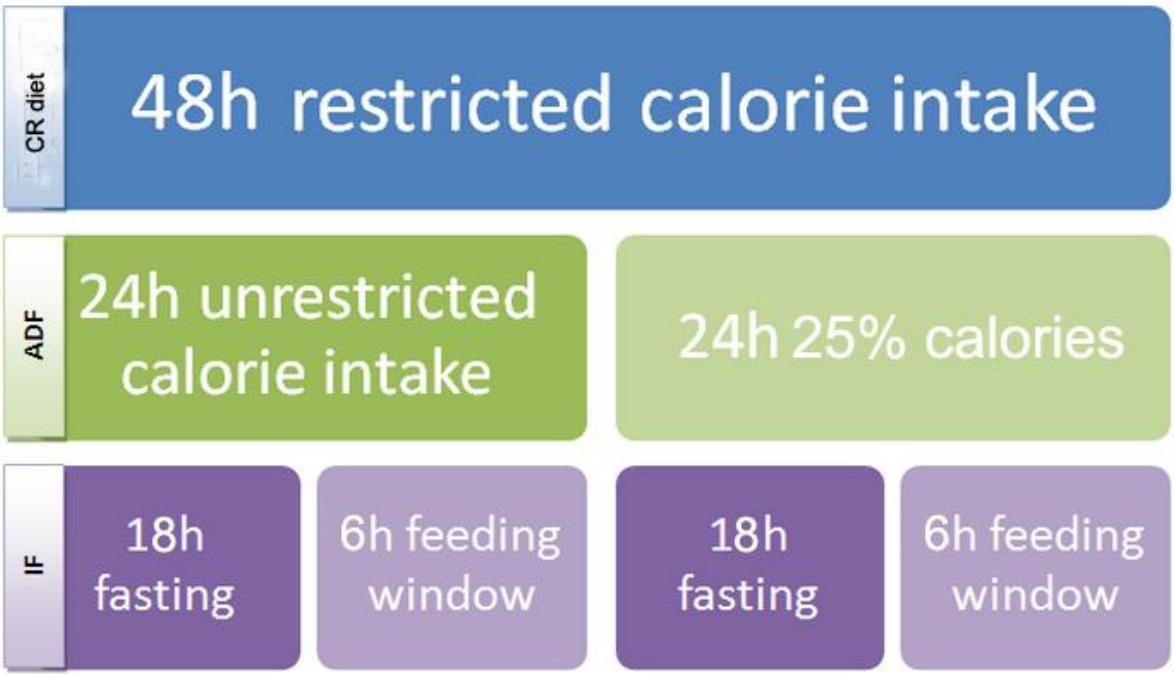


Breakfast: 1 boiled egg, half a grapefruit (125 calories)
Dinner: vegetarian chilli (378 calories)
Breakfast: Porridge with blueberries (197 calories)
Dinner: Chicken stir fry (306 calories)
Breakfast: strawberry smoothie (171 calories)
Dinner: Oven-baked smoked haddock (325 calories)

Same Day Intermittent Fasting

This is another popular intermittent fasting variant - eating only during a short time window each day (e.g., not eating breakfast or lunch). One version of same day intermittent fasting has been adopted in Bulletproof Intermittent Fasting. In this diet, you eat freely between 2pm and 8pm and fast for the remaining 18 hours in a day. Less research has been conducted looking directly at same-day intermittent fasting, but it triggers the same adaptive cellular stress response as CR and ADF.

Calorie Restricted dieting, alternate day fasting and same-day intermittent fasting schedules over a two day period are shown in the diagram.



Optimal Weight Range

Being underweight - just like being overweight - can result in negative health and cognitive outcomes. Excessive caloric restriction – putting you in the 'red zone' of the hormesis response – results in muscle wasting, bone mineral density reduction, libido lowering, general malaise. And being underweight long-term in adulthood and weight loss late in life is associated with poorer cognitive outcomes.

There seems to be a window for energy intake and expenditure that promotes optimal health and brain function. An energy balance that results in a BMI (body mass index) between 20 and 24 appears to be optimal for most people eating Western diets. Ensure that you remain within this window while practicing caloric restriction or intermittent fasting.

You can calculate your current BMI here

Male-Female Differences with Caloric Restriction and Intermittent Fasting

There are a number of studies indicating that caloric restriction and IF **shouldn't be practiced during pregnancy** since it alters fetal breathing patterns, fetal 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**

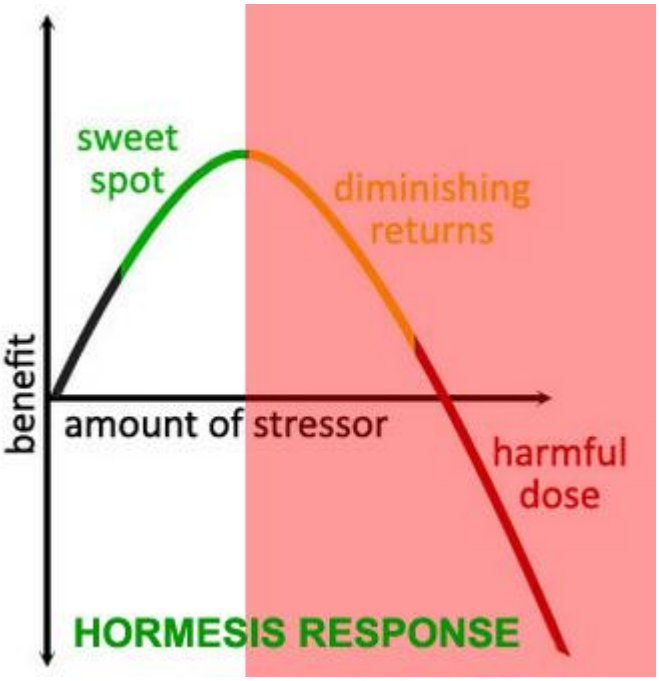
suggests that females may have evolved a greater 'survival mode' response during times of energy scarcity.

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 unreplicated, 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.



Self-Quantifying the Effects of Fasting

It is both informative and motivating to track certain variables while you are practicing caloric restriction or intermittent fasting. Useful measures that are freely available (some involving a trip to the doctor) include the following:

- weight
- waistline
- BMI (body mass index)
- body fat percentage
- blood sugar
- cholesterol levels (e.g. LDL)
- hours slept
- resting heart rate

Measures of physical performance can also be tracked such as weight lifted, reps completed, distance run/walked/cycled/rowed.

For **cognitive performance**, you may use a cognitive profiling app such as PsiProfiler for attention, executive control, working memory, reaction time and cognitive flexibility. This can be used to measure cognitive gains over time for combinations fasting, exercise, nootropics and with computer based brain training.

The **Daytime Insomnia Symptom Scale (DISS)** (Appendix 2) is a good scientific measure of overall alertness, mood, stress and fatigue. This can be used once a day over the IF period to track changes along these dimensions, which can be useful for assessing how beneficial the fasting is psychologically.

Personal Recommendations
Mark Ashton Smith, Ph.D

- Experiment with different fasting programs to find out what you can **successfully make a part of your lifestyle**. These diets should be thought of as a long-term lifestyle change – not a temporary diet plan. It is for this reason that permanent **caloric restriction (e.g. 20-25%) diets are not recommended,** as they tend to be unsustainable in the long-term. I have opted for an alternate day intermittent fasting diet, but I regularly increase my calorie intake on fasting days to over 600 calories, to supply my energy demands for long distance running and rock climbing. I have also found that my overall energy levels and cognitive health has improved with a reduced carbohydrate intake during my unrestricted diet days.
- The diet should, after a couple of weeks, be helping you feel **"more energy, more bounce, a greater zest for life"** in the words of Dr Michael Mosley. If you are feeling fatigued, over-stressed, or run down, or are experiencing disruptive swings in mood and energy levels, then the diet is not working and should be adjusted. I believe, however, that some stress-reactivity should be tolerated during the first weeks as your body adapts to the new regime.
- You may need to develop a **tolerance for feelings of hunger** on fasting days – which in itself is not a negative.

- The idea of caloric restriction/fasting is to create **an energetic stressor to activate all the benefits of the hormesis response**. But if you overdo the fasting, or skimp on essential nutrients, you will cause the kind of system breakdown that you are trying to build resilience to – leading, for instance, to insulin resistance and poorer glucose metabolism. For women, the effects of being overstressed from fasting may be more dramatic.
- Related to the above, combining fasting with intense exercise may result in a **stress-reactivity response**, with sleeplessness and anxiety. On a couple of occasions I have experienced an intense stress reactivity during the night after long training runs during the day, with insomnia, restlessness and anxiety. I would recommend stocking up with a high carb meal the evening before endurance workouts, and ensuring that on the training day you are also well fueled with carbs.
- **Ensure that you don't become weaker through muscle loss.** Maintain at least 0.8 grams of (complete) protein per kilogram of body weight – e.g. 64 g for a 80 kg man (i.e. 256 calories) ; 45 g for a 56 kg woman (180 calories). Ensure that most of your protein intake is plant based if you are consuming more than 10% protein in your overall calorie consumption. I have switched my diet to a primarily vegetarian one for a wealth of health reasons, and find that **hemp protein supplementation has been excellent** for maintaining strength during intermittent fasting and athletic training.
- **Drinking coffee may be beneficial for fat-burning**, especially during a fast. One study found that an infusion of epinephrine (a hormone that coffee increases) during 48 hour fasting up-regulated fat-burning and metabolism. Epinephrine also **lowers appetite**, which can be helpful for people trying to stave off hunger during a fast.
- **Avoid alcohol during fasting**. The inebriating effects of alcohol are more pronounced during fasting, and alcohol is itself relatively high in calories.
- **Meditation on fasting days is recommended**. In my own experience, mindfulness meditation before sleep on fasting days helps counteract stress-reactivity, and helps with overall adaptation to prolonged intermittent fasting.
- **Phytochemical consumption on fasting days is recommended**. The health and cognitive benefits of phytochemical-rich nootropics such as green

tea, blueberries, and Turmeric may be heightened when the adaptive cellular stress response is already ‘primed’ by fasting.

- **High Intensity Interval Training (HIIT) is recommended for fasting days**. Based on the same principle of brain cross training synergy, combining briefer periods of high intensity workouts with fasting may be a highly beneficial strategy. Experimentation is needed, to ensure that this doesn’t result in an unhealthy stress-reactivity outcome.
- **Intensive computerized brain training** (such as i3 Mindware or EQPro) may also act synergistically with fasting, with greater neuroplasticity and brain health benefits when the adaptive cellular stress response is already primed.

APPENDIX 1

MARK SISSON'S THEORY OF KETO-ADAPTATION

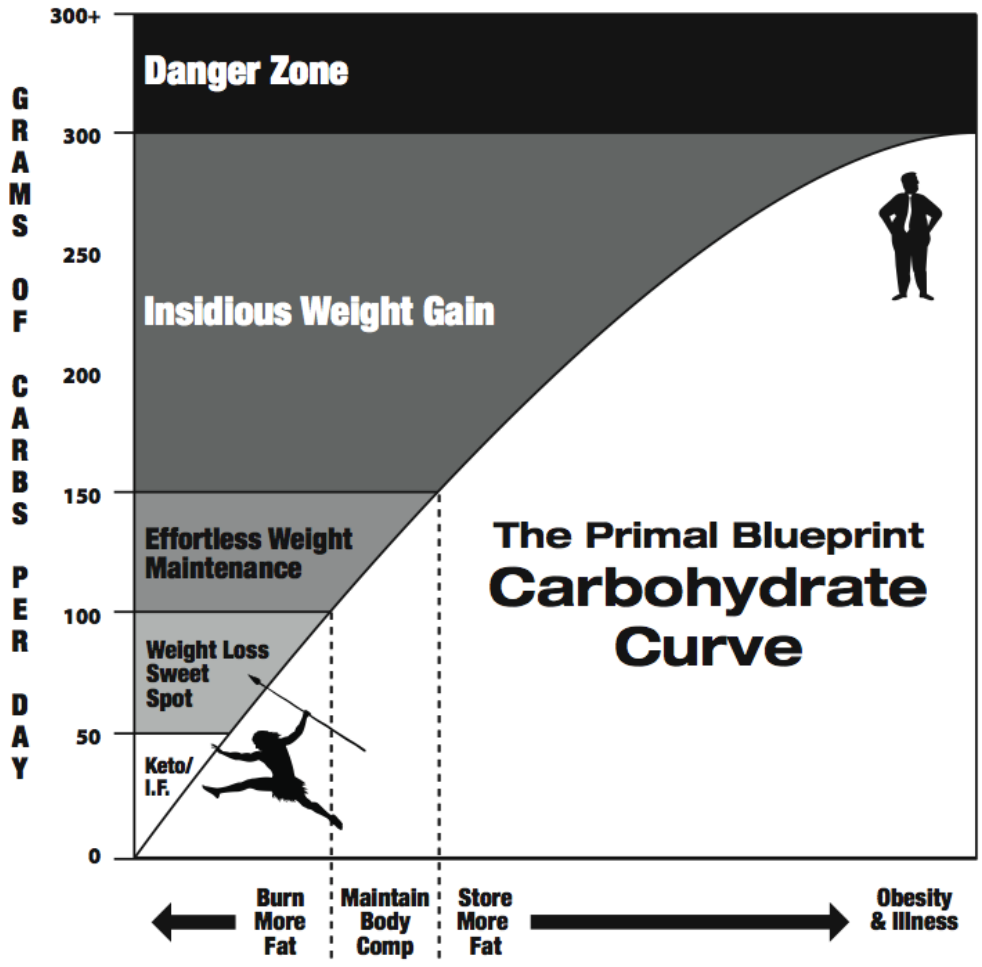
According to Mark Sisson we are stuck in a biologically maladaptive 'carb' paradigm that we need to break out, adopting a low carb-eating diet and reprogramming our genes to become 'keto-adapted'. Other prominent 'biohackers' have endorsed this 'paleo diet' philosophy, including Tim Ferris and Dave Asprey.

> "The studies keep piling up indicating that carbohydrate intake is the major variable in determining body composition and that excess glucose from carbohydrate intake (especially from processed grains and sugars) is the primary culprit in obesity and in many disease processes. It follows logically that if you can limit carb intake to a range of which is absolutely necessary (and even up to 50 grams a day over) and make the difference up with tasty fats and protein, you can literally reprogram your genes back to the evolutionary-based factory setting you had at birth – the setting that offered you the opportunity to start life as a truly efficient fat-burning organism" Mark Sisson

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



According to Sisson's paleo-diet theory, 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. He sums up the paleo-diet 'manifesto' in this way:

> most typical human movement patterns can be fueled almost entirely by fats and/or ketones (PDF) 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.

It is also acknowledged that more carbs are needed if you are a physical laborer or are training hard on a daily basis.

Whether or not you accept the theory that by adopting a paleo diet we can become "fat-burning and keto-adapted beasts" and whether or not you accept that that carbs in the forms of grains, seeds and fruits should be minimized to such an extent for a more healthy diet, there are **obvious overlaps with the brain cross training practice of caloric restriction or intermittent fasting**. 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 and act as a stand in for sugar in the brain. As reviewed above, caloric restriction increases the production of ketone bodies. These can enter the brain and protect neurons against injury and disease.

APPENDIX 2

DAYTIME INSOMNIA SYMPTOM SCALE (DISS)

University of Pittsburgh

Reference

Buysse,D.J., Thompson,W., Scott,J., Franzen,P.L., Germain,A., Hall,M., Moul,D.E., Nofzinger,E.A., & Kupfer,D.J. (2007) Daytime symptoms in primary insomnia: A prospective analysis using ecological momentary assessment. Sleep Medicine, 8, 198-208.

EXAMPLE:

How alert do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

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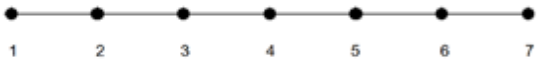
1. How **alert** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

2. How **sad** do you feel?

Very Little  Very Much

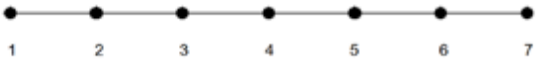
1 2 3 4 5 6 7

3. How **tense** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

4. How much of an **effort** is it to do anything?

Very Little  Very Much

1 2 3 4 5 6 7

5. How **happy** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

6. How **weary** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

7. How **calm** do you feel?

Very Little  Very Much

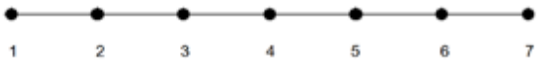
1 2 3 4 5 6 7

8. How **sleepy** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

9. **Overall**, how do you feel?

Very Bad  Very Good

1 2 3 4 5 6 7

10. How **clear-headed** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

11. How **fatigued** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

12. How **anxious** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

13. How **exhausted** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

14. How **relaxed** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

15. How **forgetful** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

16. How **efficient** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

17. How **stressed** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

18. How **energetic** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

19. How **irritable** do you feel?

Very Little  Very Much

1 2 3 4 5 6 7

20. How well are you able to **concentrate?**

Very Poorly  Very Well

1 2 3 4 5 6 7