# Focus, Learning & Memory

Huberman Lab Keypoints

Episodes in this pack: 18

# How to Accelerate Learning & Improve Education | Joe Liemandt

Guest: Joe Liemandt
Date: 2026-08-31 · Duration: 2:33:43
URL: https://www.youtube.com/watch?v=Uzoe1RYVjiA

## KEYPOINTS

### 1. Schools gave universal access; the next goal is universal learning
The K–12 classroom model came from Prussia about 100 years ago, when society first set out to educate everyone. Around 30 students per teacher was what that goal could afford. Liemandt, principal of Alpha School, argues that kids now have access, but how much they learn over 12 years varies hugely. He believes AI makes it possible, for the first time in 50–100 years, to redesign how learning happens.

### 2. One-on-one tutoring to mastery is the gold standard
He cites Benjamin Bloom's 1980s 'two sigma' paper: individually tutored students who learned to mastery performed about two standard deviations higher, roughly top 2%. Parents' fixation on class size, he says, is really a proxy for getting closer to one-on-one. The part people forget is mastery, not just the tutor.

### 3. Alpha's model: about two hours of AI-guided academics, then life skills
Students do roughly two hours a day of individualized lessons, and Liemandt says they learn about twice as fast as peers. He stresses this isn't a chatbot. Dropped into a normal school, he says, chatbots get used to cheat by about 90% of kids. Afternoons go to workshops on building, sports, entrepreneurship and public speaking, led by adult 'guides' rather than academic teachers. He says 100,000 people applied for those roles last year.

### 4. Mastery has three layers
First, can you solve a problem at all? Second, true mastery means doing 10 hard problems, not three easy ones. Third, can you still do them a month or two later? That calls for spaced repetition rather than cramming. American schools, he says, move kids along with an 80% 'B,' leaving holes. His analogy is a basketball coach who wouldn't practice dunks with a team losing the ball 20% of the time; 85% isn't acceptable.

### 5. Fluency frees working memory
We have only a few working-memory slots. If you know 7 × 8 = 56 cold, it costs nothing; if you have to calculate it, it uses up slots needed for a multi-step algebra word problem. So, he says, kids who struggle in algebra usually have a third-grade math-facts problem, not an algebra problem. Gifted kids, who have the most slots, often skip writing down their work and hit this wall later.

### 6. Material must sit at the right level
What you know is the base for what you can learn. Give someone material that's too hard, like an MCAT to a non-biologist, and no amount of 'grit' or 'growth mindset' helps. You have to roll them back to where they actually are and build up. AI can generate the exact missing lessons and set an individual pace.

### 7. Measure growth rate, not achievement, and remove the blocks
Alpha benchmarks each student against peers at the same percentile. Its claim is that top-1% students learn twice as much in two hours as other top-1% students learn in a full day, which Liemandt says rules out a simple rich-kid selection effect. Guides' daily job is to find each child's mental block, such as middle-school girls convinced 'I'm not good at math,' and remove it.

### 8. Paying kids can work, he argues
Liemandt says paying for mastery doesn't destroy motivation in their experience, though he acknowledges the self-determination-theory debate. Alpha pays students $1,000 to reach the top 1%. Against roughly $20,000 per pupil per year in public school, or about $240,000 over K–12, he calls small cash incentives cheap. Public schools are legally barred from paying students cash.

### 9. In traditional schools, family income predicts scores best
He says the top predictor of test scores is family income, with IQ secondary. Then come IQ and Big Five conscientiousness: natural 'grinders' who do every problem in the book are running a mastery system on themselves. Smart kids without that trait struggle in time-based schools.

### 10. Kids want high standards and hard things
Liemandt says high standards are key to a child's happiness, not a source of stress. Over 90% of Alpha students say they love school, and 40–60% said they'd rather go to school than on vacation, depending on the vacation. In the past year, 85% of parents said they had seen their child do something they thought was impossible for that age.

## EXAMPLES

### 1. The 710 SAT student and her multiplication tables
A girl stuck in the low 700s on the math SAT kept being told her errors were careless. The real cause was that she hadn't memorized her math facts. Persuading a 710 scorer, and her parents, that the fix was a third-grade lesson took a lot of motivational work from the guides.

### 2. '100 for 100'
Seventh graders had gaps from earlier grades, and their parents refused to send them back to fourth-grade material. Liemandt went straight to the kids and offered $100 for a 100 on the state test at any grade level, starting with third grade. They earned $100 on the third- and fourth-grade tests, scored 85 on fifth, asked the AI for the missed lessons, finished them that week, and kept climbing to seventh.

### 3. Kindergarten feats

Alpha kindergarteners climb a 40-foot rock wall. At the San Francisco campus, kids learned to ride a bike and then rode 5 miles across the Golden Gate Bridge without stopping.

### 4. A 40-step special-effects glass lab

Science labs train two skills: how many steps you can follow in a row, and your margin of error. Making safe stunt glass is about a 40-step process with little room for error. Kids who start at 1 p.m. expecting to finish by the end of school are still at it at 6 p.m. and refusing to go home. Liemandt pairs 11 minutes of app-based mastery with 45 minutes of hands-on experiment.

### 5. Texas Sports Academy demand

Texas vouchers, for kids with a learning disability or families under $65,000 income, had $1 billion allocated and ran out. Within 100 days of vouchers opening on January 1, over 120,000 Texas families had signed up saying they wanted a voucher for Alpha's sports-academy model, which costs less than $20,000 a child.

### 6. How Liemandt came to Alpha

Founded 12 years ago by Mackenzie and Brian, Alpha first looked to him like a 'janky' school, with no teacher at the front and girls reciting vocabulary while doing handstands. One daughter was struggling in Catholic school. She tried a week at Alpha in summer, when her school was out, and wanted to stay. He's now in his fifth year as principal.

## OTHER RELEVANT

### 1. Fix foundations before advancing

If a child is stuck, look for gaps a grade level or more back, such as math facts to fluency, instead of more practice at the current level.

### 2. Use AI as a tutor, not an answer engine

Structured, mastery-gated lessons help. Open chatbots in a standard classroom mostly enable cheating, by Liemandt's estimate.

### 3. Test retention, not cramming

Revisit material a month or two later. Spaced repetition is what turns 'solved it once' into real mastery.

### 4. Make kids build things

Liemandt argues that drones, robots, businesses, books, videos and sports are what engage kids, a return to the old idea of shop class. He says MIT's Blueprint Labs will run randomized trials to test whether the model works, and where it doesn't.

# Accelerate Learning & Increase Cognitive Capacity | Dr. Tommy Wood

Guest: Dr. Tommy Wood
Date: 2026-07-20 · Duration: 2:41:26
URL: https://www.youtube.com/watch?v=bPd9NnOzx78

## KEYPOINTS

### 1. Protecting the aging brain takes three things together
Based on population studies and trials in older adults, Wood's framework is to exercise, keep doing the things you already know how to do, and keep learning new things you can't yet do. 'Use it or lose it' is true, but novelty and being bad at something are what push the brain to change.

### 2. Adults lose function partly because they stop doing hard, new things
In a paper with a colleague, Wood argued that cognitive decline partly comes from no longer giving the brain new, complex inputs, because 'adults hate being bad at things.' The discomfort of mistakes is part of learning. A beginners' class where everyone fails together makes it easier and more fun.

### 3. Pick skills that combine movement and thinking
Pick something well outside your current skills that has both motor and cognitive parts, such as dance, sports, music or other arts. Narrow brain-game practice mostly makes you better at that game. Broader, more human skills engage many brain networks and probably carry over further into daily life.

### 4. Processing-speed training has the best long-term evidence among brain games
The ACTIVE trial in the 1990s, the largest pure brain-training trial in people in their 60s and 70s, tested memory, reasoning and visual processing-speed training. Speed training flashes items for shorter and shorter times, down to hundreds of milliseconds. A recent secondary analysis found that speed training with booster sessions at one and three years was linked to significantly lower dementia risk 20 years later. The US POINTER trial used BrainHQ, built on Michael Merzenich's work, alongside diet, exercise and cardiovascular-risk management.

### 5. Deep focused work tops out at about 60–90 minutes per session
In the classic violinist practice study behind the '10,000 hours' idea, top players typically practiced in two sessions of 60–90 minutes a day. Wood suggests that pattern as a rule of thumb for work that pushes past your current skill. Huberman adds that marathon days of 6–12 hours led to a drop in output afterward.

### 6. Eat enough, but not too much, and cover key nutrients
Studies of the Bolivian Tsimane (hunter-gatherers), the Moseten and industrialized populations found a bell-shaped curve between energy availability and brain volume. The nutrients with the best evidence for cognition and dementia risk are vitamin D, iron, omega-3s, and the methylation B vitamins (B12 and folate, possibly B6 and riboflavin). Polyphenols from berries, coffee, tea and chocolate, plus carotenoids such as lutein, zeaxanthin and astaxanthin, have decent support.

### 7. Nutrients work together, which explains many 'failed' supplement trials
In the Oxford VITACOG trial, later replicated in B-PROOF, B vitamins lowered homocysteine but brought no benefit when omega-3 levels were poor. In OmegAD, omega-3s didn't help people whose homocysteine was high. Wood's point is that trials that don't first check what participants lack shouldn't be expected to show effects.

### 8. Stimulants set the stage for learning but don't cause it
Huberman and Wood agree there's no 'plasticity pill.' Caffeine and other stimulants raise arousal and focus, which learning needs, so any benefit is likely indirect. For peptides and newer compounds, Wood personally wants documented safety first and a specific problem to solve. Often all that exists is an absence of reported harms over short periods of use.

### 9. Fitness intensity matters for the hippocampus
In one trial, older adults were randomized to low-intensity exercise, Zone 2 treadmill work three times a week, or the Norwegian 4x4 interval protocol three times a week for six months. The 4x4 means 4 minutes at 85–95% of max heart rate, 3 minutes of rest, repeated four times. Fitness gains were similar in the Zone 2 and interval groups, but the interval group showed better hippocampal function and better-preserved hippocampal structure on MRI. Separately, 6–12 months of basic machine resistance training changed white-matter structure and improved executive function.

### 10. Training volume can steal mental energy
A flat-out 2K row, about 6 minutes at maximal effort, leaves the brain useless afterward. Huberman does low-volume, high-intensity lifting: about two sets per exercise and two to three exercises per muscle group. Adding a third set leaves him dragging for the rest of the day. Leaving something in the tank on volume, though not within each set, helps when hard thinking comes next.

### 11. Most dementia risk factors can be changed
The Lancet Commission on dementia prevention, led by Gill Livingston, lists 14 modifiable risk factors that together account for about 45% of cases. They include low early-life education, high blood pressure, diabetes, hearing loss, vision loss, brain injury, high LDL cholesterol and physical inactivity. APOE is the most common risk gene, but late-onset Alzheimer's is driven mainly by lifestyle and environment.

## EXAMPLES

### 1. Shingles vaccine natural experiments
In Wales, Australia and Canada, eligibility for the shingles vaccine began on a specific birth date, so people born a day apart were compared. Those eligible or vaccinated consistently had lower dementia risk, while other diseases and vaccine uptake didn't differ. These studies used the older live vaccine Zostavax. A US study looked at the newer recombinant Shingrix, and a

fully powered trial is being planned.

### 2. Illness causes stepwise drops in cognition

In the Adult Changes in Thought study (University of Washington) and Rush Memory and Aging Project, cognition didn't decline steadily. It dropped in steps after major illness, with bigger drops after hospitalization, so avoiding serious illness protects the brain.

### 3. MIND diet vs. calorie restriction

In a New England Journal of Medicine trial, the MIND diet and standard calorie restriction gave similar benefits. Wood suspects that's because many people live in chronic energy excess. A UK Biobank analysis found that removing any single Mediterranean-diet food, olive oil included, didn't change the diet's link with lower dementia risk. He reads that as nutrient-dense whole foods mattering more than any one item.

### 4. Creatine after concussion

The best trial, in children and teens aged 1–18, used 0.4 g per kg per day, which would be about 28 g for a 70 kg adult. Wood says recent meta-analyses find GI side effects rarely exceed placebo, and poor-quality products may cause many complaints. Huberman recalls the 1990s loading protocol of 5 g four times a day in grape juice.

### 5. Branched-chain amino acids for brain injury

Studies gave up to 60 g of branched-chain amino acids daily. In one veterans study, Wood recalls three 20 g doses spread across the day, far above the typical 3–5 g gym dose.

## OTHER RELEVANT

### 1. Practical learning schedule

Do one or two focused blocks of 60–90 minutes with short breaks, on something just beyond your skill. Expect some discomfort and mistakes.

### 2. After a concussion

Wood's early steps: avoid alcohol and caffeine, partly to protect sleep, and consider creatine, which has some reasonable evidence. Physical therapy and other supports come later. Get medical guidance for any brain injury.

### 3. Test before supplementing

Check vitamin D, iron, B12, folate, homocysteine and omega-3 index. Wood doesn't know whether pushing an omega-3 index from about 7–8 up to 12 helps further.

### 4. Don't fear cortisol from training

Cortisol naturally swings 20–30 fold from morning to night. Short spikes from hard workouts or cold showers are not Cushing's syndrome, which involves pathologically high cortisol.

# How to Improve Your Memory & Cognitive Function at Any Age | Dr. Alan Castel

Guest: Dr. Alan Castel
Date: 2026-07-13 · Duration: 2:28:39
URL: https://www.youtube.com/watch?v=EIhilBpn8Ow

## KEYPOINTS

### 1. Memory is reconstructive, and we misjudge how well we know things
Castel, a UCLA memory researcher, notes that two people can see the same event and remember it differently a day later. Awareness of your own thinking (metacognition) is often poor: we feel we know something we don't. As a child he rehearsed a single line in The Wizard of Oz ('there's a cyclone on the way, hurry and get into the cellar') and on opening night swapped 'cyclone' and 'cellar.'

### 2. Seeing something often doesn't mean you remember it
People have seen the Apple logo thousands of times but can't say which side the bite is on or whether it has a stem or a leaf, an update of the classic penny study. Drawing it while looking helps. Better still is struggling to draw it from memory first and then checking. Making mistakes before seeing the answer produces stronger learning than simply studying.

### 3. Desirable difficulties beat easy studying
Castel cites work by his UCLA colleagues on 'desirable difficulties': learning that feels uncomfortable often sticks better, even though teachers and students tend to make it easier. Students who highlight 80% of a textbook and still get a C show the real skill is picking out what matters and organizing it around themes, such as findings that make intuitive sense versus counterintuitive ones.

### 4. Name tricks are workarounds, and forgetting names is normal
Mnemonics like 'Castel rhymes with pastel' require extra effort and cause predictable errors ('Pastel'). Names get harder with age because there are more Davids and Andrews competing in memory. Using the name several times and practicing recall help. Castel argues that remembering what you talked about, or whether you can trust someone, matters more.

### 5. Confidence is not accuracy, as eyewitness cases show
In the Ronald Cotton case, a woman who was assaulted deliberately studied her attacker's face so she could identify him. She confidently picked Cotton, and he was convicted. Decades later DNA evidence exonerated him. Factors included cross-race identification, which is less reliable, and the way an identification can overwrite the original memory. Castel says memory should be treated as one source of evidence that can be contaminated, like DNA.

### 6. Under stress we fall back on habit, so rehearse plans ahead of time
Castel walks to the fire exits when he checks into a hotel, after guests once asked him which way to go during an alarm. Under high arousal people default to what they already know. Prospective memory, remembering to do something in the future, is especially prone to failure when attention wanders, as when you suddenly realize you've driven home on autopilot.

### 7. Walking can enlarge the hippocampus
The hippocampus, key for remembering facts and events, shrinks about 1–2% a year in later life. In a randomized trial, older adults who walked three to four times a week for 40 minutes grew hippocampal volume by about 1% compared with a stretching group, and their memory was better a year later. Castel sees exercise as a stronger memory tool than any pill.

### 8. Brain pathology doesn't fully determine behavior
In the Nun Study, some nuns whose brains showed Alzheimer's plaques and tangles after death had functioned well cognitively in life. Castel suggests purpose, social connection, exercise and sleep may help explain the gap. The amygdala, which tags memories with emotion, stays active with age, which is one reason embarrassing mistakes stick so well.

## EXAMPLES

### 1. Taking 'mental photographs'
Huberman describes deliberately 'snapshotting' moments, such as a picnic with his first girlfriend, which now stays somewhat blurry. Castel says research on photographic memory shows that even people with exceptional visual memory make errors. Choosing to mark a moment as special, especially one with emotional weight, is what helps it stick, and those memories can still drift in their details.

### 2. The one-leg balance test
One in four people over 65 will fall, and a fall can lead to bed rest and less walking, which shrinks the hippocampus. Castel's quick check is to stand on one leg for at least 10 seconds, holding on to something if needed. Most people never test their balance.

### 3. Subjective age predicts longevity
After 40, most people feel about 20% younger than their actual age, and how old you feel predicts lifespan better than chronological age. People with positive attitudes toward aging live longer and are less likely to develop dementia. Pessimism about aging in general paired with a sense of control over your own aging is also linked to longer life.

### 4. SuperAgers and the anterior midcingulate cortex
Huberman notes that in SuperAgers the anterior midcingulate cortex keeps or gains volume. When Josef Parvizi stimulated this area in patients, they described a sense of challenge and the will to push through it.

### 5. AI voice-clone scams
Scammers use voices taken from social media to fake a grandchild calling for help. These scams exploit socioemotional selectivity, older adults' focus on family and feelings, and AI makes them harder to spot.

## OTHER RELEVANT

### 1. Castel's ABCs of successful aging

Partly inspired by his conversation with UCLA coach John Wooden, whose two takeaways were love and balance: A is attitude and adapting to changes, B is balance (SuperAgers are rarely extremists) and C is connection with the people and activities you love.

### 2. Be selective as you age

Under Laura Carstensen's socioemotional selectivity theory, people focus on what matters most as their time horizon shrinks. Selective optimization with compensation means keeping the one hike you love rather than doing everything. Castel's research finds older adults focus more selectively on what's important to them, and they also show a positivity bias.

### 3. Maintain and learn new things

Castel's father, in his 80s and 90s, still plays the piano pieces he knows. Castel recommends a mix of keeping existing skills and taking on new ones that sit just beyond your current skill.

# Enhance Your Learning Speed & Health Using Neuroscience Based Protocols | Dr. Poppy Crum

Guest: Dr. Poppy Crum
Date: 2025-09-29 · Duration: 2:35:50
URL: https://www.youtube.com/watch?v=MlmFj1-mOtg

## KEYPOINTS

### 1. Every technology you use is reshaping your brain maps
Crum, a Stanford neuroscientist and former chief scientist at Dolby Laboratories, argues we are more plastic than we realize, and that the statistics of our environments and tools allocate our limited neurons. As we age, that shaping depends increasingly on how attentive and engaged we are rather than on passive consumption.

### 2. The textbook homunculus is out of date
Wilder Penfield's 1940s map came from stimulating the cortex of awake epilepsy patients and asking what they felt. Crum asks students what is wrong with it today: thumbs should be bigger because of phones, and ankle representation may shift as driving changes. The map reflects how the brain allocates resources for success in a given era. Texting did not build a new brain area; it reallocated existing ones.

### 3. Your environment sets your sensory thresholds
Cities have sonic imprints from their vehicles, density and construction, so hearing thresholds and sensitivities can partly predict where someone lives or grew up. Sounds that mattered in childhood, such as a neighbor's rooster, become deeply embedded.

### 4. Perception is sensory input filtered through priors
We combine sensory data, accumulated statistics called Bayesian priors, and expectations, so people experience the same physical information differently. Crum's two-and-a-half-year-old daughter, seeing NASA's image of Earth in a Smithsonian planetarium, shouted 'Minions!' because her prior for that image was the Universal logo. Speed at probabilistic inference is a strong predictor of success in many environments.

### 5. Closed-loop feedback accelerates skill learning
Video games give real-time performance data in a controlled, closed loop, which is why Crum teaches a Stanford course on neuroplasticity and video gaming to musicians, computer scientists and athletes. Real-time feedback, including auditory feedback, sharpens neural representations so you can detect finer differences.

### 6. Ask whether a tool makes you smarter or just faster
Crum sorts tool use into two bins: using technology to gain insight and become cognitively or physically more effective, or using it to replace a cognitive skill for speed. GPS is a replacing tool. London taxi drivers once had more hippocampal gray matter from mental maps; without GPS today, do not expect the same navigation ability. Huberman's worry is that time saved gets filled with things that are neutral to harmful.

### 7. Writing with LLMs cuts the load that builds learning
Cognitive load theory splits effort into intrinsic load from difficult material, extraneous load from poor presentation or a noisy setting, and germane load spent building mental schemas. Germane load is the work of learning. In an MIT EEG study comparing essays written with brain only, search engines or LLMs, the LLM condition reduced engagement and transfer. Crum predicts professionals who learned their field before LLMs will be better at extrapolation and spotting patterns.

### 8. Your body broadcasts your state
Breath carries a shifting mix of CO2, acetone and isoprene that changes with stress or suspense. Pupil size tracks arousal and cognitive load and is now measurable with open-source software on laptops or phones. Huberman notes that changes in lighting can be corrected for by dividing by ambient light measured at the eye. Crum expects smart glasses and environmental sensors to read these signals and adjust rooms to support focus or relaxation.

### 9. Plasticity is as fast as the incentive requires
Eric Knudsen raised owls in prism glasses shifting vision by 15 degrees. Their auditory neurons realigned to form a second map, and much faster when hunting and feeding depended on it. Huberman's takeaway: habits do not take a fixed 29 or 50 days; they form as quickly as necessary, within limits.

## EXAMPLES

### 1. 40 hours of Call of Duty
Self-identified non-gamers who played 40 hours of Call of Duty developed gamer-level contrast sensitivity that persisted a year later. Work by Alex Pouget and Daphne Bavelier found trained players made the same probabilistic decisions as non-players, but much faster.

### 2. A homemade swim-stroke analyzer
Crum used AI coding tools such as Perplexity Labs and Replit to build a phone-camera computer vision app that tracks her 10-year-old daughter's roll, arm entry, velocity and stroke consistency. She stresses good coaches come first and that she uses the data to support their cues, not lecture her child.

### 3. Crum's two absolute-pitch maps
Crum has absolute pitch and can name frequencies such as 442 Hz. Playing Baroque violin tuned to A at 415 Hz, close to modern G-sharp, she heard every A as wrong until she developed a second absolute-pitch map, letting her switch between A415 and A440 with nothing in between. Reading Knudsen's owl paper led her into neuroscience.

### 4. Breath CO2 tracking Free Solo

At Dolby, CO2 measured from tubes on the floor of a theater showing Free Solo revealed where Alex Honnold summited, abandoned a climb or hurt his ankle, without annotation. Another study found audiences' exhaled chemistry marked when Katniss's dress catches fire in The Hunger Games.

### 5. The moth that beats the bat

Echolocating bats adjust constant-frequency calls so echoes return in their most sensitive range, tracking Doppler shifts for speed, and use FM sweeps for surface detail. Moths escape about 80% of the time: a few neurons trigger random flight, then a drop to the ground as calls get close, while body structures deflect call energy. Orb-weaver spiders tune webs to resonate; when Crum sings near 880 Hz, the spider reacts as if to a threat.

## OTHER RELEVANT

### 1. Use AI to quiz yourself, not to think for you

Huberman feeds verbatim text from papers he has already read and annotated into AI, asks it to test him, and asks where he is weak, such as third-order conceptual links. Self-testing away from the material is what drives memory. Crum built a free, no-coding protocol for creating a custom AI coach for any skill or health routine.

### 2. Quantify to motivate, then go beyond summary numbers

Sleep scores and step counts work because they give something to aspire to. Huberman notes 7,000 steps is now considered the threshold, not 10,000. Crum prefers richer feedback on specific components of a skill. Scaring people stops behaviors; making the right ones engaging and measurable starts them.

### 3. Choose which maps you let technology change

Smartphones took about 15 years to integrate and we are still cleaning up harms such as late-night light and constant contact. With AI arriving faster, be deliberate about which skills you hand off. Berkeley students told Crum many peers cannot start a paper without ChatGPT.

# How Nature & Other Physical Environments Impact Your Focus, Cognition & Health | Dr. Marc Berman

Guest: Dr. Marc Berman
Date: 2025-07-14 · Duration: 2:11:46
URL: https://www.youtube.com/watch?v=ewnvjnuFTOY

## KEYPOINTS

### 1. There are two kinds of attention, and only one fatigues
Berman, a University of Chicago environmental neuroscientist, builds on his mentor Steve Kaplan's Attention Restoration Theory. Directed attention is choosing what to focus on, such as a lecture, paper or math problem, likely relying on frontal cortex. It runs down with use, which is why students start nodding off about 45 minutes into his lectures. Involuntary attention is captured automatically by something interesting and doesn't tire.

### 2. Depleted directed attention costs more than focus
Berman argues directed attention helps control nearly all behavior. When it is fatigued, impulse control drops, people can behave more aggressively and goals slip. He notes a puzzle: the brain uses about 20% of the body's energy whether you are sleeping or solving calculus, so the neural basis of mental fatigue is still unclear.

### 3. Nature restores attention through 'soft fascination'
Two ingredients matter. Natural settings make few demands on directed attention: no streets to cross, traffic or ads. They also offer softly fascinating stimulation, such as a waterfall's sound and froth, that engages involuntary attention while leaving room for your mind to wander. Times Square is 'harshly' fascinating: it grabs all your attention and leaves none for reflection.

### 4. The benefit doesn't depend on enjoying it
Mood improved on nature walks, but mood gains barely correlated with the cognitive gains. People who walked in January at 25 °F and hated it got the same working-memory boost as June walkers at 80 °F who loved it. Berman concludes something deeper than pleasantness is at work.

### 5. Pictures and sounds help, but less than the real thing
About 10 minutes of viewing nature photos, rating each from 1 to 3 to keep people engaged, also improved backwards digit span relative to urban photos. Nature sounds and videos help too. Berman cautions the effects are smaller than a real walk.

### 6. Fractals and compressibility may explain the effect
Natural scenes contain repeating fractal patterns, curved edges and color variation. Berman's student ran a JPEG compression algorithm on thousands of images, and nature scenes compressed into fewer bits than urban scenes, suggesting they may be easier for the brain to process. Brain signals measured by MRI and EEG are more fractal when the brain exerts less effort: in easy or well-practiced tasks, and less so with age. Nature may push the brain toward that restful state.

### 7. Rumination doesn't spoil a nature walk
Berman worried that walking alone might deepen rumination in depressed people. Instead, participants with clinical depression, deliberately prompted to recall a troubling memory first, gained even more working memory than non-clinical participants. He suggests nature frees attentional resources that rumination normally consumes.

### 8. Restoration differs from meditation
Meditation uses directed attention; nature restoration is passive and relies on involuntary attention. Berman wonders whether ancient practices held in beautiful settings combined both. Huberman frames the distinction as 'passive restorative' versus 'passive depleting' activities like phone scrolling, and speculates that focus circuits can strengthen or atrophy with use.

### 9. A restorative environment needs extent and compatibility
Kaplan's criteria include extent, meaning enough to explore, though not Yosemite scale. Berman's example is the roughly 100-square-meter Garden of the Phoenix near his office, with a path, a small waterfall and a view of Lake Michigan. The setting also has to fit your goals. For maximum benefit Berman suggests solitary time without phones, music or podcasts.

## EXAMPLES

### 1. The 2008 Ann Arbor walk study
Participants did a backwards digit span task (repeating up to nine digits in reverse), then walked about 2.6 miles (around 50 minutes) through the Ann Arbor Arboretum or busy downtown streets. They had no phones and wore GPS watches to confirm the route. A week later they did the other walk. Working memory and directed attention improved by about 20% after the nature walk compared with the urban walk.

### 2. Roger Ulrich's hospital-window study
In a 1980s study at a Philadelphia hospital, gallbladder-surgery patients randomly assigned to rooms with a modest view of trees and shrubs went home about a day earlier and used less pain medication than those facing a brick wall.

### 3. 580,000 Toronto trees
Using health data on about 30,000 residents and a catalog of every public tree, Berman's team found that one more tree per block was linked to a 1% rise in perceived health. That was comparable to a $10,000 higher neighborhood income or being seven years younger. One more tree per neighborhood was linked to a 1% reduction in stroke, diabetes and heart disease, equivalent to $20,000 more income or being 1.5 years younger. Berman stresses the data are correlational.

### 4. Happy hour then and now
Huberman recalls daily end-of-day drinks in Berkeley's psychology library until the late 1990s, and Friday volleyball happy

hours in graduate school. They ask whether phones filled that gap with passive depletion. Berman says happy hour was probably good socially but not for directed attention.

## OTHER RELEVANT

### 1. Walk before focused work

Treat time in nature like a warm-up before lifting. If you can't focus even after good sleep, morning light and caffeine, Berman's first suggestion is a walk in nature.

### 2. Use substitutes when you can't get outside

A window view, nature sounds, videos or photos give smaller but real benefits.

### 3. Aim for about 20 minutes, alone and unplugged

Huberman takes away a minimum of about 20 minutes. If daily isn't realistic, take longer outings on weekends and leave the phone and earbuds behind.

### 4. Bring nature indoors and into cities

Plants, greenery in hospital rooms and possibly aquariums may help. Huberman's view on aquariums is a personal impression without data. Street trees appear to carry measurable community health associations.

# Improve Focus with Behavioral Tools & Medication for ADHD | Dr. John Kruse

Guest: Dr. John Kruse
Date: 2025-03-10 · Duration: 2:38:06
URL: https://www.youtube.com/watch?v=NtQ-kdLlQiU

## KEYPOINTS

### 1. ADHD is defined by ordinary behaviors taken to a disruptive extreme
The diagnosis rests on 18 symptoms, nine inattentive (losing items, failing to follow through, distractibility) and nine hyperactive-impulsive (interrupting, blurting, fidgeting). Adults need at least five, present to an excessive degree, causing distress or dysfunction, and showing up in multiple areas of life. Psychiatrist John Kruse notes the old belief that children outgrow it is wrong; most do not, and symptom severity fluctuates across adulthood.

### 2. Strongly genetic, but highly sensitive to structure and demands
Heritability is around 0.8, comparable to height. Kruse frames ADHD as an executive-function problem affecting working memory, selective attention, emotional regulation and impulse control, so the brain relies more on outside structure. Structure is a Goldilocks issue: assembly-line work is too rigid. Working from home during COVID cut structure while raising demands, a perfect storm for symptoms.

### 3. Build the day around four essentials before any tasks
Kruse asks patients to schedule sleep, regular meals, exercise or movement, and relaxation time first, framing the scheduler as a nurturing 'mother hen' rather than a taskmaster. Forgetting to eat is common enough that a patient saying 'it was 4 p.m. and I hadn't eaten' is a clue to him, possibly reflecting weaker attention to internal body signals.

### 4. Sleep timing matters as much as sleep duration
People with ADHD lean toward night-owl chronotypes, partly through over-represented genetic markers and partly through procrastination. Kruse, who did his PhD on circadian rhythms, says a late schedule such as 2 a.m. to 10 a.m. is fine if it is consistent. Paradoxically, stimulant medication helps many patients regularize sleep, perhaps through a daytime anchor or an evening wind-down.

### 5. Most insomnia is an arousal system that will not switch off
Kruse cites sleep research suggesting that in at least 90% of insomnia the sleep system is intact; the daytime wake system fails to disengage. So the goal is to remove arousal: plan a bedtime, avoid late exercise that raises body temperature, keep the phone out of the bedroom entirely, and recruit a partner for agreed-upon reminders that do not feel like nagging.

### 6. Childhood stimulant treatment appears to lower addiction risk
Roughly 20% of Americans develop a substance problem; for people with ADHD the rate is almost double, near 40%, and higher in men. Several large meta-analyses, though not every study, find that treating children with stimulants largely normalizes that risk, perhaps by reducing impulsivity and helping them absorb information about drugs.

### 7. Amphetamines are the most effective medications; methylphenidate is closer to the rest
Amphetamine blocks dopamine and norepinephrine reuptake and also forces larger release from vesicles. Kruse argues methylphenidate (Ritalin) mainly blocks reuptake, like bupropion, and its efficacy sits nearer non-stimulants such as atomoxetine and guanfacine. Unlike antidepressants, ADHD drugs show a more linear dose-response relationship.

### 8. Amphetamine-induced psychosis is rare but serious
Kruse puts the risk near 1 in 500, likely dose-dependent. Unlike alcohol intoxication, the paranoid, schizophrenia-like state can persist for weeks or months after stopping, and about 20% of affected people remain psychotic 20 years later. In his San Francisco practice the rate exceeded 1 in 100, which he links to HIV and methamphetamine histories. With any personal or family history of psychosis, including a cannabis-triggered episode, he would not prescribe an amphetamine.

### 9. Cardiac risk is small for most people
Stimulants raise heart rate and blood pressure a few points on average, with roughly 80% showing no change. Sudden death is tied to rare inherited conduction problems, usually flagged by family history or fainting. A recent meta-analysis following people up to 14 years found a statistically significant rise in cardiovascular risk, mostly in the first three years, but the absolute risk stayed very low. Kruse favors careful histories over routine EKGs for everyone.

### 10. Non-stimulant options work differently
Guanfacine, an alpha-2 agonist originally for blood pressure, appears to strengthen prefrontal synaptic connections (work associated with Amy Arnsten's lab at Yale) and takes two to four weeks. It is sedating, so Kruse uses cheap immediate-release doses at bedtime; it causes less rebound hypertension than clonidine when doses are missed. Modafinil and armodafinil promote wakefulness with less agitation, though 10 to 15% of people feel revved up for the first few days.

## EXAMPLES

### 1. Nicotine and caffeine as self-medication
Kruse says nicotine improves some executive functions and, unusually, both alerts and calms; a few patients prefer gum to any medication, though clinical trials are lacking and smoking, vaping and chewing are harmful. Caffeine is a weak stimulant at typical doses, and dosing is unreliable: a University of Florida study found a threefold difference in caffeine content in the same Starbucks drink over three weeks. Caffeine plus L-theanine has limited supportive data.

### 2. Fish oil dosing
Evidence for omega-3s is most consistent for depression, where Kruse suggests about 1,000 mg of EPA daily, doubling if benefit seems incomplete; a mania trial used up to 7,000 mg. ADHD studies in children are mixed. Because the brain is rich in DHA, he prefers products near nature's 2:1 EPA-to-DHA ratio over EPA-only formulas. Huberman takes 1 to 2 g of EPA

daily.

### 3. Cyclic sighing at bedtime

Kruse counts about 20 to 25 slow cyclic sighs (roughly five minutes, long exhales) instead of using a timer, which could rouse him. It helped him fall and stay asleep after two decades of insomnia. Huberman reports nighttime waking to urinate dropped from nightly to about four times in 18 to 20 months.

### 4. Vyvanse's built-in slow release

Lisdexamfetamine links dexamphetamine to the amino acid lysine; red blood cells cleave it at a limited rate, so it enters and leaves smoothly and is inactive if snorted. Higher doses mostly extend duration rather than raise the peak. Immediate-release stimulants allow flexible timing but often bring an afternoon crash in energy and mood.

### 5. Lateness that does not feel like lateness

People with ADHD estimate elapsed time inconsistently in lab tests. One patient insisted she was never late, arriving at 9:15 or 9:20 for a 9:00 start, which shows why symptom checklists need context.

## OTHER RELEVANT

### 1. Use one consolidated task list, triaged A, B, C

ADHD-adapted CBT, developed independently by groups including Mary Solanto and Steven Safren with Russell Ramsay, centers on daily schedule blocks plus a single list. A items are urgent and important, B important but less urgent, C everything else, which resists the pull toward easy, crossable chores.

### 2. Lock away distractions

If willpower fails, use blocking apps, then physical lock boxes. Huberman keeps social media on a separate old phone. Brain-training games and neurofeedback lack convincing real-world evidence; FDA clearance of a device mainly shows it is safe.

### 3. Drug holidays mainly matter for growth

Stimulants reduce adult height by about 2 cm; breaks of several months, such as summers, appear to offset that. Kruse sees no evidence that weekend breaks reduce tolerance or addiction.

### 4. Morning bright light may help

One or two studies found early bright light improved ADHD symptoms even without depression, possibly by resynchronizing body clocks.

# How to Use Exercise to Improve Your Brain’s Health, Longevity & Performance

Date: 2025-01-06 · Duration: 1:49:32
URL: https://www.youtube.com/watch?v=J2oqi41dCNc

## KEYPOINTS

### 1. Most of exercise's immediate brain benefit comes from arousal
Huberman's central argument is that the short-term cognitive boost from exercise mostly comes from autonomic arousal: higher epinephrine, norepinephrine and cortisol. Growth factors like BDNF, IGF-1 and irisin matter more over the long term. Because the effect works through arousal, timing exercise relative to learning matters, and so does not overdoing it.

### 2. Arousal improves memory both before and after you learn something
Work from Larry Cahill's group and others shows that raising arousal after exposure to information, using the cold pressor test (arm in ice water for 1–3 minutes) or adrenaline injections, improves memory for the information and its details. Exercise produces similar arousal. Studies show benefits whether it's done before, during or after learning, so you can fit it to your schedule as long as the two are reasonably close in time.

### 3. One HIIT session sharpens executive function, but two can dull it
A high-intensity session before, or even during, cognitive-flexibility tasks like the Stroop test improves performance, likely through arousal plus increased cerebral blood flow. But after two hard sessions in a day (for example two rounds of 4×4 intervals), cognitive performance drops, and this tracks with reduced cerebral blood flow. Too much arousal leads to a trough that makes learning harder.

### 4. The brain can drive the adrenals directly through movement circuits
Peter Strick's lab at the University of Pittsburgh traced three networks of brain areas that connect to the adrenal medulla: cognitive, affective and, most strongly, the motor network. Motor regions controlling the trunk and core are especially well connected. That's one reason Huberman favors compound movements like squats, deadlifts, rows and pull-ups for energy and focus. The slower hypothalamus–pituitary pathway still operates alongside this.

### 5. Loaded bones release osteocalcin, which supports the hippocampus
Studies, first in mice at Columbia and later in humans, show that bones under mechanical stress release osteocalcin. It crosses the blood–brain barrier and promotes neuron growth and connections in the hippocampus, possibly (Huberman stresses 'perhaps') including new neurons in the dentate gyrus. Many of exercise's BDNF effects appear to depend on osteocalcin. No one has systematically worked out which exercises release the most, so impact and jumping are a reasonable inference rather than a proven protocol.

### 6. Lactate is brain fuel and helps protect the blood–brain barrier
During intense exercise, neurons prefer lactate as fuel, which spares glucose for cognitive work afterward. Lactate also acts on the hypothalamus to suppress appetite after hard efforts. It also triggers VEGF, which strengthens the blood–brain barrier. Huberman points out that this barrier breaks down with age and especially in Alzheimer's disease.

### 7. Exercising after one bad night of sleep is fine, but don't make it a habit
After a single night with about two hours less sleep than usual, exercise can offset some of the cognitive effects. Keep the intensity moderate to avoid suppressing the immune system, and be careful with complex movements, since sleep deprivation is strongly linked to injury, pain and slower recovery. Using exercise regularly to make up for lost sleep is a mistake.

### 8. Doing hard things you don't want to do may keep the brain young
The anterior mid-cingulate cortex lights up when we push through physical or mental challenges. Stimulating it, as in work by Josef Parvizi at Stanford, makes patients feel an impending challenge they're ready to meet. In 'SuperAgers,' people whose cognition stays sharp into their 80s and 90s, this area holds its volume or even grows. Huberman's inference is to do something safe but unwanted at least once a week.

## EXAMPLES

### 1. Six-second sprints
In one study, six all-out 6-second sprints on a stationary bike, each followed by one minute of rest, significantly improved cognitive performance in healthy young adults. Huberman says he'd bet 'six of my 10 fingers' that the effect comes from arousal, since growth factors can't act that fast. The same logic helps explain why exercise snacks like 20 air squats or jumping jacks can help.

### 2. Single-leg extensions in older adults
Many brain studies use a seated single-leg extension because untrained people over 65 can do it safely with little instruction. The papers Huberman cites include 'A single bout of resistance exercise can enhance episodic memory performance' and 'Executive function after exhaustive exercise.'

### 3. Huberman's short HIIT session
When he's short on time, Huberman warms up on an Assault/AirDyne bike for 1–2 minutes, then alternates one minute all-out with 30 seconds of rest for about eight rounds. He notes that Andy Galpin sees the 4×4, 3×3 and 6×6 variants as roughly interchangeable, and that 6×6 is too much for many people.

### 4. Cold exposure as his 'unwanted' challenge
Huberman is heat-adapted and 'close to hates' the cold, so getting into a cold plunge or cold shower for 1–3 minutes is his weekly anterior mid-cingulate workout. He's more interested in that resistance than in the cold itself, and he mentions experimenting with rope flow as a new skill.

## OTHER RELEVANT

### 1. Build four elements into your week

Huberman's list: (1) one long slow distance session of 45–75 minutes in zone 2, using any activity you can do without injury, such as jogging, rowing, cycling or rucking; (2) at least one HIIT session; (3) time under tension, meaning an explosive lift followed by a lowering phase at least twice as slow, without setting the weight down; (4) explosive jumps with controlled landings.

### 2. Add a fifth: something hard you'd rather skip

Choose a safe physical or mental challenge you dislike and do it weekly. Huberman suggests the reluctance itself is the stimulus.

### 3. Bring in jumping and landings gradually

Try jump rope with high knees or double-unders, or box jumps starting low, on mats, grass or dirt. New eccentric work causes a lot of soreness and can lead to injury, so build up slowly. Peter Attia's point about falls, fractures and mortality makes controlled landings useful at any age.

### 4. Use the Foundational Fitness template if you want a structure

Huberman's free plan has about three cardio sessions (roughly 12–60 minutes) and three resistance sessions (45–75 minutes) a week, none longer than about an hour. Adapt it if you already have a program that works.

# How to Improve at Learning Using Neuroscience & AI | Dr. Terry Sejnowski

Guest: Dr. Terry Sejnowski
Date: 2024-11-18 · Duration: 2:34:11
URL: https://www.youtube.com/watch?v=etbfLTHD_VU

## KEYPOINTS

### 1. The brain learns actions by predicting the next reward
Sejnowski, a computational neuroscientist and PhD physicist, says the algorithm the brain uses to learn sequences of actions toward a goal was worked out theoretically in the 1990s and later confirmed with neuron recordings and human imaging. You predict the reward an action will bring, compare it with what you actually get, and use the difference to adjust synapses. Over a lifetime this builds a 'value function' of what is good or bad for you, such as knowing what to order at a restaurant.

### 2. The same algorithm powered AlphaGo
In AI this is reinforcement learning, the approach DeepMind used to beat the world Go champion. Sejnowski notes Go is to chess what chess is to checkers in difficulty, because many battles unfold across the board at once.

### 3. Basal ganglia loops run both movement and thinking
The basal ganglia form loops with the motor cortex for actions and with the prefrontal cortex for thinking. The prefrontal loop is among the last to mature, in early adulthood. Sejnowski says adolescents' 'no-go' circuitry often doesn't yet kick in to stop actions that aren't in their interest.

### 4. Procedural learning beats book learning for fast, expert skills
Cognitive learning is step-by-step and inefficient; procedural learning becomes automatic. You can't learn tennis from a book. As a physicist, Sejnowski says solving problem sets, not memorizing equations, made him competent. Huberman adds that knowing the mechanism behind a protocol and then practicing it reinforces both.

### 5. Sleep spindles move the day's learning into long-term memory
Recording from epilepsy patients who spend about two weeks in hospital with brain electrodes, Sejnowski's team found spindles (bursts of 1–2 seconds in non-REM transitional stages) traveling in circles around the cortex. Spindles help consolidate the hippocampus's replay of daytime experience into cortical storage. Getting enough sleep is the first lever, and the two discuss research linking daytime exercise to more spindles.

### 6. Every brain hack has a cost
The Ambien finding (below) shows you 'don't get anything for free.' Huberman extends the point: low-dose testosterone therapy can bring vigor but is like a second puberty, and puberty is one of the fastest phases of aging. Growth hormone can likewise give vigor while visibly aging skin. He says he is neither for nor against them; responses are highly individual.

### 7. Aging thins connections but preserves old memories
Infants overproduce synapses and then prune them because synapses are energetically expensive. Pruning slows but continues with age, so the cortex thins. Memories laid down young remain 'rock solid' and form the foundation for later learning, and adults can still learn, if less quickly.

### 8. Mitochondria explain falling vigor, and exercise restores it
With age, mitochondria become fewer and less efficient, so learning costs more energy. Some prescription drugs can also harm mitochondria. Sejnowski calls exercise 'the best drug you could ever take' because it benefits every organ, including the brain. He runs on the beach below the Salk Institute daily and climbs back up the roughly 340-foot cliff.

### 9. Ketamine reveals a glutamate side of schizophrenia
Ketamine blocks NMDA glutamate receptors and reduces inhibitory interneuron signaling, raising cortical excitation. People who use it at parties two days in a row can arrive at emergency rooms in full psychosis, with auditory hallucinations and paranoia indistinguishable from a schizophrenic break, which resolves after a couple of days of isolation. Sejnowski believes large language models could have flagged this connection 20 years earlier.

### 10. Parkinson's alters the sense of speed
Dopamine neurons, which carry the reward-prediction signal for procedural learning, are vulnerable to toxins such as pesticides. When the first L-DOPA trials began, people who had been 'locked in' started talking again. Parkinson's patients who move slowly feel they are moving fast, yet they can move at normal speed if asked, suggesting the brain's internal set point for speed has shifted.

## EXAMPLES

### 1. Ambien doubled spindles and next-day recall
In Sara Mednick's experiment, people learned material at night and then took zolpidem (Ambien). Sleep spindles doubled, they remembered about twice as much the next morning, and the memories stayed stable. The catch: the drug strengthens memories formed before the dose but can erase those formed after it, so some people wake in a hotel room with no memory of getting there.

### 2. The 'Learning How to Learn' course
Built with Barbara Oakley, the free online course has about 50–60 videos of roughly 10 minutes each over a month, with quizzes and forums. It was aimed at high school and college students, but enrollment peaks at ages 25–35. These are working adults, half of them college graduates, who need new skills but can't return to school.

### 3. Education and Alzheimer's onset in China
A study Sejnowski heard about from the head of an Alzheimer's program compared peasants with almost no education, high

school graduates and highly educated people. Alzheimer's onset came earliest in the least educated and latest in the most educated. He suggests mental exercise builds reserve, while acknowledging no one knows the cause.

### 4. Huberman's 'cognitive velocity' drill

Huberman reads just slightly faster than his reflexive pace while still trying to retain the content. He feels the energetic demand and backs off and pushes forward to find the sweet spot.

### 5. Ideas on the run, captured by voice memo

Sejnowski gets his best ideas walking or jogging with no music or podcasts, and used to forget them by the time he reached his office. Now he records voice memos. Psychologists call this mind wandering, and it is linked to 'aha' moments.

## OTHER RELEVANT

### 1. Practice, don't just read

For any skill that must run fast and accurately, drill it the way you would clearing a scuba mask in a pool or working through problem sets.

### 2. Protect sleep after learning

Spindles do the consolidation, so cutting sleep after a day of learning undercuts it. Avoid relying on sleep drugs for this purpose given the amnesia trade-off.

### 3. Exercise daily to bank energy reserves

Sejnowski frames exercise as storing reserves for later life, and pairs it with lifelong learning.

### 4. When stuck, step away

Learning How to Learn teaches students to stop beating their heads against a problem and take a walk or do the dishes. They often see the answer when they come back. Build input-free time into your day rather than filling every gap with your phone.

# How to Improve Memory & Focus Using Science Protocols | Dr. Charan Ranganath

Guest: Dr. Charan Ranganath
Date: 2024-09-30 · Duration: 2:39:08
URL: https://www.youtube.com/watch?v=jC8Pu9HBd48

## KEYPOINTS

### 1. Memory is for navigating the present and predicting what comes next
Ranganath, a memory researcher at UC Davis, argues that we never perceive the present raw. The brain builds a predictive model from semantic memory (knowledge) and episodic memory (events), which tells it what to ignore and what is surprising. That is why about 40% of viewers miss the gorilla walking through the basketball video. It is also why waking in an unfamiliar dark room, or with jet lag, can briefly leave you lost: you have to actively retrieve how you got there.

### 2. Curiosity creates a state that boosts memory for unrelated information
In his trivia study, the more curious people rated themselves (on a 1–6 scale), the more activity appeared in dopamine-rich midbrain and nucleus accumbens regions. That activity was driven by the question, not the answer. Faces shown during curious states were remembered better even though they had nothing to do with the trivia. Ranganath cautions that fMRI measures metabolic activity, not dopamine directly.

### 3. The prefrontal cortex 'biases the competition' toward what matters to your goals
The prefrontal cortex makes up about a third of the primate brain and provides cognitive control. Patients with prefrontal damage can repeat digit strings and learn the Wisconsin Card Sorting rules, but they fail once distractions appear, because the environment rather than their goals steers attention. Prefrontal signals keep goal-relevant neurons active even when something shinier competes.

### 4. Age-related memory decline is largely about white matter and control, and much of it is preventable
Hypertension and diabetes damage white matter, the long-range wiring connecting the prefrontal cortex to the rest of the brain. With weaker control, irrelevant details get remembered at the expense of important ones. Ranganath frames this as one of the most preventable aspects of cognitive aging.

### 5. Healthy lifestyle factors roughly doubled memory performance over a decade
Ranganath cites a study of 29,000 people in China followed for 10 years, which tracked factors such as exercise, cognitive and social engagement, a healthy diet, not smoking and limited alcohol. Everyone started out similar. After ten years, those with four to six healthy factors scored almost twice as high on memory tests as those with zero or one.

### 6. Attention can be captured by anything; intention decides what you keep
Ranganath distinguishes attention, which anything salient can grab, from intention, the deliberate sense of what you want to take away from an experience. Many everyday memory 'failures' are really failures of intention at the time of encoding.

### 7. Multitasking fragments memories and drains cognitive control
Switching between tasks saps executive control, creates fragmented memories and raises stress. Even an unacted urge to check your phone costs some control. Ranganath says the people who think they are great multitaskers are not.

### 8. Recalling a memory changes it
Each time you retrieve a memory it becomes more accessible but also more abstract and story-like, and less immersive. Traumatic memories are hard to update because intense neuromodulator release during the event locks them in, and retrieval can retraumatize. Ranganath suggests a strong prediction error, or therapies that open a window of plasticity, may help reframing.

### 9. Déjà vu is familiarity without recollection
Familiarity is processed in the perirhinal cortex, separate from recollection of the actual episode. Anne Cleary's virtual reality studies created rooms that shared the exact spatial layout of earlier rooms but had a different 'skin', such as a museum versus an arcade. These reliably triggered déjà vu: enough overlap to feel familiar, with a mismatch that blocks recollection.

## EXAMPLES

### 1. Rebecca Burwell's stimulation experiment
By stimulating the perirhinal cortex of rats at beta versus gamma frequencies, Burwell could make novel objects seem familiar and familiar objects seem novel. This changed how long the animals explored them.

### 2. Hearing, vision and teeth as memory protectors
Ranganath says effect sizes for treating hearing loss are strong for reducing dementia risk. He notes a Lancet public-health recommendation to screen hearing and encourage hearing aids, and says treating cataracts matters too. Gum disease is linked to Alzheimer's risk, possibly via inflammation; Huberman mentions cavity bacteria entering the bloodstream. Ranganath had custom earplugs made for playing in his loud band.

### 3. Ranganath's ADHD and values work
He describes his own ADHD and an ADHD coach who had him write down and rank his values. Before a dreaded meeting or admin task, he now asks 'why am I doing this?' and links it to a value. He calls this game-changing, though it takes conscious effort.

### 4. Concert photos versus the experience
Filming a whole show can leave you remembering the act of filming rather than the friends and feelings. Ranganath took a few deliberate pictures when he finally saw the Descendents. Revisiting such photos later and recalling the emotions around

them strengthens access to the memory.

### 5. Huberman's separate social-media phone

Huberman keeps social media only on an old phone stored in a box, with a daily timer that he keeps shortening, and says the productivity gains have been enormous. Ranganath calls it engineering your environment to regain control.

## OTHER RELEVANT

### 1. Cover the health basics first

Sleep, exercise, a sensible omnivorous diet, social and cognitive engagement, no smoking and limited alcohol carry the strongest evidence. Controlling blood pressure and blood sugar also protects white matter.

### 2. Protect your senses and gums

Get hearing checked and use hearing aids if needed, wear earplugs around loud music, treat cataracts, and keep up oral hygiene.

### 3. Do one thing at a time and remove the cues

Silence alerts, separate distracting apps from your working devices, and protect blocks of single-task focus.

### 4. Use curiosity on purpose

Before learning something, generate questions you really want answered. The curious state primes memory for what follows.

### 5. Take fewer, more intentional photos and revisit them

Decide what you want to remember, capture a few images, and later spend a few minutes recalling the emotional context.

# Optimal Protocols for Studying & Learning

Date: 2024-08-26 · Duration: 1:41:39
URL: https://www.youtube.com/watch?v=ddq8JIMhz7c

## KEYPOINTS

### 1. Learning is mostly a matter of offsetting forgetting
Huberman's central frame: we forget most of what we encounter each day, which is a good thing. People with rare clinical conditions in which they remember everything struggle in work and relationships. Studying well means deliberately guarding chosen information against that natural forgetting. The research doesn't support doing it by matching your 'learning style'. What works is engaging the memory systems that offset forgetting.

### 2. Plasticity works by rewiring existing connections
New neurons are added in the hippocampus's dentate gyrus, but that isn't the main route to adult learning. Learning comes from strengthening, weakening or forming connections between existing neurons. Weakening isn't necessarily forgetting. Brain development from infancy to adolescence is largely the removal of connections, while the remaining ones become more robust. That's why a toddler eating spaghetti is clumsier than a teenager.

### 3. Strain during learning is the signal to change
The agitation you feel forcing focus reflects release of epinephrine (adrenaline) and other neuromodulators that flag circuits to change later. Hydration, enough caffeine to be alert but not jittery, and, for diagnosed ADHD, a conversation with a doctor about medication can all help. Huberman also cites Wendy Suzuki's NYU work: 5–10 minutes a day of mindfulness meditation, returning attention to the breath, improves focus and memory. Missing a day doesn't matter.

### 4. The rewiring happens during sleep and NSDR
Connections are actually reordered during deep sleep and sleep-like states, not while you're studying. Because of the 'first-night effect', most of what you learn that day is consolidated the following night. A poor night doesn't erase it, but late caffeine and all-nighters work against learning. Huberman recommends 10–20 minutes of non-sleep deep rest (NSDR, related to yoga nidra) at any time of day, and adds that more data on it are emerging.

### 5. What top students do
In a self-report study of nearly 700 medical students, the best performers scheduled study time, put their phones away, told friends and family they'd be unreachable, studied alone, studied 3–4 hours a day in two or three sessions at least five days a week, and taught peers. Huberman flags that the data are correlational. The top students also held a broad, aspirational sense of how their studies would change their lives and families.

### 6. Testing is a learning tool, not just evaluation
Research on this goes back more than 100 years. In a 1917 study, schoolchildren who read a biography once and then repeatedly recalled it in their heads 'vastly outperformed' children who reread it the same number of times, in both the amount and the accuracy of what they recalled. Even scoring 40–50% on a test right after studying beats rereading, as long as you then learn the correct answers.

### 7. Rereading creates false confidence
Students exposed to material four times predict they'll do best. Those who studied once and were tested three times feel less confident, but they perform far better. Huberman calls this the difference between familiarity (recognizing something) and recollection (bringing it to mind and using it). He cites a review in the journal Hippocampus.

### 8. Timing matters: test soon after first exposure
Comparing three schedules, the best results came from studying, testing the same day or next day, then a long delay before the final exam. Spacing tests evenly was in the middle. Waiting until just before the exam to test was worst. So spend a few seconds or minutes recalling the material as you leave class, before reaching for your phone.

### 9. Use open-ended questions
Short-answer or long-answer questions with minimal prompts force recollection. Standard multiple choice can be answered on familiarity, except for 'trick' formats like the GRE, LSAT or MCAT, where distractors demand mastery. Announcing that there will be frequent quizzes beats pop quizzes, which students resent.

### 10. Emotion strengthens memory
Epinephrine and norepinephrine can produce one-trial learning, as with witnessing a car accident, and also underlie PTSD, which is treated with exposure therapy, EMDR or medication. Excitement or story in material helps it stick. With a monotone source, you have to generate that intensity yourself. Caffeine raises epinephrine modestly and 'probably' helps a little.

## EXAMPLES

### 1. Learning neuroanatomy
Huberman studied by mentally tracing pathways through the brain until he hit the point where he didn't know what came next, then looking it up. Guessing 'fimbria' and being wrong is why he'll never forget the habenula, now known to be involved in disappointment and depression.

### 2. Gap effects
Pausing for 5–30 seconds during learning lets hippocampal neurons replay new information about 20–30 times faster than normal, as they do in REM sleep. Huberman does this in the episode itself, along with quizzing listeners on the three mechanisms of plasticity.

### 3. A medieval cold-water practice
In a review by memory researcher James McGaugh, people were described being thrown into cold water after learning

something, to release adrenaline and consolidate the memory. Huberman says a cold shower while mentally reviewing material is an option, using safe practice.

### 4. Interleaving

Related but non-central anecdotes, like Huberman's bulldog or the Olympics, act as breaks and seem to enhance learning compared with an uninterrupted fire hose of material.

### 5. Watch one, do one, teach one

This saying from Huberman's training labs fits the finding that top students teach their peers. Teaching is itself a test of mastery.

## OTHER RELEVANT

### 1. From skill to virtuosity

Huberman distinguishes being unskilled, skilled, having mastery (full depth used flexibly) and virtuosity, where great musicians and athletes deliberately invite uncertainty into what they've mastered.

### 2. Treat errors as useful

Getting answers wrong, then learning the correct ones, signals the nervous system that it needs to learn the material.

### 3. A simple routine

Schedule focused blocks without your phone, self-test right afterwards, protect that night's sleep, and add NSDR.

# How to Optimize Cognitive Function & Brain Health | Dr. Mark D'Esposito

Guest: Dr. Mark D'Esposito
Date: 2024-02-19 · Duration: 2:32:37
URL: https://www.youtube.com/watch?v=HYVeP4F0GNU

## KEYPOINTS

### 1. The prefrontal cortex is the brain's CEO, and it's the first system to falter
D'Esposito, a neurologist, defines executive function or 'cognitive control' as the ability to plan, organize and turn goals into actions rather than being ruled by automatic behavior. The frontal lobe has perhaps 25 subregions, with the lateral portion central to executive function. Sleep deprivation, stress and normal aging hit this system first, which is why everything feels harder on a bad day. He notes that insurers' age-25 cutoff roughly tracks when frontal lobes finish maturing.

### 2. Working memory is active manipulation, not passive storage
Working memory is holding information in mind while doing something with it, like a math problem or planning a sentence, and it's the foundation of executive function. Neurons in the frontal lobes keep firing persistently while information is held. D'Esposito explains that dopamine acts as a modulator that keeps this persistent activity stable. Deplete dopamine and working memory drops significantly, and replace it and performance recovers.

### 3. Dopamine and working memory follow an inverted U
In D'Esposito's studies, people with a low working-memory span (holding about five or six letters) improved on bromocriptine, a dopamine agonist, while people with a high span got worse. PET scans showed span correlates strongly with frontal dopamine, so a simple span task can serve as a rough behavioral proxy for baseline dopamine. 'More is just not better,' he says. The goal is to bring people to their optimal level.

### 4. Genetics sets your dopamine baseline
The enzyme COMT breaks down dopamine in the prefrontal cortex. D'Esposito estimates that in roughly 25% of people it's overactive and in another 25% underactive, though this varies by ancestry, so about half the population sits off-center. Knowing your COMT status and span may eventually help predict who benefits from boosting dopamine and who would be harmed.

### 5. Healthy volunteers can't tell when bromocriptine is helping
Bromocriptine is short-acting (about four to six hours) and kicks in roughly 90 minutes after dosing. D'Esposito says healthy subjects on low doses can't distinguish it from placebo and don't feel 'buzzed.' They only learn their working memory improved when shown the data, and the gains reflect better performance, not just speed. He's disappointed that drug companies, focused on disease markets, never took up cognitive optimization with these already-approved drugs. Huberman stresses he is not encouraging anyone to take it.

### 6. Norepinephrine is another lever, and combinations may matter
Anything that boosts norepinephrine seems to help executive function. Guanfacine, a blood-pressure drug, is the most used, and D'Esposito says a study found it improved COVID brain fog, with trials now under way. Neuromodulators interact: in one example, low doses of two drugs were effective together when neither worked alone. On stimulants like Adderall, Vyvanse and Ritalin, he says decisions belong with a psychiatrist, and he cites the 1980s Wall Street cocaine culture as proof that 'more is better' fails.

### 7. Concussion recovery: protect sleep, move as tolerated, retrain skills
Almost every concussion patient reports poor sleep, which compounds deficits, and a large share still feel mentally foggy, light-sensitive or dizzy a year out. Advice has shifted from dark-room rest to activity as tolerated without worsening headache or light sensitivity. Patients who feel fine after a couple of weeks off often find their first day back at work a disaster, so D'Esposito favors a graded return. Goal management training helps but isn't covered by insurance, so '99%' of his patients get no intervention. He points to online training like BrainHQ as a scalable option.

### 8. Estrogen modulates frontal dopamine
The frontal lobes may hold more estrogen receptors than any other brain region, and estrogen boosts dopamine. In a study by a colleague, Berkeley undergraduates were tested at low- and high-estrogen points of the menstrual cycle and genotyped for COMT. Frontal function and working memory dipped at low estrogen, especially in those with low baseline dopamine. This fits anecdotal reports of working-memory gains in postmenopausal women on estrogen.

### 9. Aerobic exercise and mindfulness train executive function directly
Arthur Kramer's group at the University of Illinois found aerobic exercise as effective as cognitive therapy for improving executive function. D'Esposito frames mindfulness (focusing on the breath, noticing when focus drifts and returning) as focus training, since losing focus is 'half the problem' with not reaching goals. In his studies, the specific style didn't seem to matter.

## EXAMPLES

### 1. Bromocriptine before the Olympics
D'Esposito says sprinters once took bromocriptine before the Olympics, when it wasn't on the banned list, because faster reaction times worth hundreds of milliseconds can decide the podium. He thinks it's banned now.

### 2. Nicotine and Alzheimer's
Asked about nicotine as a neuroprotectant, D'Esposito knows of no evidence that it prevents neurodegeneration. It was used in early Alzheimer's studies because of its effect on the cholinergic system, which is impaired in the disease. Families of patients on cholinesterase inhibitors sometimes report better memory, but the disease course isn't slowed. Huberman adds that nicotine raises blood pressure and that smoking, vaping and dipping are harmful.

### 3. No checkup measures your brain

D'Esposito notes that routine physicals check blood, heart and skin but never cognition, because the field hasn't given doctors a simple brain-health test. He hopes brain fitness will 'take off the way physical fitness did.'

### 4. Smartphones versus working memory

Both agree the modern world, with its texts interrupting conversations and constant notifications, is built to disrupt frontal-lobe working memory. They say it needs deliberate training, the way muscles and cardiovascular fitness atrophy without exercise.

## OTHER RELEVANT

### 1. Protect the basics first

Sleep, stress management, nutrition and aerobic exercise are the core tools D'Esposito and his neurology colleagues now use to optimize the frontal lobes, a conversation he says wouldn't have happened 30 years ago.

### 2. Train working memory with demanding activities

Games and skills that require holding information in mind, like chess (which Huberman resolves to learn) or a new skill learned step by step, exercise the same circuits.

### 3. Treat cognitive drugs as optimization, under supervision

Because of the inverted U, a drug that helps a low-baseline person can impair a high-baseline one. Stimulant and off-label use decisions belong with a psychiatrist or physician.

### 4. After a concussion, ramp up gradually

Fix sleep, stay as active as symptoms allow, and rebuild work and cognitive demands step by step rather than returning at full speed.

# Tools to Enhance Working Memory & Attention

Date: 2024-01-29 · Duration: 1:31:12
URL: https://www.youtube.com/watch?v=CQlTmOFM4Qs

## KEYPOINTS

### 1. Working memory is built to discard information, not store it
Short- and long-term memory depend on neuroplasticity: long-term potentiation, long-term depression and, in some cases, neurogenesis. Working memory, as far as anyone knows, does not. It is a circuit running the same algorithm over and over to hold information just long enough to sequence actions, then drop it. Huberman's example is a morning routine: water, coffee, shoes, then deciding your running route.

### 2. Almost every daily task depends on working memory
From waking to sleep, sequencing cognitive and motor steps requires it. People with diminished or (rarely) absent working memory struggle badly to order everyday activities. Deficits in working memory and attention are also hallmarks of frontal traumatic brain injury, Parkinson's, some dementias and ADHD.

### 3. Dopamine sent to the prefrontal cortex sets your working-memory span
Brainstem dopamine neurons project to the prefrontal cortex (the mesocortical pathway). How much dopamine is released there per unit of time strongly predicts whether capacity is low, medium or high. In imaging studies, short spans correlate with less dopamine available for release and longer spans with more.

### 4. Dopamine and working memory follow an inverted U
In bromocriptine studies from Mark D'Esposito's lab at UC Berkeley, low-span people improved substantially after taking the drug, often going from 0–3 remembered words to 4 or even 6. High-span people gained little at low or moderate doses, and at the highest dose their performance dropped to low-span levels even though dopamine availability had risen. More dopamine helps only up to a point.

### 5. Working memory has two separable parts: switching tasks and ignoring distractors
Task and context switching relies largely on dopamine to the basal ganglia, the brain's 'go/no-go' circuitry. Filtering out distractors relies mainly on dopamine to the prefrontal cortex. Studies that selectively boost one pathway improve one ability without the other, so protocols differ in which aspect they help.

### 6. Your baseline score determines whether boosting dopamine is a good idea
Because of the inverted U, Huberman says people with already-high spans probably should not stack dopamine-raising protocols right before working-memory-heavy tasks. Those protocols can still be useful at other times. People with low or moderate spans are the ones most likely to benefit.

### 7. NSDR and yoga nidra can raise baseline dopamine substantially
Yoga nidra ('yoga sleep') is lying down with a script that guides long exhales and muscle relaxation; NSDR is Huberman's term for the version without intentions or mystical language. In one study, baseline dopamine in the basal ganglia was up to 60% higher after an hour-plus session compared with a control protocol. He notes it is a single study and that shorter sessions were not tested.

### 8. Deliberate cold exposure produces long-lasting catecholamine increases
In a study where people sat neck-deep in water in the low 60s °F for 45 minutes or more, epinephrine, norepinephrine and dopamine rose significantly and stayed up for hours. Colder water for a shorter time, such as about 30 seconds at 45 °F, may give a comparably large rise. He prefers these slow-tapering increases to the sharp spikes from video games, sex or chocolate.

### 9. Binaural beats give small-to-moderate working-memory gains
With headphones, each ear hears a different frequency and the difference (for example 40 Hz or 15 Hz) entrains certain circuits. A 2019 study of 24 people aged 19–31 found modest but significant working-memory improvements with 40 Hz beats. A 2016 study using 15 Hz beats linked changes in cortical connectivity to better visuospatial working memory. Whether this works through dopamine is unknown.

## EXAMPLES

### 1. The six-sentence span test
Listeners hear six sentences (for example 'some reptiles eat only once a year') and then recall the last word of each: costs/up, summer, cars, year, life, country. Recalling 3–4 is average; 4–6 counts as high span and fewer than three as low span. Getting all six is very rare.

### 2. Letter-string warm-up
Before the sentence test, he reads strings of 5–7 letters (J K Z P I; R O M K L E; W A C Q V D N), repeating each one to make it easier than a lab version. Attention split with driving or chores lowers scores.

### 3. Tyrosine in a multitasking environment (Thomas et al., 1999)
Participants took 150 mg/kg of crystalline L-tyrosine mixed into applesauce, versus placebo, and showed statistically significant but not large working-memory gains while multitasking. For Huberman at about 100 kg, that would be 15 g. He feels a clear lift from 500–1,500 mg and will not recommend the study dose.

### 4. Bromocriptine timing
The dopamine agonist peaks in about 90 minutes, which is when testing was done. It is sometimes prescribed off-label by neurologists for TBI, Parkinson's-related or ADHD-related working-memory deficits, but it is not a standard treatment for those conditions.

## OTHER RELEVANT

### 1. Test yourself first, then pick tools

Use the sentence test to estimate your span. Low or moderate scorers can try NSDR or yoga nidra (free scripts, including 10-minute versions and ones by Kelly Boys running from about 8 to 45 minutes), or a cold shower 30–60 minutes before focused work. The cold-shower timing is his mechanistic guess; it has not been tested directly.

### 2. Cold-water safety

Most people use 30 seconds to 3 minutes in a shower, plunge or other body of water. He insists you never combine hyperventilation or breath holds with cold water, because you can pass out and die.

### 3. Supplements: talk to a provider and start with a minimal dose

For L-tyrosine he suggests trying about 250 mg at 50 kg or 500 mg at 75–100 kg, and watching for a crash 3–4 hours later. Mucuna pruriens is essentially L-dopa (about 99%) and potent; studies use 1–5 g, but he suggests starting at 250–500 mg and only with a doctor's approval.

### 4. Prescription stimulants have a place

He believes Adderall and Ritalin (which differ in their dopamine-to-norepinephrine ratio), and modafinil in some cases, are probably over-prescribed but genuinely help some children and adults, partly by enabling plasticity in attention circuits. Behavioral and nutritional tools may allow some people to lower their doses, but any change should be made with a physician.

# AMA #11: Improve Task Switching & Productivity and Reduce Brain Fog

Date: 2023-09-29 · Duration: 0:34:36
URL: https://www.youtube.com/watch?v=7Ey_vTTgJGc

## KEYPOINTS

### 1. Task switching is distinct from cognitive flexibility
Huberman explains that the prefrontal cortex, really a collection of subregions, lets us apply context-specific rules. A high-school student, for example, follows different rules in math class than in history, and different teachers allow different behavior. Cognitive flexibility is the ability to change the kind of mental operation you're running. Task switching depends on that flexibility but is a narrower skill: stopping one activity and fully engaging in another.

### 2. How labs study task switching
In typical experiments, people perform one mental task, such as counting up in sevens or in alternating steps of seven plus one and seven minus one. At a tone or a fixed interval, perhaps every 10 minutes, they must switch to a different cognitive task. Other studies switch between manual tasks, such as fitting puzzle pieces. Fewer studies look at switching between physical and mental tasks.

### 3. Expect 5–10 minutes before focus arrives
Unless material grips you, such as a text you're eagerly awaiting or directions to find a friend in a busy city, the circuits needed to understand and remember a book chapter, spreadsheet or tax form take about 5–10 minutes to reach the activity level you experience as focus. Huberman says many people wrongly blame themselves for poor attention because they expect instant immersion. He adds that he can't rule out clinical ADHD for anyone.

### 4. Switching is push-pull: some circuits ramp up while others quiet down
Moving to task B requires engaging new neural circuits and disengaging or letting fade the ones that served task A. He compares this to dimming the lights in one room while brightening another. The same applies to physical work: no one expects peak lifting or cycling performance without a warm-up, or while still replaying the conversation they had on the way in.

### 5. Insert a deliberate transition period, even 15 seconds
Huberman describes findings that even a short, arbitrary transition, one you consciously label as transition, leads to more complete and efficient engagement in the next task than switching straight across. He calls this a top-down effect: knowing why the gap helps lets you use it, with no drug or supplement needed.

### 6. Scale the gap to how deep you were
After light work, such as email, a routine meeting or chatting with a coworker, a minute or two is enough. After deep immersion, give yourself 5–10 minutes if you can. If time is short, any designated transition helps, even 60–90 seconds, or just a 10-second count from 10 down to 1.

### 7. Bring in no new information during the gap
The key ingredient is the absence of new input. Checking your phone, texting, social media or any other 'foraging' is itself a task: images, videos and new ideas anchor attention and will intrude on task B. His advice is to avoid turning A-to-B into A-to-C-to-B. He isn't anti-smartphone. He uses his phone often between bouts of focus, just not in these windows.

### 8. Visual focus and time perception are linked
Where you place your visual attention changes how finely your brain slices time. Attending to your body or nearby space resembles high-frame-rate, slow-motion video (fine slicing), while gazing at the horizon slices time more coarsely. Different tasks, like a Zoom meeting versus lifting weights or reading, also run in different time domains, so switching tasks partly means switching time scales.

### 9. A daily perceptual drill to train switching
Huberman does a 2–3 minute 'space-time bridging' practice most mornings. He frames it as a visual perceptual exercise, not meditation. Moving attention through near-to-far 'stations' trains the brain to shift visual focus and time perception, and makes you aware of how transitions feel. He thinks even once or three times a week helps.

## EXAMPLES

### 1. How to do the drill
Eyes closed, attend to body sensations or breathing for about 5–15 seconds. Eyes open, focus on your hand for 5–15 seconds. Then look about 10 feet away, then about 50 feet away, then as far toward the horizon as possible, holding each spot for 5–15 seconds while keeping some awareness of your breathing. Finish by closing your eyes and returning to your immediate surroundings. A view from a balcony or outdoors is ideal, and the distances needn't be precise.

### 2. Chess boxing as extreme switching
In this real sport, opponents alternate rounds of chess with boxing rounds of roughly one to three minutes. Huberman cites it as task switching at its most extreme and explicitly does not recommend it.

### 3. Huberman's own struggle
He drops into deep focus easily but struggles to leave it, which is why he sometimes runs late. As a new assistant professor writing grants, he'd get two lines down before a knock at the door about syringes or buffers pulled him away.

### 4. The three-things list
While he was a master's student at Berkeley, a professor told him he wrote down no more than three critical tasks each day. Routine activities like cycling to campus, running or the gym didn't count. Huberman still lists one to three demanding tasks per day, and leaves the rest of his day to automatic routines.

## OTHER RELEVANT

### 1. Don't do the drill while driving

He considers space-time bridging very safe and free, but says not to do it while driving or operating machinery.

### 2. Tune out lab or office distractions

From years in busy labs, he says getting good at your craft includes learning not to join the crowd around a screen (say, a World Cup score) when you're moving between focused tasks. He still encourages socializing, such as chatting in the hallway after a meeting.

### 3. Coverage note

The freely available portion of this AMA addresses only task switching. The brain-fog and productivity topics in the title are covered in the members-only remainder.

# How to Use Music to Boost Motivation, Mood & Improve Learning | Huberman Lab Podcast

Date: 2023-09-18 · Duration: 1:44:25
URL: https://www.youtube.com/watch?v=gveDhZW-rUk

## KEYPOINTS

### 1. Music both conveys and evokes emotion, and it also signals intent
Low-frequency drumming whose cadence speeds up as it approaches reads as aggression or 'war drums,' whereas other tone patterns signal something entirely different. Unlike words, music carries that intent through the listener's body. It recruits premotor circuits, the neurons that fire just before an action, which is why music so often makes you feel you need to move.

### 2. The urge to move to music is innate
Babies as young as 3 months respond to music differently than to the same sounds scrambled in time, and they do it with rhythmic movement. Some sound patterns move mostly the torso, others mostly the limbs, and others both, which Huberman compares to the different dancing styles you see at a wedding. This happens before anyone teaches them what music or dancing is.

### 3. 10–30 minutes of focused listening a day raises heart rate variability, mostly through breathing
Meta-analyses of studies in which people listened only to their favorite genre (rock, classical, country) for 10–30 minutes a day, sometimes up to 60, found lower resting heart rate and higher heart rate variability. The HRV gains lasted around the clock, including during sleep. A review in Trends in Cardiovascular Medicine concluded the effect works mainly through unconscious changes in breathing rather than through sound acting directly on the heart.

### 4. Respiratory sinus arrhythmia is the link between breathing and heart rate
On a deliberate inhale, the diaphragm moves down, the heart gets temporarily larger, blood moves more slowly through it, and the nervous system speeds up the heart. On a long or forceful exhale, the heart becomes smaller, blood moves faster, and a parasympathetic signal slows the heart. Music makes you inhale in anticipation and exhale on release, so it works these controls without your noticing.

### 5. Music engages prediction, reward, emotion, memory and movement circuits together
The frontal cortex predicts the next sound. When a prediction is broken in a way you like, the mesolimbic pathway (ventral tegmental area and nucleus accumbens) releases dopamine. A disliked surprise drops dopamine below baseline, which Huberman calls a 'muffin song' that is great at the top and disappointing in the middle. The amygdala drives arousal, the hippocampus and parahippocampal cortex bring back vivid memories, and the basal ganglia and cerebellum handle the urge to move and rhythmic timing.

### 6. Music faster than about 140–150 bpm increases motivation to move
Fast music shifts the balance between the basal ganglia's 'go' and 'no-go' circuits and releases catecholamines (dopamine, norepinephrine and epinephrine). This narrows the visual field toward a tunnel focus that suits effort. The effect holds whether or not you know the song or its lyrics are motivating; motivating lyrics simply add to it.

### 7. For learning, silence beats music, and favorite songs with lyrics are worst
In controlled studies of focus-heavy learning tasks, the order of performance was silence, then instrumentals, then music with lyrics, with your favorite lyrical music last. Huberman's explanation is that reading creates an inner narration with subthreshold premotor signals to the larynx, which Eddie Chang has described, and familiar lyrics compete with that narration. Separate studies found white noise, brown noise or 40 Hz binaural beats improved focus compared with silence, but none compared them directly with music.

### 8. The evidence on binaural beats is mixed
Some decent studies show that 40 Hz binaural beats enhance concentration. Other recent studies found binaural beats impaired cognitive performance, but those used other frequencies. Huberman uses the Brainwave app at times but admits he has never run a controlled comparison on himself.

### 9. Mood follows tempo more than lyrics
Meta-analyses link 'happy' music to tempos of roughly 140–150 bpm or faster in major keys. Nonsense lyrics lifted mood as much as lyrics about love or friends, which Huberman says explains catchy, mostly upbeat one-hit wonders and why AI may get good at writing hits. 'Sad' music tends to run below about 60 bpm and activates the corrugator muscles that furrow the brow, while happy music relaxes and raises the brows.

### 10. Learning instruments and singing increases brain connectivity
Children who learn one to three instruments, especially before about age 8, or who sing in a choir or solo, show up to 30% greater connectivity across the corpus callosum, the link between the two hemispheres, and it persists into adulthood. Age 8 is a study cutoff, not a closed window: adults gain from learning an instrument, singing, or attentively listening to unfamiliar music 30–60 minutes about three days a week. Huberman calls the 'left-brained versus right-brained personality' idea nonsense.

## EXAMPLES

### 1. Survey of why people listen to music
About 90% listen to relax, 82% to feel happier, 46.5% to process emotions (most often sadness) and 32.5% to concentrate. People could give multiple reasons.

### 2. 9 minutes to lift mood, 13 to process sadness
Across studies, the threshold for a significant shift toward happiness was about 9 minutes of upbeat music. People who were

already sad were helped to process it by 13 minutes or more of slow music (about 50–60 bpm or slower), which supports a cathartic 'match the feeling' approach.

### 3. 'Weightless' by Marconi Union

A study from the University of Pennsylvania reported up to 65% reductions in anxiety after just 3 minutes of this song, comparable to a commonly prescribed benzodiazepine. The top YouTube version runs 10 hours and has around 47 million views.

### 4. 'Bass face' as a labeled line

Low-frequency tones spaced apart reliably produce a characteristic facial expression, which suggests a dedicated pathway from the ears to the facial muscles. Erich Jarvis argues that such music, dance and song circuits probably came before spoken language.

### 5. Huberman's violin story

He was assigned the violin as a child and learned with the Suzuki method. In his one concert photo, every other child's bow is up and his is down. He quit and still plays nothing, which he says likely means he missed the childhood connectivity boost. He plans to learn an instrument now, away from people and pets.

## OTHER RELEVANT

### 1. Prime motivation with fast music for 10–15 minutes beforehand

Before a workout or a hard cognitive session, play fast music you like for 10–15 minutes. Then do focused work in silence, with white or brown noise, or with 40 Hz binaural beats.

### 2. Save lyrical favorites for study breaks

Uplifting familiar songs during breaks between 30–90 minute work bouts appear to improve focus and learning when you return to the work in silence.

### 3. During exercise, alternate music with silence

Results for music throughout a workout are mixed and individual. Huberman reads the data as favoring familiar, motivating music between sets or at intervals during a run or ride over a constant soundtrack.

### 4. Use specific tracks for anxiety and low mood

Keep 'Weightless' ready for a 3-minute reset alongside the physiological sigh (two nasal inhales, then a long exhale through the mouth). Use about 9 minutes of upbeat music to lift mood, or let slow music carry you through sadness.

### 5. Listen to new music attentively

Deliberately seeking out and paying attention to unfamiliar genres, rather than leaving them in the background, appears to support neuroplasticity well beyond music itself.

# How Emotions & Social Factors Impact Learning | Dr. Mary Helen Immordino-Yang

Guest: Dr. Mary Helen Immordino-Yang
Date: 2023-06-05 · Duration: 2:41:22
URL: https://www.youtube.com/watch?v=S8jWFcDGz4Y

## KEYPOINTS

### 1. Emotions are the foundation of thinking and learning, not an add-on

Immordino-Yang, who studies emotion, learning and adolescent development, argues that emotions drive all thinking, decision-making, relationship-building and well-being. That doesn't license acting on every feeling. It creates a responsibility to develop habits of questioning and reframing emotional narratives when they aren't serving us or the world.

### 2. Complex social emotions recruit the same body-regulating systems as basic ones

In her MRI studies, people heard true stories meant to evoke compassion or admiration. Emotions about physical pain and inspiring stories of virtue both engaged the brainstem, hypothalamus and anterior insula, the cortex that senses visceral states like heartbeat and digestion. Even our most abstract feelings are built on the physiology we share with much simpler animals.

### 3. For story-based emotions, valence matters less than whether you must build a narrative

Her surprise finding: once emotions are about stories, whether they're positive or negative is no longer the defining feature. What matters is whether you directly witness something (someone breaks an ankle stepping off a curb) or must construct a story in your mind (a man dining alone whose spouse of 75 years recently died). That narrative leap is uniquely human and develops slowly.

### 4. The default mode network activates during effortful meaning-making

Her team was among the first to show the default mode network actively engaging, not just switching off, during a demanding task: deciding how you feel about a story that requires cultural, contextual and personal knowledge. Stories that inspire admiration for someone's character or state of mind, such as Malala standing up to the Taliban, engaged it more than admiration for physical or cognitive skill.

### 5. Responses can be predicted story by story

In a two-hour interview before scanning, participants reacted to about 50 stories. The stories that individually inspired someone predicted which ones would activate these networks for that person in the scanner. Immordino-Yang calls this 'transcending' a situation: going from 'that's unfair to her' to what it means about the world and about oneself.

### 6. Adolescence is the developmental window for complex meaning-making

Young children can't fully appreciate others' mental states. Teenagers become driven to construct big meanings: their shoes become a statement about sustainability or counterculture. Yet that is exactly when school, she argues, doubles down on transactional testing, such as asking whether the servant in Great Expectations is Molly or Maria.

### 7. Dehumanization works by rewriting the story

Asked how people who love their families can take part in genocide, she explains that the narrative imposed on another's pain shifts from 'another human suffering' to 'a rat, a pig, a bug'. That brings a different set of values into play. Huberman connects this to classic obedience studies suggesting most people could harm others under the right conditions.

### 8. You can't think expansively when you feel unsafe

Default-mode activity, the basis of self-awareness and of building narratives, is fundamentally incompatible with vigilance about your immediate physical or social surroundings. Feeling physically, emotionally, culturally or socially unsafe makes it neurobiologically hard to imagine alternative perspectives, future outcomes or ethical implications. She notes creativity is also tied to these networks.

### 9. Mirror neurons as a special cell type haven't been found

She says that, as far as she knows, the predicted dedicated mirror cell type was never found. She prefers Antonio Damasio's late-1980s model of convergence-divergence zones, in which networks bring processing together and send it back out, linking perceiving others' actions with our own goal-directed action.

## EXAMPLES

### 1. 'I love you more than I'm glad there's daytime'

At about two, her daughter Nora saw her looking sad, pressed her mother's arm to her face and said she loved her, adding that she really loved her arm. Two years later, Nora whispered from bed that she loved her mother more than she was glad there's daytime. Immordino-Yang argues the visceral attachment was the same; what had developed was the ability to conceptualize love as an idea.

### 2. Teens pausing during the Malala video

In experiments with teenagers, some covered their faces, closed their eyes or looked at the ceiling while watching. Coders watching with the sound off could spot these pauses. Afterward, speech slowed and posture closed, and students moved to bigger meanings, ethics, and themselves: 'I take school for granted; maybe I should do something for others.'

### 3. The seventh-grade question about hominids

As a young science teacher in a South Boston public school district, she built an integrated, web-like curriculum linking nuclear fission, the sun, photosynthesis and metabolism. A student bravely asked why early hominids in a Nova documentary always looked Black. Her answer about melanin near the equator opened months of discussion spanning biology and culture, which hooked her on studying development and learning.

### 4. Zeno's paradox and a student who never passed math

In a New York performance-assessment school, a Sudanese immigrant student who had never passed math spent months on a 'walking to the door' problem. If you keep going halfway, do you ever arrive? He said he learned fractions because he needed them, and became fascinated with finite and infinite. She quotes him in an article with Doug Knecht, 'Building Meaning Builds Teens' Brains'.

## OTHER RELEVANT

### 1. Lead learning with meaningful problems

Start with what a learner finds interesting and give them real problems that require the skills: writing, math, argument, filmmaking. Skills are 'what's in the cart'; the aim is developing 'the horse' that pulls it. Assessments based on deep projects, like those in a consortium of New York City public schools that replace standard exit exams with performance assessments, are one model.

### 2. Interrogate your own default story

Ask what broader historical, ethical and civic implications follow from the narrative that feels like the truth, and invite others to tell you their version. Huberman deliberately follows social media accounts he disagrees with to keep perspectives in view.

### 3. Create psychological safety for hard conversations

Whether in a classroom or a heated discussion, people need to feel safe before they can explore alternative perspectives or be creative. Reduce threat first, then invite reflection.

### 4. Cold exposure when healthy; warmth when sick

Her teenage son had taken daily cold showers and reported no colds since. Huberman says short adrenaline spikes are protective while chronic stress isn't, citing Bruce McEwen and Robert Sapolsky. Once you're actually sick, he advises switching to warm showers, baths or sauna that aren't stressfully hot.

# Science-Based Mental Training & Visualization for Improved Learning

Date: 2023-04-24 · Duration: 1:59:47
URL: https://www.youtube.com/watch?v=0RYyQRQFgFk

## KEYPOINTS

### 1. Visualization speeds learning but can't replace real practice
Huberman's central message: mental training is a complement. Done well, it makes learning faster and more stable, but it can't stand in for real-world execution of a cognitive or motor skill. Like any deliberate learning, it depends on focused attention during the session and on sleep afterward.

### 2. Principle 1: keep each visualization very brief, simple and repeated
Most people (roughly 90–95%) can briefly imagine a yellow cube beside a red rose, the opening riff of AC/DC's 'Back in Black', or the feel of chinchilla fur. Almost no one can sustain long, multi-sensory scenes. Effective sessions use sequences that take about 15 seconds or less, run over and over with high accuracy.

### 3. Imagined experience runs at the same speed as real experience
Roger Shepard (Stanford) found that the time needed to imagine and rotate an object scales with its complexity. Stephen Kosslyn (now at Harvard) found that mentally 'walking' between landmarks on a memorized island map takes time in direct proportion to the real distance. Imagining a golf swing therefore takes about as long as making one, and at the neural level imagery closely mirrors perception.

### 4. Principle 2: neural equivalence isn't learning equivalence
Although imagery recruits similar circuits, it improves performance less than real practice. Hour for hour, real-world training (physical or cognitive) always beats mental training, and mental training beats no training.

### 5. Principle 3: combining real and imagined practice adds depth
No one can flip an imagined bistable image (faces/vases) or impossible figure in the mind's eye, according to neuroimaging. Once people trace or draw the figure by hand, they can. Huberman uses this to show that real motor and perceptual experience is what makes imagery flexible.

### 6. Principle 4: give each practiced element the same label in both settings
Imagery is sharper for things with real-world labels; the brain is above all a face-recognition machine. So name the element, such as 'golf swing 1A' versus 'putt 1B', and use that same name in both real and mental practice. Labels have to match reality: 'you can't just lie to yourself and learn better.'

### 7. Principle 5: imagery tracks real perception, so use your eyes
Behind closed lids, people look up when imagining a tiled ceiling and down when imagining a rattlesnake on a trail. Inspecting a mouse's whiskers takes longer than locating an elephant's trunk, because you have to 'zoom in'. Deliberately moving your eyes toward what you're imagining recruits more of the real circuitry.

### 8. Visualize in the first person, and video of yourself counts
Imagining from the inside out (feeling your hands on the piano) is significantly more effective than watching yourself from across the room. Many strong studies used eyes-open protocols in which people watch looped video of themselves; brain imaging shows we process video of ourselves more like first-person experience than video of others.

### 9. Mental practice trains 'no-go' as well as 'go'
Huberman estimates that half to three-quarters of skill learning is suppressing wrong movements or words, a job of the basal ganglia. Imagery can improve this inhibitory side too, provided practice mixes go and stop trials.

### 10. You only gain from imagery on skills you can already sometimes perform
In nearly every positive study, participants could already do the real sequence. Imagery can raise success, for example from hitting the ball cleanly 10% of the time to more often, but it's a poor tool for something you've never managed. Once a skill is consolidated you can stop visualizing it and move on to a new one.

## EXAMPLES

### 1. 50 imagined finger-tapping trials improved speed and accuracy (2022)
In 'Mental practice modulates functional connectivity between the cerebellum and the primary motor cortex', people imagined the 1-2-1-3-1-4-1-5 finger sequence 50 times and then performed it faster and more accurately. Transcranial magnetic stimulation showed increased net excitation from the cerebellum to motor cortex (M1) through reduced inhibition.

### 2. Stop-signal task: combined training nearly doubled some gains
Using Gordon Logan's task (press left or right within about 500 ms, but withhold the press when a red stop signal follows 100–350 ms later), a small study trained people once a day for five days. Physical-only and mental-only groups both improved, but combined training produced far larger gains, in some measures nearly double.

### 3. 10 hours real practice plus 30–60 minutes mental practice beats 10 hours real alone
Huberman's synthesis of the research: nine hours physical plus one hour mental does not beat ten hours physical. Mental training helps when added on top of the maximum real practice you can sustain.

### 4. An injured Stanford tennis recruit came back better
An anecdote from a Stanford psychology colleague, which Huberman labels as only an anecdote: the athlete reframed the layoff as extra time for mental training and returned better than before the injury. Studies of stroke, TBI and limb-injury patients also suggest imagery can maintain or rebuild skills.

### 5. Aphantasia and synesthesia can coexist

About 5–15% of people visualize poorly, and some can't at all (aphantasia). Research shows people with aphantasia can still have synesthesia, such as a friend who sees E-flat as amber, and that aphantasia correlates with more autism-spectrum traits. Huberman stresses that the causal direction is unclear.

## OTHER RELEVANT

### 1. Protocol: 15-second epochs, 50–75 reps, 3–5 times a week

Fit as many repetitions of the brief sequence as you can into about 15 seconds (for example three 5-second golf swings), rest about 15 seconds, and repeat for 50–75 total. Do this 3–5 sessions a week. Don't obsess over exact timing.

### 2. Timing matters less than sleep

Huberman isn't aware of data showing mental practice must come before or after real practice. What matters is good sleep the night after either kind of session; he points to Walker and Stickgold's 2003 paper on sleep and the time course of motor skill learning. Avoid practicing when you should be sleeping.

### 3. Use imagery to calm yourself before public speaking

For nerves, loop a short scene of walking onstage and scanning the room while deliberately staying calm, or watch video of yourself doing it. This trains your autonomic state rather than specific words.

### 4. Who benefits most

Later research found no meaningful sex differences in visualization or its benefits. People over 65 may gain especially from combined mental and physical training, though it's unclear whether that reflects limits on how much physical practice they can do.

# Using Play to Rewire & Improve Your Brain

Date: 2022-02-07 · Duration: 1:46:35
URL: https://www.youtube.com/watch?v=BwyZIWeBpRw

## KEYPOINTS

### 1. Play is regulated like hunger
Jaak Panksepp, known as the 'rat tickler', found that rats, puppies, kittens and other animals laugh at ultrasonic frequencies when tickled. He also showed that animals and children deprived of play play more once allowed, just as a hungry animal eats more. To Huberman, this places play deep in ancient brain circuitry rather than treating it as a recent, optional higher function.

### 2. Play runs on brainstem opioids that make the prefrontal cortex more flexible
The periaqueductal gray (PAG) releases small amounts of the body's own opioids, such as enkephalins, during play. Far from dulling the prefrontal cortex, Huberman says, this state lets it take on different roles and test more 'if I do this, then that happens' contingencies. These internally made opioids are distinct from the drugs behind the opioid crisis.

### 3. The key chemistry is high opioids plus low adrenaline, which requires low stakes
Play opens neuroplasticity only when the stakes are low enough that epinephrine stays down. Once you care too much about the outcome, stress chemistry takes over and the exploratory mode closes. Huberman calls play 'the portal to plasticity' at every age.

### 4. Our first rule is that relief comes from outside us
A baby in discomfort cries and someone outside resolves it with milk, water or being let out of the stroller. Huberman notes many adults never outgrow looking outside themselves to manage stress, sometimes reaching for alcohol. Through childhood play, we gradually test other contingencies and learn to regulate our own states.

### 5. Playful animals signal with 'partial postures'
Animals heading into rough-and-tumble play approach slowly with their fur down rather than raised. People about to play-fight similarly make themselves smaller, unless the context is truly competitive, like boxing or football. These signals tell the other side it's play, not a threat.

### 6. Role play trains prediction
Games that assign leader and follower, dominant and submissive, or solo and group roles force the prefrontal cortex to run more prediction algorithms from new standpoints. Huberman cites his sister's doll-house games and imaginary friend as ordinary examples.

### 7. Development is largely pruning, and play guides it
Roughly 40% of the connections present early in life are removed by age 25. Glial cells physically separate and even eat unused synapses (work from Beth Stevens' lab at Harvard). Play strengthens some connections and prunes others. Huberman notes 'fire together, wire together' is often credited to Donald Hebb but was coined by Carla Shatz.

### 8. Trauma suppresses play circuits, and play can help reopen them
Chronic stress means chronic epinephrine, which shuts down play circuitry. Huberman says this is why children with heavy trauma show limited plasticity later. Some prominent treatments for severe, long-lasting trauma now use dance and unfamiliar body movement, and he doubts any pill will simply erase trauma.

### 9. Novelty matters more than mastery
An expert chess player gains less play-related plasticity from chess than from something new, such as soccer. Getting better at what you already know improves only that skill. Novel activities expand how adaptable you are in relationships, finances and life generally.

## EXAMPLES

### 1. Smartphone reading suppresses sighing (Honma et al.)
In 34 healthy people, reading on a smartphone produced worse comprehension than reading on paper. Overall breathing patterns were the same, but physiological sighs (a double inhale and long exhale, normally about every 5 minutes) were suppressed, and the prefrontal cortex became overactive. Huberman distinguishes this from 'email apnea' and suggests deliberate sighs or printed material for important reading.

### 2. Feynman's playful spirit
Richard Feynman learned to paint and draw well into his 60s and was infamous for bongo drumming on the Caltech roof, sometimes naked. He wrote about working to keep his playfulness because it helped him see the world differently and make discoveries.

### 3. Tinkerers at NASA
Huberman notes that NASA, and later competitive companies, became known for favoring applicants who were tinkerers as children. Low-stakes exploration, such as hitting balls without caring whether they land in, expands the range of moves that drilling alone can't.

### 4. Competitive but joyful horseshoes
A friend of Huberman's plays horseshoes to crush him every time and clearly loves it. You can compete and still play, Huberman says, as long as you're enjoying yourself.

### 5. Personal play identity (Güne òÂ # # •
A review in Current Psychology by Gökhan Güne ò FW67 ibes four dimensions of how we play: play style and personality, socio-

cultural setting and environment, economics, and technology. Patterns set in childhood carry into how adults approach play.

## OTHER RELEVANT

### 1. Schedule at least an hour of pure play a week

Choose something novel and low-stakes, ideally with several possible roles and no rigid linear structure, and don't worry about getting good at it. Huberman sees this as going beyond 'beginner's mind', which still assumes you're working toward proficiency.

### 2. Add novel movement and speeds

Huberman, who runs about three times a week, has added backward walking and backward sled pulls after following Ben Patrick (the 'knees over toes guy') and finds them good for his back. Dynamic, unfamiliar movement is one of the two forms of play he says has good peer-reviewed support for plasticity.

### 3. Don't assume exercise alone covers it

Regular exercise sharpens thinking for many people, though very intense sessions temporarily blunt it. Repetitive, linear exercise doesn't offer the role and contingency exploration that play does. For more guidance, Huberman recommends Charlie Hoehn's 'Play It Away: A Workaholic's Cure for Anxiety'.

# ADHD & How Anyone Can Improve Their Focus

Date: 2021-09-13 · Duration: 2:18:01
URL: https://www.youtube.com/watch?v=hFL6qRIJZ_Y

## KEYPOINTS

### 1. ADHD is strongly genetic and unrelated to intelligence
ADD appears in the medical literature as early as 1904 and was renamed ADHD in the mid-to-late 1980s. If an identical twin has ADHD, the other's chance is up to 75%, compared with about 50–60% for fraternal twins and 10–25% when a parent has it. Huberman stresses that ADHD appears across every level of IQ, emotional intelligence and other kinds of intelligence. A family history raises risk but does not determine the outcome, and symptoms can be overcome.

### 2. The core problems are attention, impulse control, time and working memory
People with ADHD often hyper-focus on things they enjoy, which shows the capacity for focus exists but is hard to direct. They also struggle with time perception, run late, organize in 'piles' and have weak working memory. Huberman links hyper-focus on preferred activities to dopamine.

### 3. In ADHD, the brain's resting and task networks fire together instead of opposing each other
The default mode network, which Huberman describes as including the dorsolateral prefrontal cortex, posterior cingulate and lateral parietal lobe, is normally synchronized internally. Task networks, centered on the medial prefrontal cortex, suppress impulses. Normally the two are anti-correlated, like a seesaw. In ADHD, after poor sleep, or in subclinical cases, they are abnormally correlated, like a band where every instrument plays melody. With successful treatment or when people outgrow ADHD, they return to anti-correlation.

### 4. Under the low-dopamine hypothesis, neurons fire when they should stay quiet
When dopamine is too low in attention circuits, neurons fire out of turn, like musicians ignoring the rests. Since the 1940s–60s, people with ADHD have tended to self-medicate with lots of coffee, half a pack of cigarettes a day, cocaine or amphetamine, all of which raise dopamine. Young children with ADHD often show a strong preference for sugary foods, which also raise dopamine.

### 5. Stimulant drugs may teach the brain to focus
Ritalin (methylphenidate) and Adderall (an amphetamine) raise dopamine and norepinephrine. Huberman's framing is that they let children experience sustained focus so the circuits for focus can be trained, rather than acting as a permanent crutch. Modafinil and armodafinil are weaker dopamine reuptake inhibitors that also act on the orexin (hypocretin) system, which is disrupted in narcolepsy, so they are a milder alternative.

### 6. Attentional blinks: finding one target makes you miss the next
Huberman credits Daniel Goleman and Richard Davidson's account. In a Where's Waldo-style search, or when spotting the letters R and Z in a fast stream of numbers, people who detect the first target often miss a second one shortly after, because attention briefly shuts off during a small neurochemical 'celebration.' Children and adults with ADHD have many more of these blinks.

### 7. Physical eye blinks reset your sense of time and are controlled by dopamine
A Current Biology paper, 'Time dilates after spontaneous blinking,' shows that blinks reset time perception, like the clapper between takes on a film set. Higher dopamine makes people overestimate how long something lasted because they sample time more finely, while low dopamine leads to underestimation, which fits the habitual lateness seen in ADHD. Chronic cannabis users blink less, and the more years of use, the lower their blink rate.

### 8. Elimination diets and sugar: strong results with caveats
A Lancet randomized crossover trial of 100 children (50 per group at any time) used an oligoantigenic diet that removed foods each child had mild antibody reactions to. It reported large improvements in focus, impulsivity and fidgeting with p-values below 0.00001, but later reanalyses criticized the design. A pediatric neurologist friend of Huberman's says cutting simple sugars has a dramatic positive effect in many of her patients, which is a well-informed anecdote, not a trial.

## EXAMPLES

### 1. 17-minute open-monitoring session
Sitting quietly with eyes closed and attending to breathing and body sensations, returning when the mind drifts, for about 15–20 minutes, done even once (17 minutes), significantly reduced attentional blinks in published studies. It is being explored for age-related cognitive decline too.

### 2. Visual fixation training in schoolchildren
In 'Improvement of attention in elementary school students through fixation focused training activity,' children first moved around to get rid of restlessness. They then fixed their gaze on a near target such as their hand for 30–60 seconds, then on farther points. Just a few minutes a day improved their attention to other kinds of information.

### 3. Huberman's armodafinil anecdote
While badly jet-lagged, he took half of a prescribed dose before a lecture and talked for four and a half hours without realizing it. He would not want to study or work in that state.

### 4. A pediatric neurologist's approach to medicating
His colleague, an MD-PhD who treats ages 3–21 and whose own son shows ADHD signs, sees more kids benefit than not from stimulants, provided the lowest possible dose is used and adjusted as the child matures. Huberman raises the question of waiting for puberty, when frontal executive circuits come online.

### 5. Smartphone limits

One study found adolescents needed under 60 minutes of smartphone use a day to avoid measurable attentional decline. Huberman suggests about 2 hours or less for adults, with or without ADHD.

## OTHER RELEVANT

### 1. Omega-3s and phosphatidylserine for ADHD

Across 10 studies, the attention benefit appears above 300 mg a day of DHA. For mood, 1,000–2,000 mg of EPA is the target. Phosphatidylserine at 200 mg a day for two months reduced symptoms in children aged 7–12 in studies of 147 and 36 subjects, with a stronger effect alongside omega-3s. It has not been studied in adults. These support treatment rather than replace it.

### 2. Other focus compounds need medical supervision

Alpha-GPC increases acetylcholine. People typically take 300–600 mg for studying, and doses up to 1,200 mg a day spread across the day have been studied for age-related cognitive decline. Phenylethylamine (PEA) ranges from 100 to 1,200 mg and can cause euphoria or jitters. Noopept has been studied at 10 mg twice daily. Check with a doctor, especially if you have ADHD.

### 3. Know what non-prescribed stimulants really are

Esposito et al. in Frontiers in Bioscience reviews Ritalin, Adderall, modafinil and caffeine alongside cocaine, MDMA and street amphetamine, highlighting similar mechanisms and long-term risks. Taking Adderall without a clinical need is taking amphetamine.

### 4. Let kids move before asking them to sit still

The circuits that suppress reflexive movement mature only around ages 15–16. Recess, movement before focus work, and fidget tools all serve the same purpose.