Nutrition, Fat Loss & Gut Health

Huberman Lab Keypoints

Episodes in this pack: 19

How Food Choices Shape Memory, Cognition & Cravings | Dr. Scott Kanoski

Guest: Dr. Scott Kanoski
Date: 2026-10-12 · Duration: 2:02:06
URL: https://www.youtube.com/watch?v=PXHRYbr3mp4

KEYPOINTS

1. GLP-1 drugs push GLP-1 far above anything the body makes naturally
GLP-1 drugs were first used for diabetes and only later became known for weight loss. Huberman notes they raise GLP-1 roughly a thousandfold above natural levels, and Kanoski agrees that is 'supra-physiological for sure.' What that means over the long term, good or bad, is still being worked out.

2. GLP-1 receptors sit all over the brain, so the drugs may matter beyond appetite
The receptors aren't limited to appetite and blood-sugar centers. They are dense in reward circuitry (the VTA, striatum and nucleus accumbens) and in the hippocampus, Kanoski's favorite region. Animal data support uses for substance-use disorders and possibly memory disorders and dementia. Human trials are only now coming out.

3. Whether the drugs actually get into the brain is still disputed
Rodent work from 2005–2012 on first-generation drugs suggested much of the appetite effect came from acting on the brain. Better tracer studies are now under way, using carbon-14-labeled peptides, from Elizabeth Rhea, Bill Banks and colleagues at the University of Washington. Early-generation drugs appear to enter the brain readily. For the newer drugs it's unclear, and where they act is not well understood.

4. Natural GLP-1 works locally on the vagus nerve to end a meal
L-cells in the intestine release GLP-1, which acts right next door (paracrine signaling) on GLP-1 receptors at the gut endings of the vagus nerve. The vagus carries 'within-meal' signals to the brainstem, the first brain site told that enough food has arrived. Kanoski calls GLP-1 one instrument in a 'symphony' of stomach-stretch and nutrient signals that produce fullness and stop eating. Neither man experiences 'food noise' himself, so they could only guess at what the drugs quiet.

5. Your memory of a meal shapes hunger hours later
Fullness right after eating follows what you actually ate, which Kanoski calls 'the wisdom of the body.' A few hours later, hunger ratings track what people think they ate. That makes the hippocampus, the brain's memory center, part of appetite control, not just a store of facts.

6. A Western-style diet impairs hippocampal memory in animals quickly
His lab's 'Western diet' gets about 35% of calories from fat and 15% from mostly simple sugars. In rodents it can impair hippocampus-dependent memory within about a week, though most studies run a few months. The hippocampus seems more vulnerable than other memory systems. Teenage exposure has been a major focus of his lab.

7. Diet in midlife is linked to later dementia risk
Human prospective studies link midlife diet and metabolic health, including visceral (belly) fat, to dementia risk. In mice engineered to develop Alzheimer's-like disease, a Western diet makes symptoms appear earlier. Kanoski sees diet as prevention across a lifetime rather than a treatment once symptoms start.

8. Exercise can rescue diet-induced memory deficits in rats
Rats switched from an unhealthy diet to a healthy one can keep long-lasting memory deficits, and exercise reversed them. Kanoski thinks the benefit comes partly from better metabolism and partly from direct changes in the brain.

9. Gut signals reach the hippocampus through a three-step acetylcholine pathway
Vagus nerve signals reach the brainstem, which projects to the medial septum. Acetylcholine-producing neurons there connect to the hippocampus. His lab is studying acetylcholine as the 'currency' of this gut–brain–memory link and asking whether disrupting the vagus nerve matters for Alzheimer's.

10. Dopamine responses to sweet foods can be retrained
Rats show a dopamine response to sucrose, or to a cue that predicts it. If sucrose is paired with a few minutes of drug-induced sickness, that response disappears. Kanoski calls this an extreme example of how flexible the reward system is. He notes that old punishment-based approaches in humans (shock, nausea) were unethical, and he knows of no good evidence they work, for example for quitting smoking.

11. Oxytocin reduces eating mainly through the brainstem
Oxytocin has long been known to suppress appetite. Work by Harvey Grill and others points to the brainstem as its strongest target. Oxytocin is made in the hypothalamus (the PVH) and released into the blood, and some oxytocin neurons project straight to the brainstem.

EXAMPLES

1. Artificial sweeteners in adolescent rats
Juvenile and adolescent rats got a daily sweetener dose within FDA acceptable-daily-intake levels, which he estimated at something like six servings a day, and drank it voluntarily. Tested as adults after the sweetener had stopped, they showed unexpected memory problems and changes in blood-sugar regulation. The mechanism is unknown and this is a single rodent study.

2. The 'magic soup bowl' experiment
Bowls were secretly refilled or drained, so people might see 300 mL while eating 500, or the reverse. Right after the meal, hunger matched what they actually ate. Hours later, it matched what they thought they ate.

3. People with amnesia eating three lunches

In studies Kanoski credits to Paul Rozin, patients with severe amnesia (memory spans of roughly 10–40 seconds) ate a second and third meal when offered, and still rated their hunger about 7/10. Their gut was signaling, but without the hippocampus they couldn't interpret it. Rats with hippocampal lesions likewise can't use internal hunger states as cues.

4. Heat-treated 'AGE-enriched' food and gut bacteria

Heating food creates advanced glycation end-products (AGEs, which act on the RAGE receptor). Rats raised on an AGE-enriched diet had memory impairments as adults. Heating wiped out a Lactobacillus population whose levels tracked memory performance, and restoring that bacterium rescued memory. This work is unpublished, at the preprint stage.

5. Vagotomy and dementia in Taiwan

In the 1980s and '90s, surgeons in Taiwan sometimes cut the main vagus nerve trunk to treat stomach ulcers. One small records study found a positive link with later dementia. Kanoski's group plans to check this in the Swedish national registry.

6. Why people stop GLP-1 drugs

Kanoski says most people stop within two years, mainly because of side effects. In older adults, loss of lean (muscle) mass is another reason; weight loss always removes some lean tissue along with fat. To his knowledge clinical trials haven't shown micronutrient deficiencies, and most trials include diet and exercise guidance.

OTHER RELEVANT

1. Treat diet as long-term brain protection

Animal and human data point to limiting excess simple sugar and saturated fat, especially in adolescence and midlife, rather than hoping to fix memory problems later.

2. Pair GLP-1 drugs with lifestyle changes

Trial results come with nutrition and activity guidance built in. 'Simply taking a pill is not the optimal way' to lose weight, and keeping muscle matters, especially as you age. Data in young people are lacking.

3. Meal timing is individual

Kanoski sees no single recipe for when or how often to eat. Huberman reads intermittent fasting as one effective weight-loss tool among others, and eating below maintenance calories across three meals works too.

4. Feed the microbiome, but expect uncertain answers

Huberman, citing Justin Sonnenburg's work, favors low-sugar fermented foods (sauerkraut, kimchi, kefir), for instance for repopulating gut bacteria after antibiotics. Kanoski notes microbiome science is young: about 7,000 PubMed results a decade ago versus about 250,000 now.

Best Tools for Gut Health & Weight Loss | Dr. Chris Thompson

Guest: Dr. Chris Thompson
Date: 2026-09-21 · Duration: 2:27:53
URL: https://www.youtube.com/watch?v=ecjEM3NJ0lU

KEYPOINTS

1. Fiber is food for your microbes, and without it they start eating your gut lining.
Thompson explains that gut bacteria ferment fiber into butyrate, which helps maintain the tight junctions that seal the intestinal barrier. Starve them of fiber and they turn to the thin mucous layer protecting the gut wall, producing less butyrate and weakening the barrier further, a 'snowball effect' he links to inflammation and broader metabolic problems.

2. Roughly 35 g of fiber a day for men and 25 g for women is a sensible target, and quality matters.
Huberman cites these standard recommendations and Thompson agrees, adding that fiber type matters. Recent studies of resistant starch type 2 (such as raw powdered potato starch) improved fatty liver and insulin sensitivity. His bowel rule of thumb: more than three movements a day leans too loose; fewer than one every three days means you're bound up, and fiber is the first thing to examine.

3. Intermittent fasting is not a major gut-health concern in his view, and eating earlier may beat skipping breakfast.
Huberman relays a Yale microbiome researcher's view that the microbiome feeds on the gut lining during a fast but often rebounds to a slightly better state afterward. Thompson thinks the benefits generally win. Newer thinking suggests eating earlier and starting the fast in the afternoon may beat skipping breakfast, though he still skips it.

4. Stress can contribute to ulcers, but H. pylori and poor blood flow are major causes.
Barry Marshall proved H. pylori causes gastric ulcers by swallowing it himself. In gastric bypass patients, Thompson found many ulcers weren't bacterial: they came from reduced blood flow (worsened by type 2 diabetes and smoking) plus acid reaching bowel that lacks neutralizing pancreatic bicarbonate.

5. GLP-1 drugs work, but stopping and restarting them can leave your body composition worse than before.
With older drugs like semaglutide, about a third of weight lost is lean mass (mostly muscle, some bone). Regained weight returns as fat, so on-off cycling steadily worsens body composition. Thompson treats these as essentially lifelong medicines and says long-term effects of super-physiologic doses are unknown, though he believes benefits outweigh costs for obesity.

6. Rather than quitting a GLP-1, taper to the lowest dose that holds your weight.
His maintenance approach: reach the effective dose, lose the weight, then 'micro-dose' down to a level that holds it and feels good; not everyone finds that spot. About 30% of users stop in the first month and around 50% by year's end, similar to other chronic medications.

7. Fasting insulin is a cheap early warning sign that almost nobody checks.
Thompson describes metabolic decline as a predictable sequence: calorie excess (often glucose), chronically high insulin, then fat stored in the wrong places (ectopic fat in the liver and organs). Eating every few hours keeps insulin elevated because it stays high for hours after each spike. A continuous glucose monitor can flag foods that push you toward 200 mg/dL, and a fasting insulin test can catch the next stage years before diabetes.

8. Your body defends a weight range, which is why weight regain is so common.
Set point is really a defended range, governed partly by leptin from fat cells acting like a thermostat. After weight loss, muscles become about 25% more efficient at the same task and resting and daily energy expenditure fall. An NIH follow-up of Biggest Loser contestants found them burning about 500 fewer calories a day.

9. Resistance training is non-negotiable during weight loss, with zone 2 and HIIT alongside.
Thompson asks all patients to start resistance training, ideally before they begin losing weight or have a procedure, to protect lean mass. Zone 2 cardio favors fat burning. High-intensity intervals help mobilize visceral fat, which carries beta-adrenergic receptors that respond to acute stress. That fat is released during the effort but burned later, since the workout itself runs on glycogen.

EXAMPLES

1. Colon cancer screening from age 45
Thompson calls colon cancer one of the most common cancers he sees and says survival is improving thanks to screening. He recommends starting at 45. With a family history, start at 40, or 10 years younger than the relative's age at diagnosis. Options include colonoscopy every 10 years if normal, or stool DNA tests like Cologuard repeated every few years.

2. Ötzi the Iceman had H. pylori
The roughly 5,000-year-old man found frozen in the Italian Alps carried H. pylori. Thompson adds that industrialization has left us with far fewer microbial species and less microbiome diversity.

3. The Whitehall II study
This long-term study followed British civil servants and found that high fasting insulin predicted diabetes 10–15 years later. Thompson's point is that the problem could be caught and addressed a decade or more early, but fasting insulin is rarely measured.

4. A Gila monster led to GLP-1 drugs
In the 1990s in the Bronx, Dr. John Eng found a molecule in Gila monster venom (exendin-4) that closely resembles human GLP-1 but resists breakdown. It binds the same receptor and became the template for long-acting GLP-1 drugs.

5. A fistula repair that cured diabetes

Around 2003–2004 Thompson closed a small leak (fistula) in a gastric bypass patient to stop reflux. The patient unexpectedly lost weight and their diabetes resolved almost immediately. That puzzle drew him into gut hormone research and procedures designed to manipulate those hormones.

6. ESG plus ghrelin-cell ablation

Thompson developed endoscopic sleeve gastroplasty (ESG) in 2012. Through the mouth, the stomach is folded on itself to make a smaller pouch. Adding argon plasma ablation of the ghrelin-producing cells in the upper stomach (an idea from Germany) raises weight loss from about 18% to over 20%, possibly around 25%, at top centers.

OTHER RELEVANT

1. Don't panic over GLP-1 blindness headlines

Thompson says vision loss affects a very small group with a particular optic nerve structure that reduces blood flow. Screening for it makes sense, but GLP-1s are 'not making people go blind all over the place.' He also says reports of apathy are amplified on social media relative to the data.

2. Artificial sweeteners: better than high-fructose corn syrup

He sees little or no effect on insulin or resting glucose; Huberman notes data showing diet-soda drinkers lose more weight than water drinkers, while not encouraging diet soda. The bigger issue is that sweeteners usually come in highly processed foods. Thompson would treat high-fructose corn syrup 'like alcohol'; fructose in whole fruit is fine because its matrix slows delivery to the liver.

3. Seed oils and omega-3s

Polyunsaturated oils are generally fine unless oxidized or reused for deep frying. He doesn't worry about the omega-3:6 ratio; occasional fatty fish (he aims for a couple of times a week) covers omega-3 needs.

4. Leaky gut is real, but name it precisely

Increased gut permeability is '100% real.' Thompson says the term 'leaky gut' irritates doctors because its meaning is vague. Describing the specific symptoms and concerns helps when raising it with your physician.

How Mitochondria Control Your Metabolism | Dr. Jared Rutter

Guest: Dr. Jared Rutter
Date: 2026-09-07 · Duration: 2:03:46
URL: https://www.youtube.com/watch?v=bv56Cuq-fyY

KEYPOINTS

1. Your metabolism is the sum of roughly 30 trillion separate cell-level metabolisms.

Rutter (University of Utah, HHMI) argues that 'calories in, calories out' hides what matters: each cell type runs its own metabolic program suited to its job. A heart muscle cell, a fat cell, a neuron and a gut stem cell take the same fuels and do very different things with them, so health and disease are best understood one cell type at a time.

2. Mitochondria do far more than make energy; they also decide how much fuel goes into building new cell material.

The 'powerhouse of the cell' label is incomplete. Mitochondria burn fuel with oxygen to make ATP, the cell's energy currency, but they also supply the building blocks (biomass) a cell needs to grow and divide. Rutter's central theme is this resource-allocation decision between burning fuel and building with it, which happens in every cell all the time.

3. Pyruvate is the fork in the road between energy and growth.

Glucose is broken down to pyruvate. Pyruvate can either be carried into mitochondria and fully burned for ATP, which heart cells 'love to do', or be diverted along with other glycolysis intermediates into making new cellular material, which is what the intestinal stem cells that rebuild your gut lining every 5–7 days do.

4. Rutter's lab helped identify the mitochondrial pyruvate carrier (MPC1 and MPC2), the gate that lets pyruvate into mitochondria.

Scientists knew for 60–70 years that such a carrier had to exist, but not what it was. Working from mitochondrial proteins of unknown function, his lab and fly geneticist Carl Thummel's lab found the two proteins around 2008–2012, publishing in 2012 at the same time as Jean-Claude Martinou's lab in Geneva. Everything that has mitochondria has MPC1 and MPC2.

5. Cells set their energy split by sensing and feedback, not a fixed ratio.

Asked whether heart cells always devote something like 90% of fuel to ATP and 10% to upkeep, Rutter said it is 'definitely not programmed' like a valve with a fixed split. Cells measure their outputs and adjust, an 'adaptive logic' that responds to what the cell and the body need at the moment.

6. Hormones carry information about which fuels are available, and cells respond in their own ways.

Insulin (and GLP-1) signals 'I just ate', so cells take up and store or use glucose. Glucagon, a fasting hormone now being combined into some newer GLP-1 drugs, does the opposite: it tells fat cells to release stored fat so the heart and other tissues can burn it.

7. Fuel use follows a rough priority order, and excess fatty acids get burned early because they are acutely toxic.

Rutter says there is definitely prioritization, though no strict rules. Excess free fatty acids can be toxic quickly, while high glucose is harmful more chronically. The heart eats a 'dog's breakfast' of fuels (fats, glucose and lactate) so it can keep beating in any metabolic state.

8. Lactate is a real fuel, not just a waste product.

When muscle runs short of oxygen during hard exercise, pyruvate can't be burned and is converted to lactate. Lactate was long seen as waste. Rutter cites work over the last 5–10 years from Princeton's Joshua Rabinowitz showing lactate is an important fuel in its own right that tissues like the heart readily burn and that moves energy around the body.

9. Cancer cells' mitochondria aren't broken; they are redirected toward building.

In the 1920s Otto Warburg saw that cancer cells use less oxygen than expected and concluded broken mitochondria cause cancer, a view that lasted decades. Rutter says the low oxygen use is real (the Warburg effect), but tumor mitochondria are 'very, very good' at making the material a dividing cell needs rather than burning fuel.

10. Overloaded mitochondria are a leading suspect in damage from excess energy and in aging.

A widely accepted but not universal hypothesis holds that when mitochondria are overpowered by too much incoming energy, they produce reactive oxygen species that damage DNA and proteins and cause mutations. Rutter adds that mitochondria become less energized and effective with age almost universally, and that damage building up over time correlates strongly with aging, though the causes are 'largely unclear'.

EXAMPLES

1. Mice lacking the pyruvate carrier don't survive.

With knockout technology (developed by Utah Nobel laureate Mario Capecchi), mice missing MPC develop for about 12–13 days, roughly two-thirds of the way to birth, and then die. Flies lacking MPC live but show specific defects, which helped reveal that pyruvate entry into mitochondria was blocked.

2. Deleting MPC only in the heart leads to heart failure from a growth decision, not an energy shortage.

In work started by Ahmad Cluntun, a former Rutter postdoc now running a lab at Rutgers, mice with heart-specific MPC loss live for weeks, then die with massively enlarged hearts. They can still make ATP by burning fat. Rutter speculates (his word) that the cells divert glucose into growth, and enlarged heart cells create the same dilated, weak-pumping heart seen in most human heart failure.

3. One cell can contain two kinds of mitochondria.

Recent work from Craig Thompson at Memorial Sloan Kettering showed that a single cell can contain distinct mitochondria. In simplified terms, one kind is more biosynthetic (building) and the other more focused on extracting energy and making ATP.

4. Mitochondrial DNA comes entirely from your mother.

Mitochondria came from a bacterium that entered an ancestral cell, and they keep their own genome. At fertilization only the sperm's nucleus enters the egg, not its cytoplasm, so all mitochondrial DNA is inherited from the egg. This has implications for how mitochondrial diseases are inherited.

5. Cancer is better classified by mutation and metabolism than by organ.

Rutter notes that some breast cancers resemble certain liver cancers more than other breast cancers, because the old system grew out of where surgeons removed tumors. Huberman cites David Fajgenbaum's nonprofit Every Cure, which tests already-approved drugs on individual patients' tumor cells. Rutter adds that a drug killing 99.9% of tumor cells can still fail because the surviving 0.1% regrow the tumor, which argues for combination therapies.

OTHER RELEVANT

1. Don't treat 'boosting metabolism' as one dial.

Since each tissue allocates fuel differently, the same intervention can push energy toward burning in one cell type and toward growth in another. Rutter frames future therapies as targeting energy allocation in specific cells, such as the pyruvate fork, rather than whole-body metabolism.

2. Excess energy has costs beyond body fat.

Huberman and Rutter agree that chronically taking in too much energy can create downstream biochemical stress, from mitochondrial overload and reactive oxygen species to the acute toxicity of excess fatty acids. This is an argument for avoiding chronic overnutrition. No specific diet or supplement protocol is offered.

3. Watch for cell-level metabolic imaging.

Rutter is excited about new tools that measure specific molecules at individual locations inside single cells, mostly in mice and cultured cells for now. Huberman imagines a future body scan showing how each organ's cells split energy between upkeep and growth across a lifetime, which Rutter treats as plausible but not available today.

4. Treat 'smelling disease' as intriguing, not diagnostic.

Huberman raises cancer-sniffing dogs and a woman reported to smell Parkinson's. Rutter finds it plausible, since scents are chemistry, but it is poorly understood, correlational and no frontline test.

Eating for Better Sleep & Foods that Improve Metabolic Health | Dr. Marie-Pierre St-Onge

Guest: Dr. Marie-Pierre St-Onge
Date: 2026-06-08 · Duration: 1:57:05
URL: https://www.youtube.com/watch?v=jjaFnKtytqI

KEYPOINTS

1. Sleep and diet affect each other in both directions.
St-Onge came to sleep research from obesity research, where population studies kept linking short sleep to higher body mass index (BMI) and more weight gain over time. Her lab tests causality both ways: how sleep loss changes eating, and how what you eat changes that night's sleep.

2. Short sleep raises appetite through different hormones in men and women.
In her inpatient study, short sleep increased ghrelin, the hormone that drives hunger, in men. In women it lowered GLP-1, a fullness hormone. Either way, participants ate about 300 more calories a day when they could choose their own food, and brain imaging showed reward centers responding more strongly to food after sleep restriction.

3. Even mild, sustained sleep loss harms blood sugar control and blood pressure.
In a free-living study of women, cutting sleep by about an hour and a half (from roughly 7.5 hours to around 6, close to a full sleep cycle) for 6 weeks increased insulin resistance and raised blood pressure. Insulin sensitivity fell more in postmenopausal than premenopausal women.

4. Sleep loss burns a few extra calories, nowhere near enough to cover the extra eating.
In a small metabolic-chamber study of women at Columbia, energy expenditure rose about 5%, roughly 90 calories, under sleep restriction, against the ~300 extra calories eaten. She also thinks sleep-deprived people become more sedentary, with less spontaneous daytime activity. Eating may also be a subconscious way to get a jolt of energy when tired.

5. What you eat during the day changes deep sleep that night.
Using nightly sleep lab recordings (polysomnography), her lab found that more fiber was associated with more deep (slow-wave) sleep, more saturated fat with less deep sleep, and more refined carbohydrates and simple sugars with more arousals during the night. When participants switched from a controlled diet to choosing their own food, they ate about 450 more calories and 33% more saturated fat. They took over 70% longer to fall asleep and had about 20% less deep sleep.

6. Mediterranean and DASH-style diets are linked to less insomnia.
With Susan Redline in the MESA cohort, diets closer to Mediterranean were associated with a better chance of adequate sleep and fewer insomnia symptoms. In Women's Health Initiative data, women whose diets aligned with Mediterranean or DASH (Dietary Approaches to Stop Hypertension: fruits, vegetables, nuts and more) were less likely to have insomnia three years later. These are observational links, not proof of cause.

7. Eating later in the day reduces fat burning, even with identical food.
In a metabolic-chamber study, participants ate the same foods in the same amounts with a 10-hour eating window, starting either 1 hour or 5 hours after waking. Meals eaten later led to less fat oxidation. Huberman summarizes the takeaway as shifting meals into roughly the first two-thirds of the day, which may help sleep and appetite too.

8. Go to bed in line with your own clock; shift workers fight their biology.
St-Onge knows of no data behind 'every hour before midnight is worth two.' But going to bed far later than your usual time puts you out of sync with your circadian system and makes good sleep harder. Shift workers try to sleep during the day when their biology isn't set up for it. On naps, she says the data are thin, but avoid napping close to bedtime so you keep your sleep pressure.

9. Small dietary tweaks can modestly raise calorie burn, and they may add up.
Medium-chain triglycerides (MCTs) go straight to the liver and are burned more readily than long-chain fats, raising the thermic effect of a meal in men and women. Over time her studies found better body composition and greater weight loss with MCT oil than with olive oil. Ginger raised calorie burn after a meal, possibly via the capsaicin receptor. She thinks such effects could be additive since they act through different mechanisms, though that hasn't been tested.

EXAMPLES

1. Nurses' Health Study (2006)
Nurses tracked over about 14 years who reported sleeping 5–6 hours gained weight at a much higher rate than those sleeping 7–8 hours. St-Onge cites it as foundational evidence.

2. Her inpatient sleep-restriction study
Participants who normally slept 7 or more hours (measured by wrist-worn activity trackers) averaged about 7.5 hours with a 9-hour sleep opportunity, versus about 3 hours 50 minutes with 4 hours in bed, for 5 nights under supervision with no naps. That's roughly half their usual sleep.

3. Two weeks of short sleep, half a kilo gained
Naima Covassin's 2022 study restricted sleep to about 5 versus 7.5 hours a night for 2 weeks, and participants gained about half a kilo. Huberman notes that roughly 3,500 excess calories make a pound, so small daily surpluses add up for night-shift workers, new parents and caregivers.

4. Coffee mannan oligosaccharides
In an industry-sponsored, placebo-controlled study, sachets of fibers extracted from spent coffee grounds improved body

composition (fat loss) in overweight men but not women. The company dropped the product, so it isn't available.

5. Kefir: a null result

In her master's work at McGill, men with mildly high cholesterol drank about 500 ml (two measuring cups) of kefir daily versus milk for a month, with no effect on cholesterol synthesis. She still favors fermented foods to 'feed your gut' and notes that other outcomes weren't measured.

6. Ginger beverage

Ginger powder dissolved in warm water was compared with plain hot water in a one-time crossover test. Calorie burn after the meal, measured for several hours under a metabolic hood, was significantly higher with ginger.

7. Corn-oil chips and the portfolio diet

In a 25-day crossover snack study, corn-oil chips produced a better blood fat profile and lower lipoprotein(a) than low-fat or high-saturated-fat snacks. David Jenkins' portfolio diet (soy protein, nuts, plant sterols, soluble fiber, now expanded to legumes and olive oil) matched a statin's cholesterol reduction head-to-head.

OTHER RELEVANT

1. Using MCT oil

Asked whether a tablespoon or two a day is the typical approach, she agrees, but it should replace other oil, not be added on top.

2. Get snoring and unrefreshing sleep tested

If you snore, wake unrefreshed or feel sleepy by day, talk to your doctor. Polysomnography is the standard test, but in-home testing is easy to prescribe. CPAP machines need a prescription because the pressure has to be set for you.

3. High-volume plant foods for fullness

She doesn't pit plants against animal foods. High-volume, lower-calorie plant foods fill you up, nuts prolong fullness, and animal products are fine with attention to portion size. Huberman flags starch-fat-sugar combinations as the easiest foods to overeat.

4. Match oils to their smoke points

Use each oil for its appropriate cooking temperature. For example, don't heat flaxseed oil to high temperatures.

How Different Diets Impact Your Health | Dr. Christopher Gardner

Guest: Dr. Christopher Gardner
Date: 2025-05-12 · Duration: 2:50:28
URL: https://www.youtube.com/watch?v=9vQZT2igXN4

KEYPOINTS

1. Gardner's research points to whole foods, mostly plants
Gardner sums up his studies with Michael Pollan's 'eat food, not too much, mostly plants'. Animal foods could make up 25%, 10% or none of the diet. He stresses that the right comparison depends on the goal: weight loss, cardiometabolic markers or something else.

2. Differences within a diet dwarf the differences between diets
In the A to Z study (Atkins, Traditional, Ornish, Zone; 311 women for a year, published in JAMA in 2007), groups ended only a few pounds apart. The only significant gap was between Atkins and Zone, the two low-carb diets. In each group of about 75, some women lost 30–50 pounds and others gained 5–10, which sent Gardner looking for what predicts individual response.

3. DIETFITS found no winner and no predictor
In this NIH-funded trial, with extra support from Peter Attia and Gary Taubes' Nutrition Science Initiative, 600 people were randomized to healthy low-fat or healthy low-carb diets for a year. Average weight loss was the same, with individuals ranging from losing 60 pounds to gaining 20 in both arms. Neither insulin resistance (measured by oral glucose tolerance test) nor a three-SNP genotype pattern from Interleukin Genetics predicted who did better.

4. Both arms in a fair comparison should be the best version
Taubes told Gardner he had 'screwed up' DIETFITS by banning added sugar and refined grains from the low-fat arm. Gardner says that was the point: a fair test gives each diet its best shot. His group used the same approach for vegan vs omnivore, keto (Jeff Volek and Steve Phinney's well-formulated version) vs Mediterranean, and Beyond Meat vs pasture-raised red meat from Good Eggs in the SWAP-MEAT trial.

5. The protein RDA isn't the average requirement
The 0.8 g/kg/day figure comes from nitrogen-balance studies, including Doris Calloway's 'penthouse' metabolic ward at Berkeley, where participants (largely conscientious objectors) collected all their outputs. The RDA adds two standard deviations to the average need, so 97.5% of people meet or exceed their requirement at that intake. Gardner accepts the argument that it's a minimum rather than an optimum. Huberman questions how artificial those inactive, confined conditions were.

6. Lactose tolerance is the clearest diet–gene adaptation
Most of the world stops making lactase after weaning, so most adults are lactose intolerant. Some northern Europeans who kept dairy herds evolved to keep producing lactase into adulthood. Gardner calls this the only well-established example of a recent evolutionary diet adaptation.

7. The NOVA ultra-processed label is useful but imperfect
Carlos Monteiro's NOVA system from Brazil underlies a decade of research on ultra-processed food. Gardner notes problems with it and argues that US rules on additives such as dyes, emulsifiers and glazing agents are too loose. Changing what manufacturers do would have more impact than teaching consumers to read ingredient labels.

8. A 'protein flip' is a better frame than 'plant-based'
Gardner and Huberman both prefer the idea of moving meat from the center of the plate to the side. Gardner says his group never pushed veganism; the vegan arm in the twin study was a design requirement. He sees taste, sourcing and convenience as what will actually shift how Americans eat.

EXAMPLES

1. The Netflix twin study
The filmmaker behind 'The Cove' and 'The Game Changers' funded a study of 22 pairs of identical twins, randomizing one twin to a healthy vegan diet and one to a healthy omnivorous diet for 8 weeks: 4 weeks of delivered meals, then 4 cooking on their own. The vegans lost a little more weight and lowered LDL (the primary outcome) and fasting insulin; results were published in JAMA Network Open.

2. Epigenetic age and telomeres in 8 weeks
A separate analysis reported that the vegan twins were slightly younger by epigenetic clocks and had longer telomeres after just 8 weeks, both statistically significant though small effects. Gardner says these aren't his specialty and that the changes were nowhere near 'years younger'.

3. What happened to the twins afterwards
Asked whether participants stuck with the diet, Gardner offers only anecdotes: of four pairs he heard from, two moved toward vegetarian eating, one landed in between and one went straight back. He stresses this is 4 of 22 pairs and 'not science'. A paper on adherence is forthcoming.

4. Fermented food vs fiber (with Justin Sonnenburg)
Eighteen people ate as much fermented food as they could and 18 as much fiber, over 4 weeks of ramp-up and 6 of maintenance. The fermented group went from under half a serving to about 6 servings a day (around 300 calories) of yogurt, kefir, kombucha, kimchi and sauerkraut. Microbial diversity rose and 20 of 90 inflammatory markers improved. The fiber group saw no gain in diversity and no overall drop in inflammation.

5. Microbes nobody ate

Sonnenburg's lab characterized the fermented foods themselves and found most of the new microbes weren't in the food. Gardner's interpretation is that changing the gut environment let previously rare species bloom.

OTHER RELEVANT

1. Add low-sugar fermented foods daily

Plain yogurt, kefir, kimchi, sauerkraut and lower-sugar kombucha are the five used in the study. One bottle of kombucha is about two servings and 50 calories. Gardner adds 'low sugar' because many people picture sweetened cherry yogurt when they hear 'fermented'.

2. Judge diets by quality and by whether you'll stick to them

Healthy low-carb and healthy low-fat performed equally on average. What mattered was cutting added sugar and refined grains and eating whole foods. Pick a pattern you can sustain in the real world, without dietitians or delivered meals.

3. Treat individual predictors with skepticism for now

Neither the glucose-tolerance test nor the genotype panel predicted DIETFITS responses. Gardner points out that around 50 SNPs are linked to obesity, so testing one set doesn't rule out genetics, but no proven tool yet tells you which diet suits you.

Tools for Nutrition & Fitness | Dr. Layne Norton

Guest: Dr. Layne Norton
Date: 2024-08-12 · Duration: 4:04:30
URL: https://www.youtube.com/watch?v=CD0bRU1e1ZM

KEYPOINTS

1. Judge claims by the full body of evidence, not a mechanism or a single study
Norton, trained in biochemistry and nutritional sciences, says he doesn't make big shifts in his opinions based on single studies. He wants many experiments from different labs, funders and countries pointing the same way, and creatine is his model of that. Study design explains many 'conflicting' results: a rice-versus-whey study found equal protein synthesis because it used 40 g, enough to max out the response with either source. Even randomized trials have limits. A one-year diet trial in 60-year-olds can't capture LDL, which Mendelian randomization shows acts as a lifetime exposure.

2. Muscle protein synthesis switches off after a meal even if amino acids stay high
In his rat studies, protein synthesis peaked about 90 minutes after a meal and was back to baseline by 3 hours, even though leucine and mTOR signaling were still elevated, an effect others call 'muscle full.' A roughly 2001 study infusing amino acids for six hours saw the same rise and fall. The only explanation his lab found was falling ATP inside muscle cells, since building protein is energetically expensive; he notes others may disagree.

3. Total daily protein matters far more than timing
Norton's rule of thumb is about 1 g of protein per pound of body weight (studies suggest about 1.6 g/kg maxes out the response on average, but he suspects some people benefit from more). Jorn Trommelen's recent study found that 100 g of protein after training was used far more than the old '30 g per meal' ceiling suggests. In Grant Tinsley's time-restricted eating trials, people who ate three high-protein meals in an 8-hour window and trained during it gained as much lean mass as those eating across the day.

4. Early versus late eating windows make little practical difference
In a recent 12-week trial with all food provided and matched calories and protein, eating 80% of calories before 1 p.m. in an 8-hour window was compared with a 12-hour window weighted after 5 p.m. The groups differed only in fasting glucose, not HbA1c. Norton reads that as a transient effect of a longer overnight fast, since HbA1c reflects glucose exposure over the whole day.

5. Get close to failure for size; mostly avoid failure for strength
Citing meta-regressions by his powerlifting coach Zac Robinson, Norton says hypertrophy needs sets taken close to failure (defined as no longer able to complete a rep in good form), but not necessarily to failure. For maximal strength, regularly reaching failure is probably counterproductive. Occasional sets to failure teach you where your true limit is.

6. Almost any training style builds muscle if you work hard and stay consistent
Machines or free weights, roughly 5 to 30 reps, to failure or a few reps short: all build similar muscle if the last reps are hard and volume is adequate (about 10–20 hard sets per muscle per week is the range discussed). Older lifters gain a similar percentage of lean mass as younger ones, and women a similar percentage as men. He estimates three or four 30–40 minute sessions a week capture most of the health benefit.

7. Metabolism barely slows with age; muscle loss and moving less do
Discussing Herman Pontzer's data on several thousand people, Norton notes that total daily energy expenditure stays fairly flat through most of adulthood and declines only later in life, and the decline tracks the loss of lean mass. That makes resistance training the lever. Poor sleep cuts spontaneous movement without people noticing.

8. GLP-1 drugs work on appetite, which is where obesity lives
Norton describes GLP-1 drugs as modified gut hormones with much longer half-lives. Raising GLP-1 naturally is a 'BB gun' compared with the drugs' 'tank.' Users often report the end of constant 'food noise.' Lean tissue makes up 30–40% of the weight lost, which he notes is similar to dieting without exercise. He expects resistance training and prioritizing protein and fiber to protect lean mass.

EXAMPLES

1. Saturated fat versus fructose in liver fat
He cites an overfeeding study in which matched excess saturated fat raised liver fat about 70% more than fructose did. On seed oils, he has not found a good human randomized trial in which swapping polyunsaturated fat for saturated fat one-for-one worsened outcomes. Both polyunsaturated and monounsaturated fats look better than saturated fat for cardiovascular risk, and he knows of nothing bad about olive oil.

2. Red meat as a marker of overall diet quality
In a 2020 Canadian analysis he recalls (Maximova), higher red meat intake was linked to more cancer only when fruit and vegetable intake was low. That suggests red meat partly tracks poor overall diet quality. Fiber and produce, by contrast, consistently show dose-dependent drops in cancer, heart disease and mortality.

3. Fructose and glycogen refilling
Muscles can't turn fructose into glycogen, but in a study by Tracy and Josh Anthony, sucrose refilled muscle glycogen after exercise as well as or slightly better than pure glucose. The fructose probably satisfies the liver and spares glucose for muscle, so fruit in a post-workout shake is fine.

4. Collagen versus whey
A study from Luc van Loon's lab found whey and collagen raised connective-tissue synthesis equally after exercise, but

collagen didn't stimulate muscle protein synthesis even at about 25 g. Norton calls collagen a poor protein for muscle. After reviewing the composition of collagen, which is about one-third glycine, and meta-analyses on skin, he has become slightly more open to possible benefits.

OTHER RELEVANT

1. Use artificial sweeteners as a tool, not a fear

Norton sees swapping five regular colas for diet ones (about 750 kcal a day) as an easy win for weight loss. Gut microbiome shifts from sucralose are real, but researchers can't yet say whether they are good or bad. He wants a dose-response before treating a cancer signal as real. Huberman notes that diet soda sometimes makes him want to eat.

2. Keep saturated fat moderate and favor the plan you can sustain

He suggests keeping saturated fat below about 7–10% of daily calories. Because 'there are no solutions, only trade-offs,' he would accept a slight LDL rise for someone who lost 50 lb on the only diet they could stick to. Even 5% weight loss quickly improves blood lipids and glucose.

3. Plan around real life for consistency

He eats about four meals a day with roughly 50 g of protein each, about 235 g in total. He tracks food and will cycle calories, for example budgeting 4,000 kcal for a Saturday with friends and less on other days, purely so he can stick with the plan. Whey and eggs are among the most leucine-rich proteins; most plant proteins have less.

The Science of Hunger & Medications to Combat Obesity | Dr. Zachary Knight

Guest: Dr. Zachary Knight
Date: 2024-06-17 · Duration: 2:18:56
URL: https://www.youtube.com/watch?v=C5KpIXjpzdY

KEYPOINTS

1. Two systems control eating: a brainstem meal-ender and a hypothalamic fat tracker
Knight, a UCSF neuroscientist, points to Harvey Grill's 'decerebrate rat' experiment from about 50 years ago. Rats with only a brainstem could still end a meal using gut signals like stomach stretch and CCK. They couldn't eat more after a multi-day fast, though, because that requires forebrain (hypothalamic) circuits that track energy reserves over days to years and adjust brainstem meal control.

2. Leptin tells the brain how much fat you carry
Leptin is made only by fat, in direct proportion to how much you have, and its working receptor sits mostly on appetite neurons in the brain. Doug Coleman's experiments linking the bloodstreams of two strains of obese mice predicted a hormone and its receptor, and Jeff Friedman's lab cloned leptin in 1994. When fat is lost, leptin falls and triggers a starvation response: more hunger, lower energy expenditure and body temperature, less spontaneous movement, even reduced fertility.

3. Leptin failed as a diet drug because obesity involves leptin resistance
Amgen paid about $20 million upfront for the patent, but obese people already have high leptin, much as type 2 diabetics have high insulin. A reanalysis showed that people with the lowest starting leptin lost the most weight. Knight thinks leptin could still help maintain weight loss, when levels drop sharply, and isn't sure why that was never developed.

4. AgRP hunger neurons predict how much you'll eat before the first bite
A few thousand AgRP neurons at the base of the hypothalamus drive hunger: stimulate them and full mice eat voraciously; silence them and mice starve. His student Yiming Chen expected their activity to fade gradually during a meal. Instead it dropped within seconds of a hungry mouse seeing and smelling food, and the size of the drop predicted how much it would eat over 30 minutes. Hunger circuits constantly forecast what's coming rather than waiting for slow gut signals.

5. Body weight is about 80% heritable, yet obesity surged because the environment changed
Twin studies put heritability near 80%, second only to height. Around 10% of severe childhood-onset obesity involves mutations in the AgRP/POMC–MC4R pathway, and most of the roughly 1,000 genes linked to body weight act in the brain. 'Genetics loads the gun, environment pulls the trigger': genes set where you fall in the distribution, and cheap, ultra-processed, highly palatable food has shifted the whole distribution upward since about the 1970s.

6. Hunger circuits count calories; protein and salt get special defense
AgRP neurons respond equally to the same calories of sugar, fat or protein delivered into the stomach, so 120 calories of olive oil equals 120 calories of chicken. Protein, which supplies essential amino acids, and sodium are the nutrients the body defends most strongly, with dedicated appetites. Knight cites protein leverage: eating too little protein makes you eat more calories trying to reach a minimum.

7. Weight regain comes mostly from rising hunger, not a slower metabolism
Energy expenditure falls about 30 kcal a day per kilogram lost. Rudy Leibel found people who lost about 100 lb burned roughly 25% less than never-obese people of the same size. Kevin Hall gave people SGLT2 inhibitors, which make the body excrete about 90 g of glucose a day without their noticing, and found appetite rose about 100 kcal a day for every 2 lb lost. That hunger increase, he says, is the main reason weight comes back.

8. GLP-1 drugs work by vastly extending how long the hormone lasts
Natural GLP-1 lasts about 2 minutes, and DPP-4 inhibitors that raise it about threefold help diabetes but not weight. Exenatide, from Gila monster venom (2005), lasts about 2 hours, liraglutide about 13 hours (7–10% weight loss), and semaglutide about 7 days (about 16% loss in a year). The drugs act mainly on the brainstem: the nucleus of the solitary tract for satiety and the area postrema for nausea, which fades as the dose is raised gradually.

9. Dopamine drives wanting and learning, not enjoying food
Mice with no dopamine still like sweet tastes but won't work for food. Knight's lab found dopamine subsystems that fire tens of minutes after nutrients or water reach the gut and blood, teaching animals which flavors nourish or rehydrate them. This slow learning is how adults come to like bitter vegetables and coffee. In New Zealand, rabbits drank no water for nine months of the year, getting it all from food.

EXAMPLES

1. Kevin Hall's ultra-processed food trial
Inpatients were offered ultra-processed or whole-food diets rated equally tasty, for about two weeks each in random order. They ate more and gained weight on the ultra-processed diet and lost weight on the whole-food diet. Possible reasons include engineered fat/sugar ratios and the much larger volume of whole foods at the same calories.

2. Semaglutide cardiovascular outcome trial
In a roughly 20,000-person, four-year trial, semaglutide cut heart attacks, strokes and cardiovascular death. Much of the benefit appeared before significant weight loss and didn't correlate with how much weight people lost, pointing to possible anti-inflammatory effects through the brainstem's inflammatory reflex.

3. Next-generation drugs
Tirzepatide (Mounjaro/Zepbound) adds GIP agonism, which seems to counter nausea, for about 21% loss at a year. Lilly's triple agonist (GLP-1, GIP and glucagon, which raises energy expenditure) produced about 25% loss in a phase 2 trial with

weight still falling. Amgen's AMG 133 antibody blocks GIP instead, lasts about a month, and weight loss held for 6 months after stopping.

4. Thirst detects a 1% change

Brain osmosensors register about a 1% rise in blood concentration as thirst; a 10% rise is extreme discomfort and 20% is a hospital case. Bengt Andersson found the sensor in the 1950s by infusing salt into goats' brains.

OTHER RELEVANT

1. Simple, evidence-based ways to eat less

Knight's own guidelines: cut ultra-processed foods, eat whole foods for volume and satiety, and get enough protein, which is filling, avoids protein leverage and costs more energy to digest. Simplifying your diet also works through sensory-specific satiety, which reduces appetite for flavors you've already had a lot of.

2. Drink water with meals

He calls the idea that water dilutes digestive enzymes a myth. Water helps if you're mistaking thirst for hunger, though it adds little stomach stretch because it empties quickly, whereas caloric drinks are held back by intestinal feedback.

3. Protect muscle on GLP-1 drugs

Without resistance training or higher protein, 25–33% of weight lost through diet or drugs can be muscle. Lifting and adequate protein can largely prevent that, which matters most for older adults. Knight considers the drugs remarkably safe so far, but notes their doses push hormone levels far above natural.

4. What you're told shapes how full you feel

Huberman cites Alia Crum's milkshake study, in which labeling the same shake as high-calorie changed hormone responses. Knight adds that in human flavor-learning studies, showing nutrition labels changed expectations enough to erase the effect.

The Science of Your Gut Sense & the Gut-Brain Axis | Dr. Diego Bohórquez

Guest: Dr. Diego Bohórquez
Date: 2024-05-27 · Duration: 2:42:13
URL: https://www.youtube.com/watch?v=SZSRgyl7pyQ

KEYPOINTS

1. Gut hormone cells turned out to be wired to nerves
The gut lining is a single layer of epithelial cells. Scattered among them, at roughly 1 per 1,000, are enteroendocrine cells, named by German physician Friedrich Feyrter in 1938 and long thought to signal only by releasing hormones. In 2015, Bohórquez's group reported that roughly a third to two-thirds of them make direct contact with nerves.

2. A 'neuropod' reaches out like Adam's hand
Some of these cells grow a long arm with a little 'hand' at its base, which Bohórquez compares to Michelangelo's Adam reaching toward God. After describing it with an unwieldy 'axon-like pseudopod basal process', he coined 'neuropod'. In a dish, isolated gut cells and sensory neurons found each other within hours and re-formed the circuit, which he first saw in June 2012.

3. One synapse separates your gut from your brainstem
Using a rabies virus engineered to jump just one connection, the lab found label in the nodose ganglion, the vagus nerve's cluster of cell bodies just below the neck, and in the brainstem. That makes it a fast, mostly subconscious line. Hormones act over minutes to hours; this transmission works in milliseconds.

4. The gut senses almost everything you eat
Cells differ by location: sugar sensing is concentrated in the upper small intestine, while fiber and fermentation products such as butyrate and propionate are sensed in the colon. Bohórquez expects receptors will be found for nearly everything we eat, along with stretch and temperature; the esophagus brings hot coffee to body temperature within seconds.

5. One glucose molecule is read in layers
Glucose activates the sweet receptor T1R3. Sodium-glucose transporters then depolarize the cell, and metabolizing the glucose into ATP depolarizes it further. The cell releases glutamate onto the vagus within milliseconds, acting on fast ionotropic and slower metabotropic receptors. A neuropeptide follows to complete the experience of 'I got sugar'.

6. Silence the gut cells and mice can't tell sugar from sweetener
Mice normally pick sugar over a noncaloric sweetener such as stevia, by the second day within about 90 seconds. When the lab used optogenetics to switch off neuropod cells in a small stretch of intestine just past the stomach, the mice became 'blind' to the difference. Switching the cells on made mice treat sweetener, or even plain water, as if it were sugar.

7. Gastric bypass rewires cravings, not just capacity
At Bohórquez's first Thanksgiving, a woman told him she lost about 40% of her body weight within six months, from around 300 pounds. Her diabetes resolved within a week, and sunny-side-up egg yolks went from nauseating to craved. He says food-choice changes after bypass were first reported clinically around 2011, and that patients' risk of alcoholism rises roughly two- to sevenfold.

8. GLP-1 works on a slower clock
Asked about GLP-1 drugs such as Ozempic and Mounjaro, Bohórquez explains that gut cells release GLP-1, mainly in response to sugar, onto vagal nerve endings. GLP-1 also acts in the brainstem to reduce appetite. The millisecond signals shape choice and how food feels; hormones like GLP-1 govern how much you eat and when hunger returns, roughly every four hours.

9. Protein is tracked closely
Bohórquez describes recent animal work: when protein is removed entirely from a diet, the gut detects it and animals stop eating it, unless it is rich in fermentable fiber that lets gut microbes make essential amino acids. When protein is merely low, animals eat more to compensate. This fits Stephen Simpson's protein leverage hypothesis; protein is the most satiating macronutrient. Bohórquez flags the gut-cell link as not yet published.

EXAMPLES

1. Gut pain cells and IBS
David Julius and Holly Ingraham at UCSF showed that serotonin-releasing cells in the colon couple to spinal nerve fibers and drive visceral hypersensitivity. Bohórquez calls this a biological basis for what can become irritable bowel syndrome and other disorders of gut-brain interaction.

2. Three sisters agriculture
Indigenous farmers plant corn, beans and squash together; Bohórquez remembers his parents sowing beans to climb the corn. On the plate, this pattern of carbohydrate, amino acids and fiber recurs worldwide: a tortilla or bread, a protein, and vegetables, or rice with beans.

3. The guayusa hour
In Amazonian communities in Ecuador, families rise between 4 and 6 a.m. to drink guayusa, a holly relative of yerba mate with nearly coffee-level caffeine but less bitterness. Over it they discuss the previous day's problems and plan the day, then eat fat- and fiber-rich chonta palm fruit around 5:30, which carries them until about 3 p.m. Guayusa hot chocolate, he notes, kept him up until 3 a.m.

4. Walter Cannon's 'Voodoo Death'
Harvard physiologist Walter Cannon proposed that a spell from a powerful shaman could cause a fatal over-activation of the

peripheral nervous system. Bohórquez uses it to illustrate how learned beliefs, acting below awareness, can drive the body and underlie superstition.

OTHER RELEVANT

1. Vagus activation isn't always calming

Huberman stresses that vagus nerve stimulation can increase arousal; it is used clinically for depression. Long exhales and the physiological sigh (two inhales, then a full exhale) engage its calming side. Humming has been linked to vasodilation, which accompanies calm.

2. Interoception cuts both ways

Meditation can raise awareness of gut and heart signals, but some anxious people become so aware of their heartbeat that it is disruptive. More body awareness isn't always better.

3. Shared food may sync people

Bohórquez cites psychology findings that people eating similar food are more likely to connect in the moment, and behavioral economists' observation that deals happen over meals. He also suggests 'hangry' irritability may reflect gut and brain electrical rhythms falling out of sync, an idea he labels unpublished speculation.

4. Practice listening to the body

He frames self-care as listening to your body's signals rather than overriding them for career goals. Huberman adds Martha Beck's approach of sensing decisions through the body alongside pros-and-cons analysis.

Transform Your Health by Improving Metabolism, Hormone & Blood Sugar Regulation | Dr. Casey Means

Guest: Dr. Casey Means
Date: 2024-05-06 · Duration: 2:56:27
URL: https://www.youtube.com/watch?v=8qaBpM73NSk

KEYPOINTS

1. Many chronic diseases share a 'trifecta of bad energy'
Means names chronic inflammation, mitochondrial dysfunction and oxidative stress as the common biology behind type 2 diabetes, obesity, fatty liver, PCOS, erectile dysfunction and more. She argues that about 90% of US healthcare spending goes to downstream symptoms of these processes, and that you can't operate on oxidative stress.

2. Underpowered cells trigger a 'cell danger response'
Using chronic sinusitis as an example, Means says the pus and swelling are symptoms; the disease is cells that can't make enough ATP. Struggling cells release ATP outside the cell, where its concentration is normally about a million times lower, and this acts as a danger signal that activates innate immunity. The threat can be a virus, a toxin, missing micronutrients or psychological stress.

3. Modern life overwhelms mitochondria on several fronts
Means lists the changes: shorter, fragmented sleep; sitting about 80% of the waking day; Americans spending about 93% of their time indoors; around 80,000 synthetic chemicals in food, water and household products; thermostats that keep us at a constant temperature; and 60–75% of calories from ultra-processed, nutrient-poor food. She thinks cells deprived of what they need drive you to keep eating.

4. Insulin resistance starts as a protective response
When mitochondria can't handle incoming fuel, cells reject glucose, insulin rises and blood glucose eventually climbs. Means explains that triglycerides reflect excess carbohydrate stored as fat in the blood, not dietary fat. She links rising insulin to higher blood pressure as well.

5. Frequent short bouts of muscle contraction beat one block of sitting-then-exercise for glucose
Muscle contraction moves glucose channels to the cell membrane without needing insulin. Means describes studies (paraphrasing two with similar results) in which 60 minutes a day of walking or light jogging, done as 20 minutes before meals, 20 minutes after meals, or 2–3 minutes every 30 minutes, produced the lowest 24-hour glucose and insulin in the frequent-bout group. The total time was the same in every group.

6. GLP-1 can be supported with food
Short-chain fatty acids made when gut microbes ferment fiber and polyphenols encourage the gut to make more GLP-1-producing L cells. Fermented foods such as sauerkraut, kimchi, kvass, miso, natto and Greek yogurt deliver these fatty acids directly. Means notes people with type 2 diabetes have far fewer L cells, though cause and effect is unclear.

7. Meal timing affects glucose
Means cites controlled studies where eating identical food and calories in a 6-hour window rather than a 12-hour window gave significantly lower 24-hour glucose and insulin. Because melatonin rising toward sleep may briefly impair insulin sensitivity, she eats lower-carb later in the day.

8. Cold and heat are useful but secondary
Means uses cold to signal mitochondria to make heat and to encourage mitochondria-dense brown fat, while saying the data are mixed. Heat also appears to help metabolic health. She ranks both below food, sleep and movement, calling them inexpensive tools that don't replace the basics.

9. A CGM shows things a single fasting glucose misses
Means highlights glycemic variability, area under the curve and the dawn effect, a jump of 5–30 points on waking. Some rise is normal, but research links a larger dawn effect to insulin resistance, and it may also reflect stress and a bigger cortisol awakening response.

EXAMPLES

1. 88% !’ 93.2%
A 2018 UNC study using basic metabolic-syndrome markers found 88% of US adults had suboptimal metabolic health. A follow-up in the Journal of the American College of Cardiology put the figure at 93.2%. Means notes the panel would cost under $100 out of pocket.

2. The standard cutoffs
Means' baseline ranges (she prefers tighter optimal targets): fasting glucose <100, triglycerides <150, HDL >40 for men or >50 for women, HbA1c <5.7%, total cholesterol to HDL ratio <3.5:1, waist <35 in for women or <40 in for men, and blood pressure <120/80, all without medication. HbA1c reflects average glucose over the roughly 90–120-day lifespan of red blood cells.

3. Spinach thylakoids and GLP-1
Means describes research in which about 100 g of spinach daily, roughly 5 g of thylakoids from plant chloroplasts, for 12 weeks raised GLP-1 secretion two- to threefold, though she says she doesn't remember the exact figure.

4. Soleus push-ups
Huberman raises a University of Houston study of seated, unweighted heel raises under a desk. The soleus is about 1% of

the body's muscle, yet the study reported disproportionate use of blood glucose. Means adds that small studies of under-desk treadmills look promising.

5. Activity gap

Means says 80% of Americans miss basic activity guidelines, 20% get essentially no activity, and the average is 3,000–4,000 steps a day, under 2 miles. US gym memberships have doubled even as metabolic health has worsened.

OTHER RELEVANT

1. Move every 30 minutes on top of real exercise

Take 2-minute breaks for walking, air squats or push-ups. Aim for at least 7,000 steps a day, plus resistance training 2–3 times a week and 150 minutes of moderate (or 75 of vigorous) cardio a week to build mitochondrial capacity. An under-desk treadmill or fidgeting adds non-exercise activity, which Rothwell and Stock's early work linked to leanness.

2. Ask for the seven basic markers and read them together

Request fasting glucose, triglycerides, HDL, HbA1c, total cholesterol, waist circumference and blood pressure, which are often free at an annual physical. Means wants patients to read the pattern as a picture of what's happening inside cells, rather than treating each flagged number algorithmically.

3. Eat to support your microbiome

Prioritize fiber, colorful polyphenol-rich plants, spices, tea and cocoa, plus 1–3 servings a day of low-sugar fermented foods. That last recommendation comes from Justin Sonnenburg and Chris Gardner's Stanford work. Kombucha tends to be higher in sugar. If you make your own sauerkraut, follow a careful recipe, because a bad ferment can be unhealthy.

4. Your bottleneck may differ from someone else's

Means lists food, sleep, movement, emotional health, toxins, light and temperature as the levers. One person's path may be mostly food and sleep, another's movement and stress. Time in nature and sunlight help break the cycle of fear and lost sense of control that she says keeps people stuck.

Intermittent Fasting to Improve Health, Cognition & Longevity | Dr. Satchin Panda

Guest: Dr. Satchin Panda
Date: 2023-03-13 · Duration: 2:49:06
URL: https://www.youtube.com/watch?v=7R3-3HR6-u4

KEYPOINTS

1. Time-restricted eating means a consistent 8–12 hour eating window, not a cut in calories
Panda separates classic intermittent fasting, which cuts calories on some days (alternate-day eating, the 5:2 diet, Valter Longo's periodic fasting), from time-restricted eating (TRE). In his lab's mouse studies, TRE animals eat the same calories as freely fed mice and still get health benefits. For people he defines it as all food and caloric drinks inside a consistent 8–12 hour window. Windows of 4–6 hours or one meal a day exist, but few people can keep them up.

2. Meal timing sets the clocks in your liver and much of your brain
Ueli Schibler's experiments around 2000–2002 showed that feeding nocturnal mice during the day made the liver clock follow food instead of light. Later work, including Panda's in 2009, found that brain regions just millimeters from the master clock (SCN), such as the dorsomedial hypothalamus, also track meals. His rule of thumb: the body needs about a day to adjust to each hour of shift, so a three-time-zone flight takes about three days.

3. Consistency lets your gut get ready for food
Saliva, stomach acid, nutrient absorption and liver metabolism all ramp up in anticipation of your usual first meal. Shift breakfast by 2–3 hours and the system starts guessing a new time, so food may arrive when the gut isn't prepared. Intestinal movement also slows a few hours after the usual last meal, which is why a late dinner can leave a 'food hangover' the next morning, even without alcohol.

4. In mice, when calories are eaten matters for lifespan, not just how many
In Joseph Takahashi's study, mice on 20% fewer calories spread across day and night lived about 10% longer. The same reduced diet eaten during the mice's rest phase (daytime) added about 20%. Eaten during their active night phase, within 2 or 12 hours, it extended lifespan about 35%. Body weight and composition were the same across groups, and standard markers such as glucose control and cholesterol didn't predict who would live longer.

5. Headlines saying TRE 'doesn't work' misread a narrow trial
In the widely reported human trial, participants already ate in about a 10-hour window. Both groups cut calories by roughly 25%; one kept 10 hours and the other ate in 8. A 2-hour difference producing similar weight loss isn't surprising, Panda says. Weight loss isn't the only endpoint either: reflux, mood and lipids can change at a stable weight.

6. Very short windows can cause relative energy deficiency (RED-S)
Squeezing food into one meal or a few hours tends to cut calories without your noticing. In active people that can lead to RED-S, which Panda says affects nearly 40% of athletes, often unknowingly. It can disrupt the hypothalamic-pituitary-gonadal axis, causing lost periods in women, along with bone loss and stress fractures, and has been linked to depression and anxiety. He suggests starting at 8–10 hours, and up to 12 for very active people.

7. About half of adults eat across 15 hours or more
Using the myCircadianClock photo app with 156 non-shift-working adults over three weeks, his lab found people ate a median of seven times a day, and the top 10% ate 12 times. About 50% had an eating window of roughly 14 hours 45 minutes or longer, and only about 10% ate within 12 hours. Surprisingly, people who cooked their own dinner tended to eat later.

8. Around half of people live like shift workers
Shift work is commonly defined as being awake and active for at least two hours between about 10 p.m. and 5 a.m., even once a week. Each such night takes about two more days to recover from. About one in five working adults are formal shift workers; add students, new parents and gig drivers and Panda estimates about 50% of adults. Shift workers carry more hypertension, diabetes, gut disease and some cancers, yet are usually excluded from trials.

9. Fire, then coffee, shaped the human evening and breakfast
Controlled fire gave humans a communal evening of cooking, storytelling, politics and song. Panda sees this as the root of our urge to eat and socialize late and of today's 'me time.' Historian Cemal Kafadar's work describes 16th-century Istanbul coffeehouses as an evening activity that later moved to the morning for dawn prayers. Strong coffee on an empty stomach caused heartburn, so people ate something first, which Panda says is how breakfast culture started there.

10. 'Night owl' identity may be shaped largely by light
Horacio de la Iglesia found that Argentine Toba people without electricity sleep about 3–3.5 hours after sunset, with bedtimes clustered within roughly 15–30 minutes of each other. Light sensitivity, measured by pupil response, varies by about a log unit between people and rises after puberty. True genetic outliers exist, such as familial advanced sleep phase syndrome caused by a PER2 mutation.

EXAMPLES

1. San Diego firefighter trial
All 155 recruited firefighters on 24-hour shifts followed a Mediterranean diet; about half also ate within a self-chosen, consistent 10-hour window, and most managed it 5 of 7 days. The TRE group improved VLDL particle size and number; those with high blood pressure saw drops a physician likened to an antihypertensive drug, and those with high glucose controlled it better. Alcohol intake fell only with TRE. Researchers first lived at the busiest station and found the whole crew wakes 10–20 times a night.

2. Swiss 12-hour trial
Tinh-Hai Collet's group compared standard Swiss nutrition advice with simply eating within 12 hours. Both groups lost similar modest weight over 3–6 months. Only the advice group improved food quality, cutting ultra-processed NOVA 4 foods, which suggests combining both approaches.

3. Camping resets supposed night owls
Ken Wright's grad students and postdocs, self-described night owls, went to bed between 9 and 10:30 p.m. while camping; Huberman notes the shifted rhythms persisted for weeks afterward.

4. Metformin timing in mice
Katja Lamia at Scripps gave the same metformin dose at different times of day and found its glucose-lowering effect changed dramatically. Panda suspects that metformin and rapamycin extend mouse lifespan partly by mimicking fasting in animals that snack when they should be fasting. Huberman reports severe hypoglycemia and an 8-hour headache from taking berberine without carbohydrates.

OTHER RELEVANT

1. Pick a window and keep both ends steady
Panda's suggestion is 8–10 hours to start, or 12 if you're very active or for children. Keep start and end times consistent at least five days a week, since swinging a meal by 3–4 hours creates a kind of 'metabolic jet lag.' Children can follow a 12-hour window naturally by finishing dinner 1–2 hours before bed.

2. Eat before coffee if you have reflux or anxiety
Caffeine on an empty stomach can trigger reflux and heighten anxiety or panic. Panda wakes at 6, eats breakfast around 8 and has coffee afterward.

3. Protect the dark hours
Even dim light (about 100 lux) during sleep has been linked to worse morning glucose. Huberman uses a red bulb at night and when traveling. Panda adds that five nights of shift-work-style sleep can push a healthy person's glucose into the prediabetic range, though these effects are reversible.

4. Be cautious with very low-carb 'fat fasting'
Panda questions the focus on avoiding every glucose spike. He wonders whether pancreatic islet cells lose function if rarely engaged, much as unused muscle weakens, and notes that insulin and IGF-1 support muscle protein synthesis and repair. Long supervised fasts, as in German fasting clinics, look safe with micronutrient and electrolyte support, but claims about mental health benefits remain preliminary.

How to Optimize Your Water Quality & Intake for Health

Date: 2023-03-06 · Duration: 2:22:23
URL: https://www.youtube.com/watch?v=at37Y8rKDlA

KEYPOINTS

1. Baseline hydration: about 8 oz ("H240 mL) per hour for the first 10 hours after waking
Huberman's rule of thumb works out to roughly 80 oz, or a bit over 2 liters, across those 10 hours. These are averages. You don't need to drink on the hour, and most people drink in boluses, such as 16 oz at once, which is fine. Exercise and heat needs are added on top of this baseline.

2. During exercise, use the Galpin equation
Taken from his series with Dr. Andy Galpin: divide your body weight in pounds by 30 to get the ounces to drink every 15–20 minutes while exercising. In metric, that is about 2 mL per kg of body weight on the same schedule. For an hour-long workout, the fluid from the Galpin equation can stand in for that hour's 8 oz baseline rather than being added to it.

3. Heat, sweating and caffeine raise fluid needs
In very hot conditions or with heavy sweating, increase the Galpin numbers by 50–100%. In a sauna, Huberman suggests 8–16 oz (240–500 mL) for every 20–30 minutes. When you feel parched, around 16 oz per hour is reasonable. Thirst is a decent guide but tends to lag behind actual dehydration. For caffeine, drink about twice the volume of non-caffeinated fluid, so 12–16 oz after a 6–8 oz coffee, ideally with electrolytes or a pinch of salt.

4. Even slight dehydration hurts focus, through a known mechanism
Mild dehydration impairs cognitive and physical performance, mostly through fatigue and brain fog. Fluid in the gut and bladder, and well-hydrated cells, raise sympathetic (alerting) nervous system activity in two ways. One is mechanical, through stretch sensors such as TRP and Piezo channels. The other is chemical, through water moving across aquaporin channels. The same alerting signal is what wakes you up at night with a full bladder.

5. How fast you drink changes how fast you urinate
The kidneys filter fluid fastest in roughly the first 10 hours after waking. Because the body senses stretch, gulping a lot of fluid quickly is excreted faster than sipping the same amount. Gulping during the day is fine, but later in the day sipping is better.

6. Most tap water contains contaminants worth filtering
After reviewing the literature and talking to toxicologists, Huberman calls the picture 'pretty grim' but fixable. He cites a 2020 review, 'Endocrine Disruptors in Water and Their Effects on the Reproductive System', which covers disinfection byproducts (DBPs) created when utilities treat water to keep it safe. DBPs can disrupt the endocrine system. He frames filtering as cheap insurance, especially for people with existing health issues.

7. Fluoride and thyroid function
Huberman points to a 2018 case-control study, 'Impact of Drinking Water Fluoride on Human Thyroid Hormones', which reported effects on TSH and T3 at concentrations as low as 0.5 mg/L. He notes it was a small case-control design, not a large trial. He suggests checking your local water report for fluoride, particularly if thyroid problems run in your family.

8. 'Hard' water with magnesium and calcium is likely good for you
A 2019 paper on EU drinking-water regulations quotes an inverse association between magnesium in water and cardiovascular mortality. Water with 8.3–19.4 mg/L of magnesium was linked to about 25% lower cardiovascular mortality than water with 2.5–8.2 mg/L. Huberman stresses this is an association, not proof that hard water prevents heart disease. Counterintuitively, hard water often tastes smoother.

9. Specialty waters probably work through pH, not magic
Huberman's interpretation is that hydrogen-rich, electrolyzed reduced and deuterium-depleted waters all have a higher pH, roughly 7.9–9.2. Less acidic water seems to be absorbed and used more readily, without changing the pH of your body or cells. Specialty waters are also filtered, which may explain some of their reported benefits.

10. Structured water lacks evidence
A 'fourth phase' of water, described by researchers at the University of Washington, does exist. But Huberman found essentially no peer-reviewed evidence that drinking it produces any specific benefit, and home systems cost hundreds to thousands of dollars. He calls it an interesting open question, not a recommendation.

EXAMPLES

1. Soldier cold-exposure study
Forty-nine men and women aged 19–30 did one 2-minute immersion per week at 3°C (about 37°F) plus at least five brief cold showers per week at about 10°C (50°F). Afterwards they warmed up naturally for 10 minutes. The study reported fat loss, especially around the abdomen, plus improvements in mood measures and sexual satisfaction. Huberman suggests easing in, for example starting around 50°F. He also notes that cold immersion within 6 hours after strength training can blunt gains, while cold showers don't appear to.

2. Søberg's 11-minutes-per-week finding
Dr. Susanna Søberg's work found that about 11 minutes per week of uncomfortably cold immersion, split across sessions and followed by natural rewarming, increased brown fat and metabolism. As far as Huberman knows, it studied only males.

3. Hydrogen-rich water trial
In a randomized, double-blind, controlled trial, drinking 1.5 L per day of hydrogen-rich water for 4 weeks reduced inflammatory markers such as IL-6 and cell death in peripheral blood cells. The effect appeared only in participants over 30. A two-part review argues that molecular hydrogen is the active agent in electrolyzed reduced water.

4. Huberman's dirty faucet aerator

Before researching the episode, he had never cleaned the small mesh filter at the faucet head. When he removed it, the back side was full of debris. Contaminants often come from pipes, pipe seals and uncleaned aerators, not just from the water source.

OTHER RELEVANT

1. Filter options by budget

Carbon pitcher filters (Brita-type) reduce DBPs if you change them often, but generally not fluoride. Huberman mentions a pitcher under about $80 (Clearly Filtered) that removes fluoride, lead and glyphosate, countertop systems like Berkey at $200–500, and whole-house filters at $2,000 or more. He says he has no affiliation with any of them. Filters let magnesium and calcium through.

2. Zero-cost option and what to avoid

If you can't buy a filter, let tap water sit uncapped (lightly covered with cloth) at room temperature for half a day or longer, then pour off and drink the top two-thirds. This removes some contaminants, not all. Don't rely on boiling, because heat can make some contaminants worse. Skip distilled water, which strips minerals. Reverse osmosis is safe but expensive and can remove magnesium.

3. Fewer nighttime bathroom trips

Hydrate well during the day. Then, from about 10 hours after waking until bed, limit fluid to about 5–8 oz and sip it rather than gulping. Waking once or twice a night to urinate is normal.

4. Optional: molecular hydrogen tablets

If your tap water has less than about 8.3 mg/L of magnesium, dissolvable hydrogen tablets are a cheap way to raise pH. Drink the water within 5–15 minutes. Use them once to three times a day, not in all your water, and never in carbonated or hot drinks. Huberman uses them himself and reports feeling better, while acknowledging possible placebo and limited studies. Drink water at whatever temperature you prefer: very cold water just absorbs a bit more slowly.

The Science of Eating for Health, Fat Loss & Lean Muscle | Dr. Layne Norton

Guest: Dr. Layne Norton
Date: 2022-11-07 · Duration: 3:49:34
URL: https://www.youtube.com/watch?v=K4Ze-Sp6aUE

KEYPOINTS

1. Energy balance governs weight, but intake is harder to measure than people think
Norton calls a calorie a unit of measurement: 'not all calories are created equal' is like saying not all seconds are equal. Sources still differ in how much usable energy they yield. Food labels can be off by up to 20%. Fiber lowers metabolizable energy, and gut microbes vary in how much energy they extract from it. Protein rarely ends up stored as fat, but surplus protein still adds calories and can let other nutrients be stored.

2. NEAT is the big, variable piece of expenditure
Non-exercise activity thermogenesis (fidgeting, pacing, spontaneous movement) varies enormously between people. As weight drops by 10%, NEAT has been seen to fall by almost 500 calories a day. Basal metabolic rate also declines, partly because the body is smaller and partly from metabolic adaptation, which Norton says averages around 15% and newer evidence suggests happens mostly in the first weeks of a diet.

3. Fitness trackers badly overestimate burn
Norton cites a 2018 meta-analysis finding wearables overestimate energy expenditure by about 28–93%. He suggests using them for relative comparisons, such as whether today was more active than yesterday, rather than eating back 'burned' calories.

4. Exercise is better at weight regulation than its calorie count suggests
Exercise alone often looks weak for weight loss on paper. Norton notes that in controlled trials, people who start exercising tend, on average, to eat less, and active people seem to match appetite to needs better than sedentary people, though some report feeling hungrier. Beliefs matter: in one study, lifters falsely told they were on anabolic steroids made greater strength and lean-mass gains than those not told.

5. Diet type matters less than adherence
When calories and protein are equated, meta-analyses find little difference in fat loss or most health markers between time-restricted eating and normal schedules, or between low-carb and low-fat diets. Norton cites Kevin Hall's 2017 analysis of 22 studies in which all food was provided, which ensured high adherence. His advice is to pick the plan you can sustain, ideally indefinitely. Huberman adds, 'pick your placebo too.' Lasting change often requires an identity shift, and Norton quotes a client who said he had to 'kill my clone.'

6. Protein: about 1.6 g/kg captures most muscle benefit
Benefits plateau around 1.6 g per kg of body weight, with possible small gains up to 2.4–2.8 g/kg on a curve that flattens. A one-year trial found no negative health outcomes up to about 4 g/kg. Participants simply felt so full they ate fewer calories. Norton dismisses fears that stimulating mTOR shortens life. Any macronutrient in isolation can be made to look harmful mechanistically, much as exercise acutely raises blood pressure and inflammation yet improves health.

7. Fasting doesn't boost protein uptake but rarely costs muscle
Studies don't show that a fast lets you assimilate more protein afterward. Typical time-restricted eating doesn't reduce lean mass compared with eating freely. Some extreme protocols like alternate-day fasting show lean-mass differences. Norton stresses you can still build muscle that way, just perhaps less.

8. Fiber is 'the longevity hack'
A meta-analysis of over a million people found every additional 10 g of daily fiber was linked to about a 10% lower mortality risk, including cardiovascular disease and cancer. Norton urges diverse sources (fruit, vegetables, whole grains), notes fiber feeds gut microbes better than probiotics can establish them, and asks fasting enthusiasts whether they're even eating 50–60 g a day. Two cups (about 200 g) of broccoli provide only 5–6 g.

9. Sugar is mostly a fiber and calorie problem
Norton once believed sugar itself was harmful. Calorie-matched trials changed his mind. In Surwit's 1997 study, people on an 1,100-calorie diet ate either about 110 g or about 10 g of sugar daily for six weeks with all meals provided, and both groups lost the same body fat with similar biomarkers. The low-sugar group had a slightly greater LDL improvement, which Norton attributes to more fiber. Fruit sugar isn't linked to the poor outcomes of sugary foods because it comes with fiber.

EXAMPLES

1. Levine's 1995 overfeeding study
In a metabolic ward, volunteers overate by about 1,000 calories a day for six weeks. One person predicted to gain 3–4 kg gained just over half a kilo because he spontaneously increased his physical activity. Norton likens this to a lean natural bodybuilder who would start sweating and fidgeting after meals.

2. Artificial sweeteners versus water
In randomized trials, replacing sugary drinks with non-nutritively sweetened ones helped people with obesity more than switching to water, possibly because the jump to water is too big. Norton says aspartame consistently shows no effect on blood sugar or insulin and stevia little effect. He calls saccharin and sucralose mixed. He criticizes a sucralose study that paired sucralose with maltodextrin against sucrose, and notes possible placebo effects among volunteers who had painstakingly avoided sweeteners.

3. Seed oils and saturated fat

Norton argues that seed oils hurt health mainly by adding calories over the past 20–30 years, not when they replace other fats one-for-one. Saturated fat as a group raises LDL, though stearic acid doesn't, and he suggests keeping it to about 7–10% of daily calories. Over time, accumulating trials persuaded him that LDL is causal in cardiovascular disease.

4. Glucose 'scavengers'

Huberman gets headaches from berberine unless he has eaten plenty of carbohydrate. Norton calls berberine, metformin and white kidney bean 'carb blockers' majoring in the minors. They act like dimmer switches, modestly reducing carbohydrate absorption, not on/off switches.

OTHER RELEVANT

1. Weigh daily, judge weekly

Weigh after waking and using the bathroom, average the week, and compare week to week. Day-to-day swings of 5–6 pounds are normal noise.

2. Prioritize protein and fiber

Aim for about 1.6 g/kg of protein and work toward 30–60 g of fiber from varied foods. Both improve satiety and make minimally processed eating easier. Norton says eating 4,000 calories from minimally processed foods would be miserable.

3. If you supplement, start with creatine monohydrate

With thousands of studies behind it, monohydrate saturates muscle phosphocreatine and supports performance, recovery, lean mass and possibly cognition. Huberman takes 5 g a day. Norton says hydrochloride costs more without clear benefit and ethyl ester is worse. Kidney and liver concerns have been debunked.

4. Watch for 'healthy' processed swaps

Keto cookies and ice creams can contain more calories than the originals. Processed foods aren't toxic per se. The issue is that they make overeating easy.

The Biology of Taste Perception & Sugar Craving | Dr. Charles Zuker

Guest: Dr. Charles Zuker
Date: 2022-07-18 · Duration: 2:17:38
URL: https://www.youtube.com/watch?v=UChhXiFPRgg

KEYPOINTS

1. Detection and perception are separate steps

Zuker, a Columbia neuroscientist and Howard Hughes investigator since 1989, defines detection as tongue cells binding a sugar molecule, before anything is perceived. Perception happens when the brain turns that electrical signal into meaning. He notes the brain is about 2% of body mass yet uses roughly 25 to 30% of the body's energy and oxygen. Because every brain encodes signals slightly differently, your experience of the same stimulus can differ from someone else's.

2. Five basic tastes, each with a built-in meaning

Sweet (energy), umami (amino acids and protein; examples are seaweed, tomatoes, cheese and MSG) and low salt (electrolytes) are innately attractive. Bitter (likely toxins) and sour (likely spoiled or fermented food) are innately aversive. You are born liking sweet and disliking bitter. Flavor is a broader experience combining taste with smell, texture, temperature and appearance.

3. Fat and metallic may not be true tastes

Zuker says much of what we call fat taste is probably mechanosensory: cells sensing fat rolling over the tongue rather than a dedicated taste receptor. Metallic taste, like a penny or blood, may be a particular ratio of activity across the existing five lines, the way pressing several piano keys produces a chord.

4. The tongue map is a myth

Each taste bud holds around 100 receptor cells, and Zuker's lab, which identified receptors for all five tastes (sour most recently), found that virtually every taste bud in the mouth contains all five types. Bitter receptors are somewhat enriched at the back of the tongue, a last line of defense that can trigger gagging before you swallow. The palate is rich in sweet receptors. He suggests the classic map likely came from mistranslated early data.

5. Taste identity and taste valence live in different brain areas

Sweet and bitter run as separate labeled lines from the tongue through the taste ganglia and brainstem stations to separate areas of taste cortex, in well under a second. Valence (whether it's good or bad) is imposed in separate amygdala targets for sweet and bitter. His lab has engineered mice that recognize sweet without finding it attractive.

6. Activating taste neurons directly creates the full experience

In mice, silencing sweet cortex neurons erased the perception of sugar. Activating bitter cortex neurons while the animal drank plain water made it gag as though tasting something bitter. In a place-preference test, mice sought out the side of a box where their sweet neurons were stimulated and avoided the side where bitter neurons fired, which shows these signals carry a felt positive or negative state and don't just drive licking.

7. Internal state rewrites what tastes good

Taste signals pass through several relays because each one lets hunger, thirst or depletion modulate the signal. Low salt is appealing and seawater is repellent, but salt-deprived animals find very concentrated salt (1 molar sodium chloride) highly attractive. Thirst suppresses hunger to conserve water: without water you'd die in about a week, while you can go without food for far longer.

8. Liking is the tongue, wanting is the gut

Mice without sweet receptors at first drink equally from sugar water and plain water. Within about 48 hours they drink almost only the sugar, finding the bottle by smell, texture or location. Cells in the intestine, not the stomach, sense glucose and signal the vagal (nodose) ganglion and brainstem that energy has arrived. Zuker calls this gut-brain signal the basis of our unquenchable desire for sugar.

9. Why artificial sweeteners don't end sugar cravings

Sweeteners activate the same tongue receptor as sugar, but the gut sensor is a different molecule that recognizes glucose, not sweeteners. Zuker believes that's why artificial sweeteners have failed to curb our appetite for sugar: they satisfy liking but never tell the brain sugar arrived. A goal for future research is finding ways to activate this circuit without sugar.

10. Processed foods hijack a deliberately slow system

The gut signal builds slowly, Zuker argues, so that in the wild an animal links its preference only to the richest, most reliable sugar sources after repeated exposure. Highly processed foods arrive pre-broken-down, activating these circuits on a timescale nature never produced and continually reinforcing wanting. He views obesity as a disorder of brain circuits rather than simply of metabolism.

EXAMPLES

1. Tangerine versus a sweetened tangerine extract

Even at equal calories, a whole tangerine and a processed tangerine extract spiked with sugar act very differently on the gut-brain axis. The fruit's sugar is bound up with fiber and long sugar chains that take real digestive work. The extract delivers ready-to-absorb sugar with no work at all.

2. Pavlov's dogs also released insulin

Beyond salivating at the bell, Pavlov's conditioned dogs released insulin to it. Zuker uses this to show the gut-brain axis runs both ways: brain associations can drive physiology in organs like the pancreas.

3. Acquired tastes and one-trial aversions

Beer and coffee overcome innate bitterness because the reward that follows (alcohol, caffeine) creates a positive association. Zuker grew up drinking wine in Chile and says that, at 19 in graduate school, he was too late to acquire a taste for beer. Conversely, one bad oyster can make you avoid oysters for months. Called conditioned taste aversion, this can even turn sugar aversive when it's paired with feeling ill.

4. Same salad, different price

Citing psychophysics experiments, Zuker describes identical 11-ingredient salads, one tossed together and one beautifully arranged. People will pay $8 for the arranged one rather than $2. He now eats red meat roughly once every four weeks, down from daily in Chile, and loves the presentation of sushi.

OTHER RELEVANT

1. Burnt tongues recover in two ways

Taste receptor cells live around two weeks and are constantly replaced, like gut lining cells. But recovery from a hot-tea burn within 20 to 60 minutes happens too fast for regeneration. It reflects damaged taste and somatosensory cells recovering function.

2. The vagus is thousands of separate channels

Zuker cautions that whole-nerve vagal stimulation, used for treatment-resistant depression and epilepsy, is like turning on every light in a stadium to find your keys: some effects help, but there's no specificity. Researchers including Harvard's Stephen Liberles are mapping individual vagal lines for heartbeat, breathing, stomach stretch and nutrients. Huberman adds that vagal stimulation can increase alertness, not only calm.

3. Reducing sugar gets easier

Huberman says that after initially restricting sweets, he has lost his appetite for them. Zuker attributes this to no longer reinforcing the sugar-wanting circuit, noting that most people are continuously exposed to highly processed foods and sugars, many hiding in plain sight.

Controlling Sugar Cravings & Metabolism with Science-Based Tools | Huberman Lab Podcast #64

Date: 2022-03-21 · Duration: 1:58:56
URL: https://www.youtube.com/watch?v=VAEzZeaV5zM

KEYPOINTS

1. Sugar acts on the brain through two main routes: its sweet taste and its nutritive effect on blood glucose
Huberman frames sugar seeking as hardwired parallel pathways, found in every mammal studied and even in fruit flies. One pathway responds to the perceived sweetness in the mouth; the other responds to how much a food raises blood glucose. Because sweet foods usually also raise glucose, a craving for cake is both a craving for the taste and neurons 'craving' the fuel that comes with it.

2. Ghrelin drives hunger and insulin clamps blood glucose to protect neurons
Ghrelin rises the longer it has been since a meal and acts on the hypothalamus to make you hungry, especially for sugary and fatty foods; eating suppresses it. Insulin keeps glucose from spiking, because very high blood sugar is toxic to neurons, which do not regenerate once they die.

3. Neurons prefer glucose, and astrocytes deliver it to them
Neurons are highly metabolically active and run mainly on glucose, which astrocytes, the brain's most abundant cell type, shuttle to them. Deliberate thinking and effortful, skilled movement raise glucose uptake, one reason focused work feels tiring. Huberman notes this does not mean more sugar improves brain function; many people report clarity while fasted.

4. Fructose is handled differently and can increase hunger, but whole fruit is not the villain
Fructose probably cannot directly access the brain and is converted to glucose in the liver. It suppresses the hormones that normally suppress ghrelin, so the net effect is more ghrelin and more hunger regardless of calories eaten. Fruit contains roughly 1–10% fructose versus about 50% (or more) in high-fructose corn syrup, so Huberman rejects the claim that fruit makes you fat; he does say people trying to control hunger may not want to eat a lot of fruit.

5. Sweet taste triggers dopamine and a pleasure–pain seesaw that pushes you to want more
Sweet tastes, especially sweet liquids, strongly release dopamine in the mesolimbic reward pathway, which drives pursuit. Drawing on Dr. Anna Lembke's 'Dopamine Nation', he explains that every dopamine rise is followed by activity in circuits for pain and lack. The longer you wait to indulge, the bigger the spike and the dip that follows, and a second bite never matches the first.

6. Gut neuropod cells drive sugar seeking below conscious awareness
Neuropod cells, discovered by Dr. Diego Bohorquez at Duke, sense sugar in the gut and signal via the vagus nerve and nodose ganglion to the nucleus of the solitary tract, triggering dopamine release whether or not you taste sweetness. That is why hidden sugars in salty foods like chips make you want more food in general.

7. A third accelerator comes from how neurons use glucose
Work from Dr. Dana Small's lab at Yale and others used PET imaging with 2-deoxy-D-glucose (2DG), which blocks glucose uptake by neurons. 2DG eliminated the preference for sweet foods, revealing a third parallel pathway. Huberman stresses 2DG is a lab tool, not something to take.

8. How fast glucose rises matters, so lowering the glycemic index blunts the dopamine signal
Glycemic index ratings are roughly below 55 (low), 55–69 (medium) and 70 or above (high), but they are measured with foods eaten alone. Fiber or fat slows the rise, which is why fatty ice cream can rank lower than mango. Using crack cocaine as a deliberately extreme analogy, he argues that the speed of the dopamine rise, not just its peak, drives the urge to repeat.

9. Flavors can be conditioned to trigger insulin, a controversial finding about artificial sweeteners
In human studies from Dana Small's lab, a flavor paired with maltodextrin (which raises glucose but has little taste) later raised insulin on its own, including the flavor of artificial sweeteners. The children's arm was stopped by the review board because of the insulin shifts. Huberman calls this unsettled and says he occasionally drinks diet soda himself.

10. Omega-3s and amino acids may substitute for sugar's gut signal
Neuropod cells respond to sugar, amino acids and essential fatty acids alike, and all three can trigger dopamine. This offers a plausible reason why EPA omega-3s or glutamine might reduce sugar cravings. Huberman is explicit that human studies have not confirmed this mechanism, and the effect of EPA could simply be calorie replacement.

EXAMPLES

1. Taste-blocked subjects still come to prefer sugar water after ~15 minutes
In sweet-receptor knockout mice and in people whose mouths are numbed, preference for sugary solutions over water initially disappears. After about 15 minutes it returns, even though the sweetness still cannot be tasted. Huberman uses this (a Frontiers in Bioscience paper with first author Freeman, among many similar studies) to show the post-ingestive pathway at work.

2. Huberman's mango habit
Despite little sweet tooth, he eats mango about twice a week, timed after resistance training or a hard run, when the body is better at using circulating sugar and replenishing glycogen.

3. Sugary drinks and ADHD meta-analysis
A systematic review and meta-analysis in Complementary Therapies in Medicine found that beyond about four 12-ounce sugary drinks per week, especially in kids, existing ADHD symptoms tend to worsen. Huberman says the data cannot show

that sugar causes ADHD, and the authors did not look at artificially sweetened sodas.

4. Lemon juice and a continuous glucose monitor

Tim Ferriss reported vinegar did not blunt his glucose. Huberman cites data, and his own continuous glucose monitor experiments, showing a couple of tablespoons of lemon or lime juice in water before, during or after a large meal blunts the glucose rise, likely partly because sour and sweet together activate distinct taste circuits (Charles Zuker's work at Columbia).

5. Berberine made him hypoglycemic

Taken on an empty stomach, berberine gave Huberman brutal headaches, dizziness and blurred vision because his blood glucose dropped too low. With a very large carbohydrate meal he tolerated 750 mg to 1 g without issue.

OTHER RELEVANT

1. Pair sweets with fiber or fat, and avoid sweet drinks

If you are going to eat something sweet, choose lower-glycemic options or eat fiber alongside to slow the glucose rise and the dopamine spike. Huberman, citing Dr. Robert Lustig's work replacing fructose with glucose at equal calories, singles out soft drinks, high-fructose corn syrup and sugary fruit juices as the main things to cut.

2. Cupboard tools: EPA, glutamine, lemon juice and cinnamon, with caveats

Huberman takes 1–3 g of EPA per day. Some people use several grams of glutamine a day split into 3–4 servings to blunt cravings; increase the dose gradually to avoid stomach upset, and he discourages it for anyone who has or is prone to cancer. Lemon or lime juice can cause hypoglycemia if you are fasted. Keep cinnamon (any real variety) to about 1–1.5 teaspoons a day because of coumarin toxicity.

3. Treat berberine like a prescription drug

He describes berberine as comparable in potency to metformin or glibenclamide. Typical doses studied are 0.5–1.5 g daily, and sodium caprate can enhance its effects. Talk to a doctor before using it, and avoid it on an empty stomach or a low-carbohydrate diet.

4. Sleep is the foundation for controlling sugar appetite

A Cell Reports study sampled sleepers' breath every 10 seconds and found each sleep stage has its own metabolic signature. Poor sleep is linked to stronger sugar cravings and shows up across obesity and type 2 diabetes data, though cause and effect are unclear. Huberman says to get quality sleep at least 80% of the time, or other tools are just 'rearranging deck chairs on the Titanic'.

Using Salt to Optimize Mental & Physical Performance | Huberman Lab

Date: 2022-03-14 · Duration: 2:03:54
URL: https://www.youtube.com/watch?v=azb3Ih68awQ

KEYPOINTS

1. Talk about sodium, not salt
About 40% of table salt by weight is sodium: one gram of salt contains about 388 mg of sodium. Guidelines and studies usually give sodium amounts, so Huberman converts between the two throughout the episode. For example, the U.S. recommendation of 2,300 mg of sodium is about half a teaspoon of salt.

2. The OVLT is the brain's salt and blood-pressure sensor
The organum vasculosum of the lateral terminalis (OVLT) is one of the few brain areas without a full blood-brain barrier, so its neurons can sample the blood directly. One group of neurons senses osmolarity, meaning salt concentration. Another group of baroreceptor neurons senses blood pressure. Huberman calls it so essential that if it fails, you are 'effectively dead or dead soon'.

3. Two kinds of thirst
In osmotic thirst, salty blood activates the OVLT, which signals the supraoptic nucleus. That leads the pituitary to release vasopressin (antidiuretic hormone), which tells the kidneys to hold water while you feel thirsty. In hypovolemic thirst, a drop in blood volume or pressure, such as from blood loss, is sensed by baroreceptors. The kidney then releases renin, generating angiotensin II, which also acts on the OVLT. Low blood volume drives a craving for both water and salt.

4. Vasopressin also affects behavior
Vasopressin, the same hormone that limits urination, appears in research on pair bonding and monogamy in prairie voles, and some people use it as an aphrodisiac. Huberman says he is not suggesting anyone do that. He warns against using vasopressin or oxytocin nasal sprays unless a doctor prescribes them.

5. The health-risk curve for sodium may be J-shaped
Huberman highlights a 2011 JAMA study on urinary sodium and potassium excretion. In it, the risk of cardiovascular death, stroke, heart attack and heart-failure hospitalization was low-ish at about 2 g of sodium excreted per day and kept falling until about 4.5–5 g. Above that, risk climbed steeply toward 7–12 g. He cautions that no single study is definitive. The 2.3 g guideline exists partly because hypertension is so common.

6. Know your blood pressure before changing salt intake
People with hypertension or prehypertension need to be careful and should work with a doctor. By contrast, some people with low blood pressure or orthostatic disorders benefit from more sodium. Huberman stresses that over time, storing excess sodium in tissues is bad for health.

7. Salt appetite is homeostatic, but it adapts
If your sodium is low, you will tend to crave salty foods, and on a mostly unprocessed diet it is usually reasonable to follow that craving. However, a controlled German study of people eating 6, 9 or 12 g of salt a day, published in the Journal of Clinical Investigation, found that the body adapts. Sodium was stored and released in regular weekly and monthly rhythms, regulated by aldosterone and glucocorticoids. That adaptation is why appetite alone isn't a perfect guide.

8. Low sodium can worsen stress and anxiety
The adrenal stress system (glucocorticoids such as aldosterone) is tightly linked to salt craving. Animal studies, and some human evidence, suggest low dietary sodium exacerbates anxiety and impairs the ability to meet stressors. Low blood pressure itself can feel like anxiety. Huberman says more studies are needed. He suggests that a slight sodium increase from sea salt in water or salting food, not processed foods, might help some people.

9. Neurons literally run on sodium
Action potentials depend on sodium rushing into neurons, followed by potassium changes and the sodium-potassium pump restoring the gradient. That is why sodium, potassium and magnesium all matter for mental and physical performance, and why dehydration and electrolyte loss cause brain fog.

10. The gut senses sugar below conscious awareness
The episode opens with Diego Bohórquez's Duke lab. Its 'neuropod' gut cells detect sugar and signal through the vagus nerve to drive dopamine release and sugar seeking. A February 2022 Nature Neuroscience paper, 'The Preference for Sugar over Sweetener Depends on a Gut Sensor Cell', showed that these cells can tell caloric sugar apart from non-caloric sweeteners. What that means for health is not yet clear.

EXAMPLES

1. Guidelines for orthostatic disorders
Citing a review titled 'Dietary Sodium and Health: How Much Is Too Much for Those with Orthostatic Disorders', Huberman notes that some recommendations for POTS and orthostatic hypotension are 6–10 g of salt per day, about 2,400–4,000 mg of sodium. The Canadian Cardiovascular Society suggests 10 g of salt, or about 4 g of sodium.

2. The sea-salt packet anecdote
Someone with low blood pressure who constantly craved sugar and felt lightheaded tried, with a doctor's permission, taking a pinch of sea salt in water, or a salt packet, instead of sugary food. They reported big relief from dizziness. Huberman labels this 'anec-data', not evidence, and specific to low blood pressure.

3. Salty-sweet foods bypass satiety
Salt and sweet each have their own 'enough' threshold, and combining them masks both, so you eat more. Hidden sugars

and sweeteners in processed foods work the same way. A sip of water with lemon or vinegar quickly cuts an overly sweet taste. Huberman notes that 'The Salt Fix' reviews data suggesting more salt on an unprocessed diet can reduce sugar cravings.

4. Adrenal removal shifts salt preference

In adrenalectomy studies, mostly done in animals, removing the adrenal glands and their hormones shifted the point at which a solution feels 'too salty'. Subjects then preferred and tolerated much saltier fluids. Huberman uses this extreme case to show how directly the stress-hormone system sets salt appetite. Normally, very salty water such as seawater is aversive, and drinking seawater can kill you.

OTHER RELEVANT

1. Hydrate with electrolytes for exercise and mental work

The Galpin equation: body weight in pounds ÷ 30 = ounces of fluid every 15 minutes, as an average rather than a timer. Start sessions already hydrated with sodium, potassium and magnesium, not just plain water. People lose roughly one to five pounds of water per hour of exercise. Hot conditions, and cold dry ones, increase fluid and salt losses.

2. Adjust for low-carb diets, fasting and caffeine

Low-carbohydrate diets make you shed water along with sodium and potassium, so many people need more of both. Caffeine is a diuretic. Huberman adds salt or an electrolyte drink, or sea salt in water, when he drinks caffeine during his fasting window or before fasted training.

3. Find your own salt needs on unprocessed foods

The more your diet is built from simple, unprocessed foods, the easier it is to read your own salt appetite. Factor in blood pressure, exercise, climate, diet and caffeine. For iodine and iodized versus non-iodized salt, see his metabolism episode.

4. Magnesium forms mentioned

Magnesium malate may reduce muscle soreness. Magnesium threonate, taken 30–60 minutes before bed, may help sleep and possibly cognition (mostly animal data). Bisglycinate seems on par with threonate for sleep. Citrate mainly works as a laxative. Check with your physician.

Nutrients For Brain Health & Performance | Huberman Lab Podcast #42

Date: 2021-10-18 · Duration: 1:41:19
URL: https://www.youtube.com/watch?v=E7W4OQfJWdw

KEYPOINTS

1. Food builds the structural fat of your neurons
Neuronal membranes are made of structural fats, not the storage fat around the belly. They consist mainly of essential fatty acids and phospholipids, so what you eat literally provides the building blocks of the cells you think with. Since you don't replace most neurons over a lifetime, Huberman frames these nutrients as long-term maintenance.

2. Most people get enough omega-6 but not enough omega-3 (EPA)
He suggests at least 1.5 g and ideally 2–3 g of EPA a day, counting EPA itself rather than total fish oil. Sources include mackerel, salmon, herring, oysters, sardines, anchovies and especially caviar, with chia, walnuts and soy for non-fish eaters, as well as krill or algae oil. He cites literature that 1–3 g of EPA a day can improve mood on par with some antidepressants, and allow lower antidepressant doses.

3. Phosphatidylserine gives modest but real cognitive benefits
In at least three studies, 300 mg a day of this lipid-like compound improved cognition, and in at least five it slowed cognitive decline. The effects were statistically significant but not large. Meat and fish (and, oddly, cabbage) supply it, so regular fish eaters probably get enough; Huberman himself does not supplement it.

4. Choline feeds the acetylcholine 'highlighter' behind focus
Acetylcholine from nucleus basalis boosts activity in selected brain areas relative to their neighbors, which is the basis of focus. Hindbrain acetylcholine neurons support general alertness, and many Alzheimer's drugs target this pathway. Egg yolks are the top source, with potatoes, nuts, seeds, grains, fruit and some fish as alternatives. He suggests 500 mg to 1 g a day, supplementing if needed to reach 1–2 g.

5. Creatine is a brain fuel, especially if you eat no meat
A 2021 review (first author Roschel) found that 5 g a day of creatine monohydrate improves cognition in some contexts, most clearly in people who get no creatine from meat. There is emerging, not yet established, evidence that it may help mild depression through frontal circuits. Huberman cautions that water retention varies and that creatine may raise DHT, which could affect hair in sensitive people.

6. Anthocyanins in dark berries protect DNA and slow cognitive decline
Blueberries, blackberries and black currants are rich in them. Supplementation with blueberry extract reduced DNA damage and modestly slowed decline in elderly patients (Afzal 2019 review). For whole fruit, he cites about 60–120 g of fresh blueberries a day as enough to shift the system; whether the effect works on neurons directly or through inflammation is unclear.

7. Glutamine may protect cognition from low oxygen and curb sugar cravings
Glutamine supplementation has offset cognitive effects of altitude and oxygen deprivation. Huberman reasons it could matter for sleep apnea, which contributes to cognitive decline. Gut neurons that sense glutamine send satiety signals, which may reduce sugar cravings. Doses run from 1 to 10 g a day, with cottage cheese, meat, eggs, beans, cabbage and spinach as food sources.

8. Gut neuropod cells steer food choice below awareness
Diego Bohórquez at Duke characterized these cells in the gut lining. They sense amino acids, sugars and fatty acids, and signal through the nodose ganglion to trigger dopamine release, driving you to seek more of that food. Processed foods exploit this with 'hidden sugars' you can't taste (a point Robert Lustig emphasizes), but the same pathway can reinforce healthy foods like omega-3-rich ones.

9. Artificial sweeteners aren't simply good or bad; context decides
Huberman says sweeteners taken alone are not the problem. Consumed together with glucose-raising foods, they can teach the body to over-release insulin. He also mentions a Nature paper showing that certain sweeteners can disrupt the gut microbiome, with results that may differ between saccharin and sucralose.

EXAMPLES

1. Sucralose with carbs (Dalenberg et al., Cell Metabolism 2020)
In Dana Small's lab (Dalenberg et al., Cell Metabolism, 2020), consuming sucralose with carbohydrate, but not without it, impaired neural and metabolic sensitivity to sugar. Huberman also cites studies where diet soda drunk with food later triggered a larger insulin response to diet soda alone; in one study of children this led to pre-diabetic insulin responses and the study was halted. He does not call sweeteners bad, only context-dependent.

2. Huberman's own regimen
He takes 1–2 tablespoons of lemon-flavored liquid fish oil, or capsules when traveling, to reach 2–3 g of EPA, plus 5 g of creatine daily as 'insurance'. He takes 300 mg of alpha-GPC 2–3 times a week, early in the day because it is mildly stimulating. Cognitive-decline studies used 600–1,200 mg of alpha-GPC.

3. The belief-effect milkshake
Alia Crum's Stanford work gave people identical milkshakes labeled either as indulgent and high-calorie or as low-calorie. Insulin, glucose and satisfaction followed what people were told. Huberman stresses this is a belief effect, not a placebo effect.

4. Learning to like flavors paired with metabolism

Ivan de Araujo and Dana Small showed in mice and humans that a taste paired with something that raises glucose, and therefore brain metabolism, comes to be preferred through dopamine, even when the taste itself carries no calories.

OTHER RELEVANT

1. Keep diet drinks away from carb-rich meals

If you drink diet soda, do it apart from foods that raise blood glucose to avoid conditioning a larger insulin response.

2. Retrain 'meh' foods by pairing and belief

Eat neutral or mildly disliked healthy foods, such as kale or mackerel, alongside foods that fuel brain metabolism (or ketones if you follow a ketogenic diet), and actively tell yourself they're good for your brain. Huberman says this cannot override true disgust, but it can shift neutral foods over time.

3. Get probiotics from low-sugar fermented foods

Fermented foods such as sauerkraut support the gut microbiota that shape these signals. Capsule probiotics may lack the right strains and have been linked to brain fog in some reports.

4. Cover the basics: hydration, electrolytes and feeding timing

Sodium, potassium and magnesium are the ions neurons use to fire. From his time-restricted eating episode, start eating at least an hour after waking, stop at least 2–3 hours before bed, and keep the eating window at roughly the same times each day.

Effects of Fasting & Time Restricted Eating on Fat Loss & Health | Huberman Lab Podcast #41

Date: 2021-10-11 · Duration: 2:26:07
URL: https://www.youtube.com/watch?v=9tRohh0gErM

KEYPOINTS

1. When you eat matters, not just what or how much
Huberman acknowledges that calories in versus calories out still governs weight, but argues that timing independently affects liver health, bile-acid metabolism, energy expenditure, inflammation, brown fat and blood glucose. Eating around the clock keeps food-related inflammatory markers raised, while a defined fasting period lets them fall.

2. The famous 8-hour window came from mouse experiments, partly for practical reasons
In Satchin Panda's lab study, mice given unlimited high-fat food at any hour became obese and sick. Mice eating the same food and calories within an 8-hour window maintained or lost weight, improved health markers and even reversed some earlier damage. Huberman reveals the window was 8 hours largely because the work was so labor-intensive: someone had to add and remove food on schedule and even clear food that mice hid in their cheeks.

3. Two rules anchor the protocol: no food in the first hour after waking or 2–3 hours before bed
Drawing on Panda's review in Endocrine Reviews, which tabulates well over 100 human studies, Huberman calls these the non-negotiables. Ideally you'd avoid even 1 g of sugar before bed and spend about 8 hours in bed, because fasting around sleep is especially important for the repair benefits.

4. An early or midday window is ideal for health but hard to live with
Because fasting around sleep matters most, a window such as 10 a.m.–6 p.m. maximizes the benefits. Huberman calls it 'absolutely dreadful' for social and family life. Most people do better with something like noon–8 p.m., kept reasonably consistent, including on weekends, when a 9:30 brunch can quietly stretch the window.

5. For muscle, protein early in the day may help
Aoyama et al. (Cell Reports, July 2021), studying mice and humans, found that protein eaten early supported hypertrophy better through the clock gene BMAL, which regulates protein synthesis in muscle. This held whether training happened early or late. Huberman's suggestion is to still skip the first hour after waking but get protein before about 10 a.m. if muscle is a priority. He stresses that eating protein later in the day isn't bad.

6. Glucose disposal agents are powerful and need caution
Metformin (prescription) and berberine (over the counter, with nearly identical effects) can sharply lower blood glucose and shift you toward a fasted state. Huberman gets a splitting hypoglycemic headache when he takes berberine without carbohydrates. Responses vary widely between individuals and by time of day.

7. Movement after eating speeds the transition to the fasted state
A 20–30 minute walk after dinner speeds gastric emptying and glucose clearance. Studies on high-intensity interval training found that HIIT early in the day can raise blood glucose, while HIIT in the afternoon or evening lowers it, which can help you enter sleep less 'fed'.

8. Time-restricted eating may lower free testosterone
In a study of trained cyclists eating about 4,800 calories a day, compressing the same calories into 8 hours significantly decreased free testosterone. Huberman notes the impact depends on your starting level: a 10–20% drop matters more if you're already low.

9. Alternate-day fasting works but is hard to sustain
Eating one day and having very little (500–600 calories) or nothing the next has been found safe, with no bone loss, and can produce faster weight loss and lower glucose than time-restricted eating. But few people can sustain it, rebound effects haven't been studied, and it's hard to combine with heavy training or work. Huberman knows of no quality clinical studies of longer fasts for dementia.

EXAMPLES

1. Fat loss, specifically, after 60+ days
Panda's review describes metabolic changes after about 60 days of time-restricted eating that bias weight lost during a calorie deficit toward fat rather than other tissue. The mechanism involves increased hepatic lipase, a liver enzyme that breaks down fat, and reduced CIDEC, a molecule that inhibits fat breakdown. Huberman stresses there's no way to out-eat the system: this applies only when you're already in a deficit.

2. Fasting and the gut
Huberman cites data that time-restricted eating improves the gut microbiome and helps people with irritable bowel syndrome and other forms of colitis. He attributes this to effects on clock genes in the gut lining and its microbes.

3. Lemon, lime and cinnamon
Cinnamon is a mild glucose-lowering agent, and lemon or lime juice can lower blood glucose through acidity. Squeezing half a lemon or lime into water quickly takes the edge off feeling overwhelmed after something very sweet.

4. Artificial sweeteners and breaking a fast
Some evidence shows aspartame and sucralose cause a brief rise in glucose, then a dip below baseline, which may explain increased hunger. Data on stevia and monk fruit are sparse. Huberman doesn't think it's fair to say sweeteners break a fast and suggests testing your own response with a continuous glucose monitor.

5. Adherence beats theoretical equivalence

Huberman distrusts studies claiming several diets work equally well, because participants are paid or monitored and log their food. In real life, adherence differs enormously, so the best plan is the one whose timing you can actually stick to.

OTHER RELEVANT

1. Build your window from sleep outward

Start with about 8 hours in bed, add at least 60 minutes without food after waking and 2–3 hours before bed, then fit a roughly 8-hour eating window around your life. Shorter 4–6 hour windows are possible, but the 8-hour version is the best tested.

2. Shift your window gradually, then hold it

Panda's group recommends a transition of one week to 10 days, moving the feeding window by about an hour a day. Once it feels sustainable, keep it for at least 30 days and ideally indefinitely. Data from their 'My Circadian Clock' app study, where people log their eating times, support this.

3. Use a pinch of salt for fasting shakiness

Huberman suggests a pinch to half a teaspoon of sea salt in water when you feel lightheaded or shaky during the fasting stretch. Salt isn't a glucose-lowering agent, but sodium stabilizes blood volume, and neurons depend on electrolytes for signaling. Adding lemon or lime can lower glucose further, which may make shakiness worse for some people.

4. Use exercise timing strategically

A walk after dinner, or HIIT later in the day, helps clear glucose before sleep. If you're experimenting with berberine or metformin, don't take them without carbohydrates on board, and watch for headaches and other side effects.

How to Lose Fat with Science-Based Tools

Date: 2021-05-24 · Duration: 1:53:54
URL: https://www.youtube.com/watch?v=GqPGXG5TlZw

KEYPOINTS

1. Calories in vs calories out still rules, but the nervous system controls the 'burn' side
Huberman's first project as an undergraduate was thermogenesis, testing how MDMA, antipsychotics, antidepressants and diet drugs changed body temperature and metabolism. His framing: fat is fuel for the body's furnace, and neurons can turn that furnace up, which helps explain why some people eat a lot without gaining fat.

2. Set the foundation before any fat-loss tool
Huberman's foundation list: quality sleep and well-timed light exposure; more than 1,000 mg of EPA a day (which may mean taking more total omega-3s) from food or supplements; glutamine, fermented foods (a serving or two daily) and amino acids, which can quiet sugar cravings; and enough, but not too much, iodine and selenium for thyroid function.

3. Fat loss has two steps: mobilization, then oxidation
Fatty acids must first be released from fat cells into the bloodstream, then carried into mitochondria and converted to ATP. If they are mobilized but not oxidized, they can be re-stored as fat. Both steps are promoted by epinephrine (adrenaline), while high insulin inhibits oxidation.

4. Adrenaline for fat loss comes mainly from nerves wired into fat, not the adrenals
Sympathetic neurons send axons directly into fat pads and release epinephrine locally. That's why Huberman calls adrenaline 'the final common path' and effector of fat loss for every kind of movement, from shivering to barbell lifts. He recommends Bartness's review, 'Neural innervation of white adipose tissue and the control of lipolysis' (Frontiers in Neuroendocrinology).

5. Fidgeting (NEAT) can burn a striking amount of energy
Rothwell and Stock in England (1960s–70s) studied people who overate without gaining weight and found they were fidgeters: knee-bouncers with angular, 'electric' movements. Huberman cites figures of 800–2,500 extra calories a day from this non-exercise activity thermogenesis, working best in people who are somewhat overweight. It doesn't replace exercise's cardiovascular benefits.

6. Shivering itself, not just cold, drives brown-fat thermogenesis
A Nature paper showed shivering muscle releases succinate, which activates brown fat thermogenesis and may, over time, convert beige fat into brown fat. If you stay calm and suppress the shiver in cold water, you short-circuit the effect. Succinate is being explored as an obesity drug; irisin, by contrast, he calls underwhelming.

7. Cold adaptation works against fat loss
Because the cooling-and-rewarming transition triggers shivering, staying in as long as possible teaches the body to stop shivering. Polar bear club swimmers get plenty of cold but are often not especially lean. Ice packs on the neck or cooling underwear aren't good fat-loss strategies either.

8. Fasted training helps fat oxidation after a switch point
In moderate-intensity (zone 2) exercise, about 90 minutes in, people who ate 1–3 hours beforehand burn far less fat from then on than those fasted for 3+ hours. Doing 20–60 minutes of high-intensity work like sprints or lifting first moves that switch point earlier. The key variable is low insulin; if you can't train without eating, eat.

9. High-intensity work burns more fat afterward, low intensity burns more during
Sprints and weights mainly use glycogen during the session, but elevated post-exercise oxygen consumption, which can last up to 24 hours, oxidizes a higher percentage of fat afterward. Long bouts of low or moderate intensity show the reverse pattern.

10. Local adrenaline makes spot reduction plausible in principle
Spot reduction was largely dismissed as an infomercial myth. Because epinephrine is released locally at fat pads, Huberman argues that exercise, shivering or NEAT that activates those specific nerves could, in theory, mobilize fat from targeted sites. He frames this as an emerging possibility, not a proven protocol.

EXAMPLES

1. Dinitrophenol (DNP)
Women painting munitions in WWII factories licked their brushes and lost large amounts of weight. The compound, DNP, later spread among bodybuilders and models, but it is deadly through hyperthermia and many have died. Huberman strongly discourages anyone from trying it.

2. Alia Crum's hotel housekeepers
Housekeepers told in detail that their daily work met activity guidelines and benefited heart health and weight lost significantly more body fat and improved waist-to-hip ratio over several weeks than a control group, simply because of what they believed.

3. Ephedrine and fenfluramine
Both increased fat loss through adrenergic pathways and were pulled from the market. With ephedrine, Huberman says, people died of overheating rather than direct heart attacks; fenfluramine lost FDA approval over cardiovascular deaths.

4. Huberman's yerba mate habit
Raised on mate as an Argentine, he brews 16–30 oz, sips it through the day and especially before training, reusing the

leaves for about a day to extract more. Studies summarized on Examine show increased fat oxidation during exercise and at rest via GLP-1, and one study even shows a slight drop in heart rate. Guayusa from Ecuador is a sweeter alternative.

5. Gardner Lab diet comparisons

Stanford work shows low-fat, high-fat, keto and intermittent fasting produce similar weight loss when people stick to them, so adherence is the decisive factor. Huberman personally eats low-carb by day and carbs at night to help him sleep.

OTHER RELEVANT

1. Shiver-based cold protocol

Get medical clearance first. One to three (up to five) times a week, find water just cold enough to make you shiver, anywhere from 60°F to the high 30s depending on adaptation. Get in until you genuinely shiver, stay about a minute, get out for 1–3 minutes without drying off, then repeat for several rounds. Very cold water can shock the heart.

2. Caffeine before training

If you're already caffeine-adapted, 100–400 mg taken 30–40 minutes before exercise can increase the share of fat oxidized. If you're not used to it, a big dose can vasoconstrict and impair performance.

3. Compounds that lower insulin or aid oxidation, with caution

Berberine and metformin powerfully lower blood glucose and insulin, but Huberman urges caution. Semaglutide and other GLP-1 drugs are prescription-only 'heavy artillery'. Acetyl-L-carnitine modestly aids fat oxidation and has other effects, including on sperm quality, CRP and HDL.

4. Behavior before pills

Huberman insists there is no magic pill. Fidgeting, shivering, fasted or high-intensity training and diet adherence come first; compounds are add-ons that work mainly by increasing epinephrine or lowering insulin.

How Foods and Nutrients Control Our Moods

Date: 2021-03-15 · Duration: 1:44:07
URL: https://www.youtube.com/watch?v=XfURDjegrAw

KEYPOINTS

1. The vagus nerve is a two-way highway, not a 'calm-down' button
Huberman describes the vagus (cranial nerve X) as carrying sensory information from the stomach, intestines, heart, lungs and immune system up to the brain, plus motor commands back down. He calls generic 'vagus stimulation' a terrible concept: the same nerve signals infection and helps trigger fever, so you want to engage specific pathways rather than the whole nerve.

2. Polyvagal theory got the branching right but is often stretched too far
He credits Stephen Porges for stressing that the vagus has many branches, but says the dorsal/ventral split does not fully match modern anatomy. His bigger complaint is popular use: diagnosing personality, freeze states or joint hypermobility from 'dorsal vagal tone' goes beyond any known physiology.

3. Gut neurons detect sugar without any taste and drive craving via dopamine
Cells in the stomach sense sugar and signal up the vagus to trigger dopamine release. In experiments where people's mouths were numbed and they were blindfolded, they still craved the food that contained sugar. That is why he sees hidden sugars as a problem for the dopamine system, not only for blood glucose.

4. A little anxiety before eating is built into the circuitry
As you approach food, the locus coeruleus releases noradrenaline, which acts on the lateral hypothalamus to inhibit feeding. Calming and fullness signals are meant to take over as you eat. He thinks this explains why some people feel stressed at mealtimes, and he suggests using how well you digest as a guide rather than strict rules about never eating while stressed.

5. People tend to eat until the brain registers enough amino acids, not until the stomach is full
Gut sensors track both how much protein you have eaten and which amino acids it contains. Amino acids matter beyond building muscle because they are the raw material for neuromodulators. L-tyrosine (found in meats, nuts and some plant foods) is the precursor for L-DOPA and dopamine, although the dopamine neurons that drive motivation live in the brain, not the gut.

6. Dopamine is about wanting, and reward prediction error shapes whether you go back for more
Expecting something releases dopamine, and so does getting it. If the actual experience doesn't at least match the build-up, you get less dopamine and are less likely to pursue it again. He uses his own 'affliction' for croissants: hyped croissants tend to disappoint, while one tried at random can satisfy more.

7. Most mood-relevant serotonin is made in the brain, even though the gut makes plenty
He pushes back on the popular claim that '90% of serotonin is in the gut, so mood lives in the gut'. Mood and satiety serotonin come mainly from the raphe nucleus. SSRIs such as Prozac, Zoloft and Paxil help many people, he says, but can blunt emotions, appetite and libido.

8. Changing the omega-3 to omega-6 ratio can affect depression
In a rodent learned-helplessness swim test, raising omega-3s relative to omega-6s made the animals keep swimming longer. In a human study of 60 people with major depression, 1,000 mg/day of EPA worked as well as 20 mg of fluoxetine over 8 weeks, and the combination worked better than either. He says PubMed now holds many studies pointing the same way.

9. EPA may work partly through inflammation and heart rate variability
He cites a 2009 study in which a high omega-6 to omega-3 ratio went along with raised IL-6 and TNF-alpha and poor response to antidepressants. Raising EPA lowered those markers, let low-dose antidepressants work and increased heart rate variability, which he links to the vagal sensing of the heart.

10. Gut microbes support mood, but more probiotics is not better
A healthy microbiome supports mood, digestion and immunity. He cites studies, which he calls somewhat controversial, linking very high probiotic intake (e.g. lactobacillus) to brain fog. Citing published work from Justin Sonnenburg's lab, he favors fermented foods such as sauerkraut, kimchi, pickles and natto, at around two servings a day.

11. Belief changes how the body responds to food
Alia Crum's work shows that what people believe about a food or activity changes measurable physiology, beyond a simple placebo effect. He stresses that this only works when people don't already know the expected outcome. You cannot talk yourself into a poison being healthy or into twelve croissants causing weight loss.

EXAMPLES

1. Milkshake study: same shake, different ghrelin response
Two groups drank an identical milkshake, but one was told it was a low-calorie 'healthy' shake and the other a decadent, high-calorie one. The 'indulgent' group showed a much larger drop in the hunger hormone ghrelin, showing that beliefs about food reach hormones released in the body.

2. Hotel housekeepers told their work was exercise
In another Crum study, hotel workers who were told their daily cleaning was good for their health had lower blood pressure, lost significant body fat and enjoyed their work more 8 weeks later, compared with a group that got a different message. Their actual work stayed the same.

3. Saccharin and the gut microbiome

A Nature study showed saccharin shifted the microbiome toward bacteria linked to inflammation, and antibiotics blocked the effect. Huberman stresses that saccharin shifts the microbiome rather than killing it. He says the negative findings, as far as he knows, were specific to saccharin. Stevia and monk fruit are chemically distinct, though they still need testing.

4. Acetyl-L-carnitine trials

L-carnitine (richest in beef) is converted to acetyl-L-carnitine, which crosses the blood-brain barrier. Studies collected on Examine.com report reduced depressive symptoms, better sperm motility, benefits in PCOS, and reductions in some autism and fibromyalgia symptoms. In a migraine RCT of 133 people, 500 mg for 12 weeks cut monthly attacks, although he notes the control condition was weak.

5. Mucuna pruriens, the 'dopamine bean'

This velvet bean is itchy because of serotonin on its surface and contains L-DOPA inside. Reported effects include better sperm quality, eased Parkinson's symptoms, greater well-being, higher testosterone and lower prolactin. He describes these as a window into what an acute dopamine increase does, not as a recommendation.

OTHER RELEVANT

1. Time macronutrients to your mental state

Huberman's own pattern: fast and exercise early, eat a high-protein, moderate-fat, low-carb lunch to support dopamine and alertness, then eat starchy carbs and tryptophan-rich foods in the evening to raise serotonin before sleep.

2. Be cautious with tyrosine and 5-HTP

He takes L-tyrosine occasionally. He warns it can cause a crash and brain fog the next day, that chronic use may disrupt dopamine pathways, and that people prone to mania should avoid it. 5-HTP knocks him out but wakes him 2–3 hours later, because natural serotonin release peaks late at night. It may also suppress appetite and raise cortisol. Check with a doctor first.

3. Aim for about 1,000 mg EPA per day from a clean source

Sources include fish oil, krill (which gave him itchy skin), chia, flax and grass-fed meat. Pick decontaminated brands and bite a capsule to check it isn't rancid. People with bleeding disorders such as factor V Leiden, or women on birth control, should ask their doctor first. In his words, 'better living through chemistry still requires better living'.

4. Find the diet that suits your microbiome

Keto, vegan and meat-heavy diets each shift the microbiome, and some people feel better while others feel worse. Highly processed foods, animal or plant, drive overeating, as a Cell Press paper showed. Fasting for a day or more depletes gut microbes, which may explain why the first meal back can feel rough, so return to eating gradually.