COGNITIVE
DNA Wellness
Report

Bioneer

Report Summary for
Bioneer

Reported traits		Your SNP based summary
Overall Cognitive Ability	Overall Cognitive Ability	Considerably above-average overall cognitive ability

The above estimate is based on the genetic variants reported in your genotype file. Note that this information represents an **overall estimate of your traits** based on the most up-to-date scientific research available at the time of this report.

Top Suggestions

Note: *A complete listing of all the gene-based recommendations made in this report — automatically ranked according to their overall importance for you — can be found in the* ***Conclusion section*** *of this report, further below.*

The following are the top three gene-based recommendations made in this report. They have been personally tailored to you based on your unique genetic information, and have been ranked according to which individual recommendations are the most likely to have the greatest overall impact on your cognitive ability as a whole.

1. Get plenty of regular **exercise**.
2. Use the **Lab Test Analyzer** to make sure that your levels of **folate**, **vitamin B12**, and ***homocysteine*** are not causing problems.
3. Use ***photo-bio-modulation*** (PBM) therapy devices, such as ***low-level laser therapy*** **(LLLT)** or **infrared light**.

Table of Contents

Welcome to your DNA Wellness Report: Cognitive Function

Our goals with this report are to:

- **Introduce you to your genetics**
- **Explain how they play a role in determining your overall cognitive ability**
- **Enable you to make the fullest use of your cognitive potential by giving you actionable recommendations to boost your brain's health and functioning**

Introduction

Welcome to your Cognitive Function *DNA Wellness Report*!

This report has been designed to analyze a number of key genes that affect your brain's overall cognitive ability.

At the beginning of this report, we examine your personal genotype file and report on what your unique genetic data can reveal about a number of important SNPs that can affect how efficiently your brain processes and uses information. **These genetic markers influence how good your brain is at cognitive processes** such as **learning**, **memory**, and **overall problem-solving.**

After analyzing your overall genetic strengths and weaknesses, we review each of the major genes in greater detail. **We then use your genetic data to deliver actionable health & lifestyle recommendations to help you optimize and enhance your cognitive ability.**

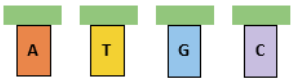
Let’s get started!

Medical Disclaimers: How To Use Your SelfDecode DNA Wellness Report

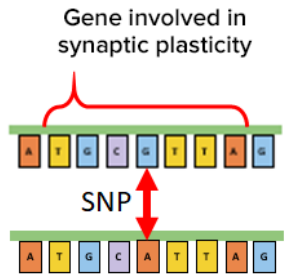
The information in this report has not been evaluated by the Food & Drug Administration or any other official medical body. This information is intended for educational purposes only, and is meant to introduce you to some of the genetic factors that may affect your relative likelihood of developing certain health conditions or traits. Always keep in mind that our analyses are based on a select number of genes and SNPs, and that the data we analyze represents only a relatively small portion of your entire genome. You will carry many more genetic variations than just the ones we report on here, and these other variants may also have a potentially strong impact on your physical and psychological traits. The variants that we focus on are those which have been linked with certain cognitive functions through association studies, which are correlative and do not necessarily imply causal relationships. Additionally, results from some studies may apply only to specific ethnic groups or a specific gender. Therefore, just because you carry certain “risk-associated” genotypes does not necessarily mean you will actually develop a specific health condition or trait! Any individual genetic variant will typically contribute only a small proportion of the overall risk of developing a given health condition or trait; many other non-genetic factors, such as environmental and lifestyle factors, can also significantly influence a person's risk of developing a health condition. Therefore, the "risk summaries" included in each section of this report are not conclusive, and only represent a limited amount of your total risk as an individual. For these reasons, the conclusions in this report should not be treated as conclusive or comprehensive, should not be used as a basis to make any medical decisions, and should never be used to diagnose, treat, cure, or prevent any illness or disease. None of the health suggestions made throughout this report should ever be used to replace any treatment approaches your doctor has recommended or prescribed. You may choose to try the complementary approaches discussed in this report if you and your doctor determine that they could be appropriate for you: but always be sure to discuss any changes with your doctor first, in order to avoid any negative interactions and other potential risks (especially if you are pregnant, nursing, taking medication, or have a diagnosed medical condition). Above all, always keep in mind that genetics are only one part of a very complex equation, along with many other factors.

How This Works

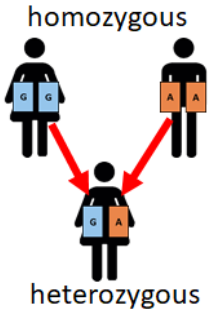
Your DNA is a like a long string packed into every cell in your body. Along this string are **bases** lined up like beads. There are four bases, marked by the letters **A**, **G**, **C**, and **T**. These align in very specific sequences to create ***genes***. Your unique genetic makeup is determined by the sequence of these bases.



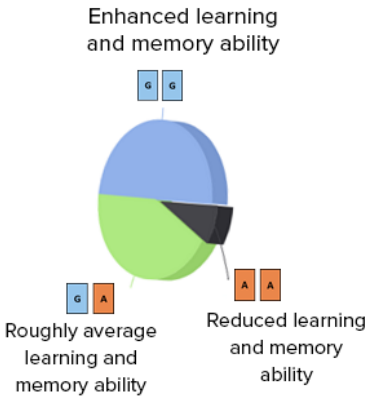
These sequences vary between people. For example, at a specific location in one gene, 75% of the population might have a “G”, while the other 25% has an “A”. The difference is only in a single base, so this type of genetic variation is called a ***single nucleotide polymorphism*** or "SNP" (pronounced “snip”). In this example, the SNP has only two possible variations: “G” or “A”.



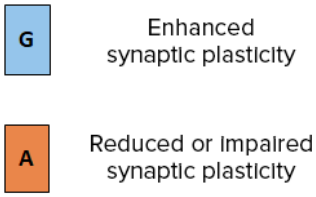
You inherit two copies of each gene: one from your mother and one from your father. In the example SNP above, if you carry one of each variant (i.e. “AG”), you would be ***heterozygous*** for this SNP. If you carried two copies of the same base (“GG” or “AA”), you would be ***homozygous*** for this SNP. These two-letter designations are your **genotype** for a specific gene.



We can extend our example by pretending that this gene is involved in supporting your brain's synaptic plasticity. People with the “G” variant might have a version of the gene that increases their ability to form new neural connections, while people with the “A” variant might have a copy that makes these processes less efficient. This would mean that people with the "G" variant might have a cognitive advantage when it comes to learning new information since their brain will be better able to quickly encode and store new memories.



Now you can see how having access to this knowledge can empower people to take steps to optimize their cognitive ability. In our example, someone who knew they had the “AA” genotype could use this information to make lifestyle adjustments that will boost their brain's level of synaptic plasticity, which could help them to achieve the same high level of cognitive function as someone with the "GG" genotype.



In this report, we discuss SNPs that have been associated with many different aspects of cognitive function such as learning, memory, cognitive flexibility, processing speed, synaptic plasticity, neurogenesis, and overall cognitive ability (general intelligence; IQ). However, this is not a definitive list of all the SNPs or genes related to cognitive ability, and many more genetic variations have yet to be discovered. **As scientists continue to discover more about the genetics of the brain, we will update our reports to take these new findings into account—so be sure to check back for future updates!**

Gene Index

Below is an index of all the genes we analyze in this report, organized into some of the broader health-related functions and mechanisms that they are related to.

(Don't worry -- each gene that you have recommendations for will also be described in the sections following your main results, farther below.)

Brain Growth Factors:

APOE [rs429358]
BDNF [rs6265]
CHRNA5 [rs588765]
DAB1 [rs1581762]
DTNBP1 [rs2619522]
HOMER1 [rs7713917]
KIBRA / WWC [rs17070145]
NOTCH4 [rs3131296]
NRG1 [rs6994992]
NRGN [rs12807809]
PDE9A [rs2839581]
RELN [rs2711870]
RGS7 [rs7730085]
ST8SIA6 [rs7897269]
TESC [rs7294919]
ULK2 / ULK4 [rs150122 & rs7627367]
ZNF365 / DBZ [rs10995170]

Thyroid Hormone-Related:

NRGN [rs12807809]
THRB [rs2596623]
RELN [rs2711870]

Cardiovascular Health / Brain Blood Flow:

PITX2 [rs6843082]
ZFHX3 [rs2106261]

Autophagy:

ULK2 / ULK4 [rs150122 & rs7627367]

Neurotransmitters:

CHRNA5 [rs588765]
CLSTN2 [rs4683505]
COMT [rs4680]
DBH [rs1108580]
DTNBP1 [rs2619522]
HOMER1 [rs7713917]
HTR2A [rs6314]
LMX1A [rs11809911]
NPS [rs4390263]
OXTR [rs53576]
UCHL [rs3775256]

Motivation & Mood:

CNR1 [rs1049353]
DRD2 [rs1800497]
RGS7 [rs7730085]

DNA Methylation & Epigenetics:

EHMT2 [rs9267663]
HDAC9 [rs11984041]
MTHFR [rs1801131 & rs1801133]

Myelination & Neural Communication:

ENPP6 [rs4241784]
SCN2A [rs10174400]
ZNF365 / DBZ [rs10995170]

Oxidative Stress:

APOE [rs429358]
BCL2 [rs956572]
LMX1A [rs11809911]
MSRB2 [rs7427]
NAT1 [rs7817820]
PARP1 [rs7515023]
UGT2A1 [rs10518065]
ZNF365 / DBZ [rs10995170]

Inflammation:

APOE [rs429358]
BCL2 [rs956572]
CNR1 [rs1049353]
NFKBIL1 [rs2230365]
PARP1 [rs7515023]
TNFSF9 [rs348373]

Diet, Nutrition & Lifestyle:

DTNBP1 [rs2619522]
ENPP1 [rs6935458]
SLC19A1 [rs1051266]
ST8SIA6 [rs7897269]
TUSC [rs240657]

Stress-Related:

BDNF [rs6265]
CNR1 [rs1049353]
HTR2A [rs6314]
OXTR [rs53576]

Introduction: The Genetics of Intelligence

Our ability to think and act intelligently is the defining characteristic of human beings as a species—and **each person's overall level of cognitive ability is one of the key factors that can affect how successful and healthy they are** [1, 2, 3].

Probably the most well-known measure of overall cognitive ability is the *intelligence quotient* (IQ). A person's level of IQ correlates with a wide variety of life outcomes ranging from how well they perform at school, how much money they make, and even how likely they are to suffer from lifestyle-related health conditions (such as diabetes, strokes, and heart attacks) [4, 5, 6, 7, 8].

IQ is also highly *heritable*: scientists estimate that 50-80% of our variability in overall intelligence can be explained by genetic factors that we inherit from our parents [9, 10]. This means that variations in our genes have a very significant impact on how well our brains function!

However, intelligence is also a highly "*polygenic*" trait, meaning that it is influenced by many different genes, each of which may only have a small effect on a person's overall level of intelligence [4, 9]. In other words, how smart you are is determined by a very large number of genes, and how they all work together in concert to promote optimal brain health and function—it's not just about a few "intelligence-related" genes!

Because the number of genes that affect cognitive potential is so large, in this report we have focused specifically on:

1. Genes that have been directly associated either with general intelligence, or with the individual cognitive functions that form the essential "building blocks" of general intelligence.
2. Genes that directly affect the various biological mechanisms that determine how effectively the brain encodes, stores, and processes information.
3. Genes whose effects can be targeted with supplements and lifestyle changes, either directly (e.g. by increasing/decreasing gene activity) or indirectly (e.g. by improving the biological system affected by a certain gene variant).

By taking this approach, we've homed in on a set of genes that not only play a role in determining how sharp you are, but which you can also target with supplements, diet, and other lifestyle hacks to help you draw out more of your brain's full cognitive potential!

Intelligence: Brain Mechanisms and Cognitive Functions

Although most people probably associate intelligence with a single "overall" measure such as IQ, **general intelligence is a highly complex trait that involves many aspects of biology and cognitive function all working together in concert** [11, 12, 13].

Some scientists who study cognitive ability have linked certain genetic variants to overall intelligence. However, the brain is incredibly complex, and it can often be difficult to identify any single gene that can be directly linked to all cognitive activity as a whole [3, 9, 14].

For this reason, **many scientists focus instead on associating certain genes with the individual biological and cognitive functions that serve as the basic building blocks of overall intelligence.** This approach makes sense because individual genes often have specialized functions—such as helping new neurons grow or creating specific types of neurotransmitters—that affect a person's ability to carry out certain types of cognitive functions. An individual's genetic strengths or weaknesses in any one specific cognitive function will therefore influence their overall level of intelligence [9, 13, 15, 16].

Some of the major **biological mechanisms** related to cognitive ability include:

- **Neurogenesis:** The brain's ability to grow and develop new neurons throughout adulthood and into later life, which is especially critical for learning and memory [17, 18, 19, 20].
- **Synaptic Plasticity:** The brain's ability to adjust how individual neurons connect and communicate with each other. This plasticity allows them to encode and store new information and memories [21, 22].
- **Myelination:** The brain's ability to provide neurons with the special coating (*myelin*) that they need to be able to transmit signals quickly and efficiently [2, 23, 24, 25].
- **Oxidative Stress:** The brain's ability to protect cells from oxidative damage caused by *reactive oxygen species* (ROS), sometimes also known as *free radicals*. Without this protection, neurons accumulate damage over time, which makes them work less effectively (or even die off altogether) [26, 27].
- **Inflammation:** The brain's ability to regulate immune system activity and prevent inflammatory responses from interfering with cognitive function. Chronic inflammation in the brain can lead to neuronal damage and cell death, which can result in cognitive impairments over time [28, 29].
- **DNA Modification and Repair:** The brain's ability to turn certain genes "on" or "off" (via *methylation*) and to repair any mistakes that might occur when cells copy their DNA during reproduction. These are critical functions with significant long-term impacts on the brain's ability to function properly [30, 31, 32, 33].
- **Diet and Other Lifestyle Factors:** The brain's response to common everyday behaviors, such as our diet and exercise habits, can have a powerful influence on how efficiently our brain carries out complex cognitive processes [34, 35].

Some of the **individual cognitive functions** that serve as the major building-blocks of overall cognitive ability include:

- **Processing Speed:** The amount of time it takes for the brain to take in, analyze, and react to incoming information [36, 37, 38, 39].
- **Learning and Memory:** The brain's ability to process and store new information so that it can be later recalled from memory. Some studies break these processes down even further into specific forms of memory and learning, such as spatial, verbal, and working memory [40, 41, 42, 43].
- **Cognitive Flexibility:** The brain's ability to adapt its processing to new contexts and situations. This function includes picking up on new information, switching between tasks efficiently, and resisting distraction by irrelevant information. Studies that look at attention, concentration, or executive function would fall into this general category of mental functioning [44, 45, 46, 47].
- **"Fluid" and "Crystallized" Intelligence:** *Fluid intelligence* refers to a person's ability to reason through and react to new situations. In contrast, *crystallized intelligence* refers to the skills and knowledge that a person has built up or acquired over the course of previous experience, practice, or education. Together, these factors make up *general intelligence* (IQ); however, some genes only affect one or the other [9, 48].

Because overall intelligence can be influenced by all of these diverse biological and cognitive factors, **the table below contains SNPs in genes that each affect different combinations of these factors.** By putting these all together, we can calculate a single overall score (a "***genome-wide polygenic score***") that represents your cognitive ability as a whole [16, 49]!

Overall Cognitive Ability

Below is a list of all the cognitive function-related SNPs we have analyzed in this report, along with your unique genotype for each.

Keep in mind that not all SNPs are made equal -- some can have a bigger effect on your overall cognitive ability than others! For this reason, **we have carefully weighted each SNP to reflect its total impact on your *genome-wide polygenic score***, which is summarized below the table.

Overall Cognitive Ability

Cognitive ability-related SNPs

SNP	Your Genotype	Associations	Reference
rs10174400	CT	Moderately enhanced overall cognitive ability	50
rs1049353	CT	Slightly reduced overall cognitive ability	51
rs1051266	CT	Slightly reduced overall cognitive ability	52
rs10518065	AA	Slightly enhanced overall cognitive ability	53

SNP	Your Genotype	Associations	Reference
rs1108580	AG	Slightly enhanced overall cognitive ability	54
rs11809911	TT	Relatively sub-optimal cognitive ability	55
rs11984041	CC	Average level of cognitive ability	56
rs12807809	TT	Slightly enhanced overall cognitive ability	57
rs150122	TT	Slightly enhanced overall cognitive ability	57
rs1581762	AG	Very slightly reduced overall cognitive ability	53
rs17070145	CC	Relatively sub-optimal cognitive ability	58
rs1800497	GG	Relatively sub-optimal cognitive ability	59
rs1801131	TT	Average level of cognitive ability	52
rs1801133	AG	Slightly reduced overall cognitive ability	60
rs2106261	TT	Slightly reduced overall cognitive ability	56
rs2230365	CC	Relatively sub-optimal cognitive ability	61
rs240657	AA	Average level of cognitive ability	62
rs2596623	CT	Very slightly enhanced overall cognitive ability	53
rs2619522	AA	Moderately enhanced overall cognitive ability	63
rs2711870	CT	Very slightly reduced overall cognitive ability	64
rs2839581	AA	Slightly enhanced overall cognitive ability	53
rs3131296	CC	Slightly reduced overall cognitive ability	57
rs348373	CC	Slightly enhanced overall cognitive ability	48
rs3775256	CC	Slightly enhanced overall cognitive ability	53
rs4241784	TT	Slightly enhanced overall cognitive ability	53
rs4390263	AG	Slightly enhanced overall cognitive ability	65
rs4680	AG	Moderately enhanced overall cognitive ability	66
rs4683505	CC	Moderately enhanced overall cognitive ability	48
rs53576	GG	Average level of cognitive ability	67

SNP	Your Genotype	Associations	Reference
rs6265	CC	Average level of cognitive ability	68
rs6314	GG	Slightly enhanced overall cognitive ability	69
rs6843082	AA	Average level of cognitive ability	56
rs6935458	AA	Slightly enhanced overall cognitive ability	48
rs6994992	CC	Average level of cognitive ability	70
rs7294919	CT	Slightly enhanced overall cognitive ability	71
rs7427	CC	Moderately enhanced overall cognitive ability	72
rs7515023	CT	Very slightly enhanced overall cognitive ability	73
rs7627367	GT	Very slightly reduced overall cognitive ability	53
rs7713917	AG	Very slightly reduced overall cognitive ability	74
rs7730085	AG	Relatively sub-optimal cognitive ability	53
rs7817820	GG	Moderately enhanced overall cognitive ability	48
rs7897269	TT	Relatively sub-optimal cognitive ability	48
rs956572	AA	Moderately enhanced overall cognitive ability	75

Congratulations! Your combined *genome-wide polygenic score* for these SNPs suggests that you are considerably above-average in your overall cognitive ability!

While these results suggest that your genetic makeup is well-tuned to support optimal cognitive function, there are always at least some factors that we can address to improve our cognitive function even further.

It is important to keep in mind that **optimizing your cognitive function isn't always just about "fixing" genes that are causing "problems" *per se***. For example, some people carry rare SNPs that can **enhance** their cognitive ability, even if the more common variants aren't necessarily associated with *reduced* intelligence. By studying what the latest science can tell us about these people and how their brains work, we can use this information to come up with recommendations that can **allow you to gain the benefits of these "good" variants, even if you don't carry these genotypes yourself!**

Therefore, in the sections below, we use your genetic data for each of the SNPs featured in the above table to provide you with **personalized recommendations** you can use to target specific genes. Some of these suggestions might involve fixing "bad" genes, while others might involve improving "good" ones.

Either way, these actionable recommendations should **help you to boost your cognitive ability even further!**

[CNR1]

Snapshot

- *CNR1* codes for CB1 receptors, which are a critical part of the brain's *cannabinoid system*.
- Your **rs1049353** genotype ('CT') is associated with **increased risk** of experiencing cognitive problems such as **"brain fog"**.
- One of the best lifestyle hacks for your genotype is to try **removing *lectins* and other plant toxins from your diet**.
- One of the best supplements for your genotype is **CBD oil (*cannabidiol*)**.

The *CNR1* gene codes for *CB1 receptors*, one of the main receptors involved in the brain's *cannabinoid system* [76, 77].

Cannabinoid receptors are highly expressed in the brain's **limbic system**, which is why the cannabinoid system is highly involved in **mood**, **wakefulness**, and the regulation of the **stress response**. These receptors are also prominent in several key areas of the brain involved in cognitive processes -- such as the **hippocampus** -- which gives the cannabinoid system a key role in several important biological and cognitive processes including **synaptic plasticity**, **learning**, and **memory** [78, 78].

Cannabinoid receptors are also very widespread throughout the **gut nervous system**, where they play a major role in **counteracting inflammation** [79, 80, 81].

> >>> *To learn more about the brain's cannabinoid system, how it works, and the effects it can have on your mental and physical health, check out this SelfHacked post.*

In general, the variants that people carry in the *CNR1* gene determine how well their cannabinoid receptors work. Because this system has so many different roles in the body, abnormal cannabinoid receptor activity can lead to a complex variety of symptoms, such as increased **inflammation**, **fatigue**, elevated **stress**, **impaired learning and memory**, and even **mood problems** [82, 83, 84].

Interestingly, this range of symptoms closely matches those commonly seen in people who have **"brain fog"**. **Therefore, the variants you carry in this gene can affect your cognitive ability by determining how vulnerable you are to brain fog.**

[rs1049353]

Your genotype for the *CNR1* SNP **rs1049353** ('CT'; *heterozygous*) is associated with **elevated risk of experiencing brain fog**.

Unfortunately, complex disorders such as brain fog have not received much attention from mainstream medicine, and modern science doesn't yet have much to say about its underlying causes, or the best ways to treat it.

However, in Joe's experience from working with thousands of clients, he has repeatedly observed that **brain fog can very often be triggered by underlying dietary sensitivities.**

Therefore, one of the best ways to manage your risk of experiencing brain fog is to take an experimental approach to identifying any possible dietary sensitivities you might have.

One of the main dietary problems that people with brain fog have is lectin sensitivity. Interestingly, many of the symptoms of lectin sensitivity closely match those of brain fog, further reinforcing this connection. **Therefore, we highly recommend that you give the lectin avoidance diet a test-run to see if this might be the case for you!**

> *>>> To learn more about lectins and the negative effects that they can have on your body and brain if you're sensitive to them, check out this SelfHacked post.*

> *>>> To read more about the lectin-avoidance diet and the best ways to follow it, read this SelfHacked post.*

Another potential way to protect yourself against brain fog and improve your cognitive function is to use supplements that boost the activity of your cannabinoid system, such as CBD oil (cannabidiol).

Although it is derived from compounds in marijuana (*cannabis*), **using CBD oil won't make you "high"** (i.e. it is not *psychoactive*) [85, 86, 87, 88]. Nonetheless, the natural cannabinoids in CBD oil have been found to treat many different conditions and symptoms that are involved in brain fog, such as **gastrointestinal inflammation** [80, 89], **oxidative stress** [90, 91, 92], **chronic pain** [92, 93], and **anxiety** and other **mood problems** [94, 95, 87].

CBD oil is also quite safe, even when used for extended periods of time, making it a great supplement to prevent yourself from potentially developing brain fog and other cognitive and mood issues [96].

> *>>> To find out more about the many potential benefits of cannabidiol / CBD oil, and the best ways to use it, check out this SelfHacked post.*

[MTHFR]

Gene Snapshot:

- *MTHFR* codes for an enzyme that regulates folate metabolism and DNA methylation, a process that turns other genes on or off.
- Your genotypes for **rs1801131** and **rs1801133** are linked to **reduced cognitive ability**.
- Some of the best supplements for your genotype include ***L-methylfolate***, **vitamins B6 and B12**, and ***creatine***.
- We also recommend getting your ***homocysteine*** levels checked.

The *MTHFR* gene codes for an enzyme called ***methylenetetrahydrofolate reductase* (MTHFR)**. This enzyme promotes the creation (*metabolism*) of active **folate**, breaks down ***homocysteine***, and helps makes **epigenetic changes** to DNA through ***methylation*** [97, 98, 99]. It is also involved in the creation of several important neurotransmitters, such as **dopamine**, **norepinephrine**, and **serotonin** [100, 101, 102].

Each of these factors are critical for brain function [52, 103, 104, 98], which is why this gene influences

cognitive flexibility (attention), **learning and memory**, and **overall cognitive ability** [52, 105].

There are two SNPs in the *MTHFR* gene that are known to have a significant impact on overall MTHFR production. Your genotype for each of these SNPs can impact your overall cognitive ability:

[rs1801131]

Your genotype for the *MTHFR* SNP **rs1801131** ('TT'; *homozygous major*) is associated with normal levels of overall cognitive ability [52] . **This suggests that your genotype for this SNP is helping you to produce optimal amounts of the MTHFR enzyme** [60]**!**

[rs1801133]

However, your genotype for the *MTHFR* SNP **rs1801133** ('AG'; *heterozygous*) is associated with reduced activity of the *MTHFR* gene, leading to **MTHFR enzyme levels that are ~35% lower than average** [60]. This genotype is also associated with **slightly lower overall cognitive ability** compared to people without the 'A' risk allele (who produce more MTHFR) [52].

Together, these results suggest that your overall MTHFR levels may be lower than optimal.

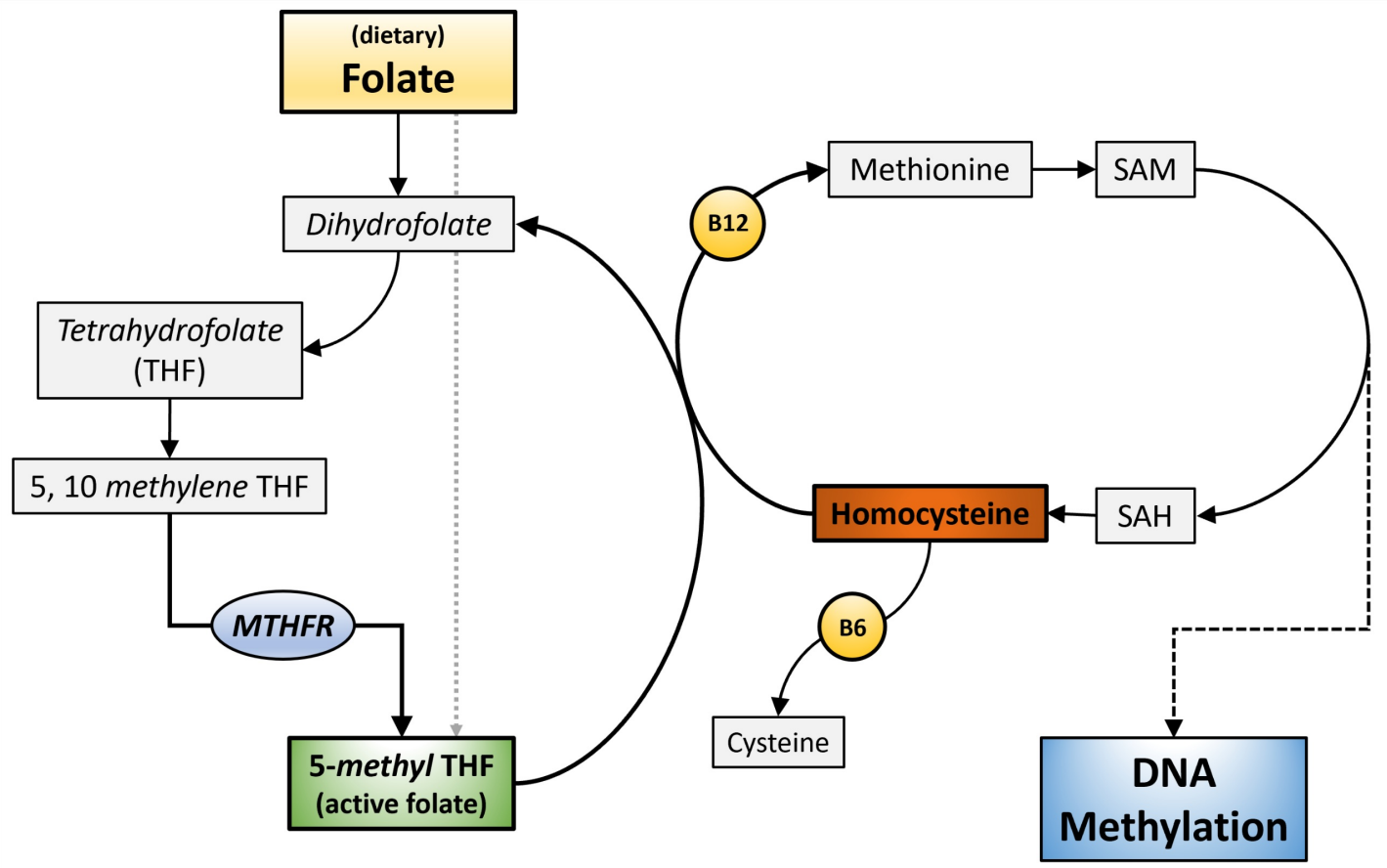
Low *MTHFR* activity can result in elevated levels of *homocysteine*, which may impair cognitive function [106, 107, 108, 109]. Homocysteine levels can also rise if you don't have enough **folate**, **vitamin B6**, and **vitamin B12** [52, 103, 104, 98].

> *>>> To learn more about what homocysteine is, why it can be bad for your health, and the steps you can take to prevent elevated levels of it, check out this SelfHacked post.*

This is where the *MTHFR* gene comes in. **This gene's main function is to convert folate (vitamin B9) from food into its active form, *5-methyltetrahydrofolate* (5-MTHF).** People with risk alleles in the *MTHFR* gene are therefore more likely to have **low levels of active folate** [98, 97, 110].

Without enough active folate and **vitamin B12**, **your body cannot break down *homocysteine*** [98].

Low levels of either active folate **or** vitamin B12 can therefore lead to elevated blood homocysteine, a condition known as ***hyperhomocysteinemia*** [101].



Therefore, you can counteract mutations in the *MTHFR* gene by increasing your levels of active folate [111, 112, 113, 114]. We recommend using supplements with the active ***(L-)methylfolate*** form. We also recommend stopping synthetic folic acid supplements if you are taking them, as these forms are often considerably less effective [115].

It would also be a good idea to supplement with vitamins B6 and B12, which both help break down homocysteine [107, 116, 117, 118]. The **active forms** of these two vitamins, *pyridoxal-5-phosphate* (PLP) and *methylcobalamin*, are most effective [119, 120, 121].

Another good way to counteract reduced MTHFR levels is to supplement with *creatine*. This is because up to half of all the methylation that takes place in your body is to produce creatine -- therefore, you can reduce the total amount of MTHFR you actually need by using supplements to provide your body with creatine directly [122].

Creatine can also help reduce elevated homocysteine levels. Several animal and human studies have found that creatine supplements can decrease homocysteine levels **by 25-50%** after just a few weeks. It may also increase the activity of the MTHFR enzyme directly, making your body more efficient at methylation overall [122, 123, 124].

Best of all, **creatine supplementation improves short-term memory, overall intelligence, and reasoning ability** [125]. Therefore, creatine can not only help correct some of the potential drawbacks of your genotype, but it can also help boost your cognitive ability directly!

> *>>> To learn more about what creatine does and the potential benefits of supplementing with it, check out this SelfHacked post.*

Finally, **many other factors beyond just *MTHFR* gene activity can affect your levels of folate and homocysteine. Therefore, it would be a good idea to check your levels of these important**

compounds, as well as your levels of vitamins B6 and B12. You can analyze these health markers easily by using the **Lab Test Analyzer**. We created this handy health tool to help you evaluate your lab results based on the latest scientific findings, and to deliver personalized dietary and lifestyle tips to help you reach optimal health!

> *>>> To learn more about these MTHFR SNPs and why they are so important for your body and brain, check out our comprehensive SelfHacked post on MTHFR.*

[NOTCH4]

Gene Snapshot:

- *NOTCH4* is part of a network of genes that regulate immunity. It also promotes the growth and development of new neurons.
- Your **rs3131296** genotype ('CC') is linked to **reduced cognitive ability and neuronal growth**.
- Some of the best lifestyle hacks for your genotype include **regular exercise** and **cognitive training programs**.
- Some of the best supplements for your genotype include ***sodium butyrate*** and **curcumin**.

The *NOTCH4* gene is located in the ***major histocompatibility complex*** (MHC), and plays a wide variety of roles in the immune and cardiovascular systems [126, 127].

In the brain, *NOTCH4* is vital for the growth and development of *neural stem cells* (NSCs). It also **helps neurons migrate and form new connections** (in a process called *synaptogenesis*). These roles probably explain how *NOTCH4* influences cognitive function [128, 129, 130, 131].

Genotypes for SNPs in the *NOTCH4* gene have been associated with **general cognitive ability** as well as **overall brain size**—especially in the prefrontal cortex (PFC) [57, 132, 133].

[rs3131296]

Your genotype for the *NOTCH4* SNP **rs3131296** ('CC'; *homozygous major*) is associated with **somewhat lower levels of overall cognitive ability** compared to people without the 'C' risk allele [57]. **This suggests that you may be able to boost your cognitive abilities even further by taking steps to stimulate neurogenesis and promote synaptic plasticity.**

One of the best ways to encourage your brain to grow and develop new neural connections is to engage in regular physical exercise [134, 135, 136, 137].

Exercise boosts neurogenesis and synaptic plasticity in several different ways, such as by **increasing the production of BDNF** [138, 139, 140]. People who exercise regularly also have **increased brain volume**, especially in key memory-related areas like the hippocampus [141, 142, 143, 144].

People who exercise are also more likely to resist cognitive decline during normal aging. This shows just how vital exercise can be for maintaining and promoting your natural cognitive ability throughout your life [145, 140]!

>>> To learn more about the many ways that exercise can promote brain health and cognitive function, check out this SelfHacked post.

>>> To find out more about BDNF, why it's important, and the steps you can take to boost your levels of it, see this SelfHacked post.

You may also benefit from several great supplements. Like exercise, ***sodium butyrate*** **helps promote synaptic plasticity**, thereby supporting your learning and memory abilities [146, 147]. It also **boosts CREB and BDNF**, which stimulates the growth and development of new neurons [148].

>>> To read more about the many potential health benefits of sodium butyrate, check out this SelfHacked post.

Another good choice for you would be bioavailable curcumin, which also enhances cognition by increasing CREB and BDNF, thereby further promoting increased neurogenesis [149, 150, 151].

>>> You can find out more about the many health benefits of curcumin by reading this SelfHacked post.

Finally, numerous studies have found that you can trigger the creation of new neurons through learning and exploration [152, 153, 154, 155]. Therefore, **a key factor in promoting neurogenesis and synaptic plasticity as an adult is to ensure that you get plenty of cognitive stimulation!**

One of the best ways to do this is to use **cognitive training programs**, which have been repeatedly shown to produce **significant enhancements in memory, processing speed, and general reasoning ability** [156].

Although many different cognitive training programs are available, one of the best is the working memory test known as the "*n-back*" task. **Regular training on the n-back task produces significant enhancements in cognitive functioning in both children and adults** [157, 158, 159].

>>> To read more about the natural ways you can boost your brain's synaptic plasticity, check out this SelfHacked post.

>>> To learn all about how you can stimulate neurogenesis naturally, read this SelfHacked post.

[DAB1]

Gene Snapshot:

- *DAB1* helps new neurons grow, get to where the brain needs them, and form connections.
- Your **rs1581762** genotype ('AG') is linked to **decreased connectivity** between neurons in your brain.
- Some of the best supplements for your genotype include ***serine*** and ***glycine***.

The *DAB1* gene stimulates the growth and development of neurons. It also helps these new neurons get to where they are needed in the brain (*neuronal migration*) and form connections with other neurons (*synaptogenesis*) [160, 161].

[rs1581762]

Your genotype for the *DAB1* SNP **rs1581762** ('AG'; *heterozygous*) is associated with **slightly reduced functioning of this gene** [53].

Deficiencies in *DAB1* gene activity have been associated with impaired neural development (reduced number of synapses between neurons). This, in turn, can increase the likelihood of cognitive deficits and various psychiatric disorders (such as schizophrenia, depression, and mania) [160, 161].

However, these negative effects can be reversed with compounds that activate NMDA receptors, such as ***d-cycloserine*** [160, 161]. **This suggests that you may be able to further boost your cognitive ability by supplementing with compounds that stimulate NMDA receptors.**

Two compounds that enhance cognitive function by stimulating NMDA receptors are ***glycine*** and ***serine*** [162, 163, 164, 165, 166].

These compounds also have additional health benefits. For example, ***glycine*** fights inflammation [167], reduces oxidative stress [168], improves blood circulation (especially in the brain) [169, 170], and enhances the absorption, transport, and metabolism of neurotransmitters and essential amino acids throughout the nervous system [171].

Similarly, ***serine*** also boosts synaptic plasticity [163], reduces inflammation [166], and improves blood flow throughout the brain [172, 164].

Therefore, these compounds are good supplementation choices for people with your genotype.

> *>>> To read more about the potential benefits of glycine, check out this SelfHacked post.*

> *>>> To learn more about the different forms of serine and their potential health benefits, read this SelfHacked post.*

[KIBRA / WWC1]

Gene Snapshot:

- *KIBRA* or *WWC1* regulates a type of receptor that promotes the formation of memories.
- Your **rs17070145** genotype ('CC') is linked to **relatively reduced** learning and memory.
- Some of the best supplements for your genotype include **resistant starches** and ***resveratrol***.

The *KIBRA* gene—sometimes also referred to as *WWC1*—promotes **synaptic plasticity**. It regulates the expression of **AMPA receptors**, which help adjust the connections between neurons through a process called ***long-term potentiation***, or LTP [173, 174, 175].

> *>>> To learn more about LTP, why it's important for brain function, and the practical steps you can take to increase it, check out this SelfHacked post.*

KIBRA is expressed throughout the brain, and is particularly concentrated in **memory-related brain areas** such as the prefrontal cortex and the hippocampus [176, 177, 58, 173].

Beneficial alleles in *KIBRA* SNPs have been associated with **enhanced learning and memory**, better **cognitive flexibility**, and **larger brains with more grey matter** [176, 174, 58, 178, 179, 177]. People with these alleles also have brains that communicate more efficiently, allowing them to perform better when they are under a high "cognitive load" — that is, when they have to think really hard [180, 181, 176].

Conversely, having low levels of the *KIBRA* gene may cause reduced synaptic plasticity, which can impair learning and memory [173].

[rs17070145]

Your genotype for the *KIBRA* SNP **rs17070145** ('CC'; *homozygous major*) is associated with **roughly average learning and memory ability** compared to carriers of the beneficial 'T' allele, who have higher levels of this gene as well as enhanced learning and memory [58, 180].

This suggests that you may be able to boost your cognitive ability even further by increasing your *KIBRA* gene activity.

The hormone ***progesterone*** **increases *KIBRA*** [182], as does a drug called ***trichostatin A***, which can triple the production of *KIBRA* by inhibiting *histone deacetylases* (HDACs) [183].

> *>>> To find out more about the functions of progesterone and how you can check and adjust your levels of this important hormone, check out this SelfHacked post.*

Natural fibers like **resistant starches** **feed the good gut bacteria that produce *butyrate*. This short-chain fatty acid may increase the production of *KIBRA* the same way that *trichostatin A* does** (by inhibiting HDACs) [184]. Therefore, **supplementing with butyrate or adding resistant starches to your diet** could be another good way to give your *KIBRA* gene levels a boost!

> *>>> To read more about resistant starches, their potential benefits, and the foods that contain them, see this SelfHacked post.*

> *>>> To learn more about butyrate and its many potential health benefits, check out this SelfHacked post.*

Since the *KIBRA* gene is responsible for creating AMPA receptors, compounds that stimulate AMPA receptor activity may help balance out your genotype. ***Resveratrol*** **is a plant compound that enhances synaptic plasticity by increasing AMPA receptors** [185, 186].

Many foods contain resveratrol, including grapes, berries, several types of nuts, and even red wine. You can also take it as a supplement [187].

> *>>> To find out more about the diverse health effects of resveratrol on your body and brain, read this SelfHacked post.*

Another great way to stimulate AMPA receptors is with the family of cognitive-enhancing ("*nootropic*") compounds known as *racetams* [188, 189, 190, 191]. Although there are many different racetams to choose from, **we would especially recommend *piracetam*** [192, 193]. Piracetam's ability to stimulate AMPA receptors may be one of the reasons it has been linked with **enhanced learning and memory** in both human and animal studies [194, 195]. Piracetam may also help **fight against age-related cognitive decline** as well [196].

> *>>> To learn more about the potential cognitive benefits of piracetam and the best ways to*

supplement with it, check out this SelfHacked post.

[LMX1A]

Gene Snapshot:

- *LMX1A* supports the growth and function of dopamine neurons.
- Your **rs11809911** genotype ('TT') is linked to **relatively reduced** protection of dopamine neurons from oxidative stress.
- Some of the best supplements for your genotype include **PQQ** and **DHA**.

In early development, the *LMX1A* gene supports the growth and development of **dopamine** neurons, which are vital for several key aspects of cognitive function, such as **working memory** [197, 198].

Throughout adulthood, *LMX1A* continues to play an important role by **protecting dopamine neurons from oxidative stress** and **mitochondrial dysfunction** [199]. This helps keep neurons healthy, which supports overall cognitive function.

SNPs in the *LMX1A* gene have been associated with **learning**, several forms of **memory**, and even **overall general intelligence (IQ)** [55, 198, 70].

[rs11809911]

Your genotype for the *LMX1A* SNP **rs11809911** ('TT'; *homozygous minor*) is associated with **roughly average levels of overall cognitive ability** compared to people with the beneficial 'C' allele, who tend to have higher levels of this gene [55, 198, 200].

This gene primarily affects the efficiency of your cell's energy-producing **mitochondria**. **Low levels of *LMX1A* cause mitochondria to become "tired out" more easily** when energy demand is high. **When the mitochondria are tired, they produce more *reactive oxygen species* (ROS)**, the compounds that cause **oxidative stress** [199, 201].

If ROS levels get high enough, they can overwhelm your neurons' natural antioxidant defenses, resulting in cellular damage or even cell death. **Oxidative stress is especially dangerous to dopamine neurons**, which have higher average levels of activity compared to other types of neurons [199, 201].

With these points in mind, **you can potentially enhance your cognitive ability even further by:**

1. **Increasing your levels of *LMX1A***
2. **Reducing oxidative stress**
3. **Boosting mitochondrial function**

Supplementing with *pyrroloquinoline quinone*, or PQQ, is a great way to accomplish all three of these goals.

LMX1A interacts with NRF1 (*nuclear respiratory factor 1*), another major gene involved in antioxidant defense. In fact, animals whose *LMX1A* genes were completely disabled could be brought back to normal

by boosting their levels of the *NRF1* gene [199].

PQQ increases *NRF1* gene activity, which in turn activates *LMX1A* [202]. It also **reduces oxidative stress** and **boosts mitochondrial function** [203, 204, 202].

This makes PQQ a great supplement for people with your *LMX1A* genotype: it protects against cellular stress, and helps reduce and manage those stresses in the first place!

> *>>> To learn more about what PQQ is, how it works, and the potential benefits of supplementing with it, check out this SelfHacked post.*

Another compound that can boost *NRF1* levels is *docosahexaenoic acid*, or DHA. DHA also **boosts mitochondrial function**; thus, it counteracts two of the potential negative effects of your *LMX1A* genotype [205]. DHA is an *omega-3 polyunsaturated fatty acid* (PUFA) found in fish and fish products, including **fish oil**.

> *>>> To find out more about the many diverse health benefits of DHA, read this SelfHacked post.*

[ZFHX3]

Gene Snapshot:

- *ZFHX3* promotes the development of the early nervous system and muscle cells.
- Your **rs2106261** genotype ('TT') is linked to **reduced cognitive ability**.
- Your genotype may also put you at increased risk of **cardiovascular issues**.
- One of the best lifestyle hacks for your genotype is **regular exercise**.
- Some of the best supplements for your genotype include **caffeine** and ***N-acetylcysteine* (NAC)**.

The *ZFHX3* gene (also known as *ATBF1*) codes for *zinc finger homeobox protein 3* [206]. This gene and its protein play many different roles in the body and brain, including **early nervous system development** and **neuronal growth**, as well as the **development of muscle tissue and cells** (*myogenesis*) [207].

Although this gene's functions are still being discovered, **genetic variants in *ZFHX3* have been strongly associated with cardiovascular health**. People with certain genotypes for this gene are at increased risk of cardiovascular problems such as *atrial fibrillation* (AF), elevated blood pressure (*hypertension*), hardening of the arteries (*atherosclerosis*), and strokes [208, 209, 210, 211, 207, 212].

Cardiovascular health can have a profound effect on brain function [213, 214, 215]. For example, people with risk factors in the *ZFHX3* gene are more likely to suffer from "***silent cerebral infarcts***" **(SCIs)**, which are small brain injuries that can occur when blood vessels in the brain are damaged [216, 217, 218].

SCIs are usually fairly minor, and often don't lead to any noticeable health problems, which is why they're called "silent" injuries. **However, these small brain injuries may build up over time, and can eventually result in impaired neural function and reduced cognitive performance**, even in people who never experience a major cardiovascular event (such as a stroke) [219, 220, 221].

This gene's effect on cardiovascular health probably explains why SNPs in this gene have been

associated with differences in **fluid intelligence (IQ)** and **general cognitive ability** [48, 56].

[rs2106261]

Your genotype for the *ZFHX3* SNP **rs2106261** ('TT'; *homozygous minor*) is associated with **somewhat reduced overall cognitive ability** [56, 210].

This suggests that your *ZFHX3* gene may not be functioning optimally. Your genotype may increase your long-term risk of cardiovascular issues and impact your brain's ability to work to its fullest potential [208, 207].

Fortunately, you may be able to counteract these potential negative effects by boosting your cardiovascular health, as well as avoiding factors which can trigger abnormal *ZFHX3* gene activity.

One of the best ways to ensure that your cardiovascular system stays as healthy as possible is to develop a habit of regular exercise. Not only can exercise do wonders for your heart and circulatory system, but **as little as one hour of mild physical activity per week** can be enough to start seeing significant health benefits [222, 223, 224, 225]!

The physical health benefits of exercise have been associated with **enhanced brain function**, **improved cognitive ability**, and even **increased brain size** [135, 226, 227, 228].

> *>>> To learn more about the many ways that exercise can boost the health of your body and brain, check out this SelfHacked post.*

Depending on how much you already consume, it may also be beneficial for you to increase your consumption of caffeine. Caffeine can help counteract the negative effects of *ZFHX3* by protecting neurons from damage and cell death [206, 229]. **Therefore, it may be a good idea to drink more coffee or tea.**

> *>>> To find out more about the many different potential benefits of caffeine, read this SelfHacked post.*

In addition to maintaining a healthy diet and active lifestyle, it would also be a good idea to avoid or protect yourself from some of the factors that can cause abnormal *ZFHX3* gene activity.

One factor that can trigger increased *ZHFX3* activity is oxidative stress, which can lead to neural damage and even cell death [206, 230]. **Oxidative stress is also harmful to the cardiovascular system**, as it damages blood vessels and can cause them to harden over time (contributing to *atherosclerosis*) [231].

Therefore, we highly recommend supplementing with a strong anti-oxidant to address both of these potential negative effects at the same time. One of the best supplements for fighting oxidative stress is ***N-acetylcysteine* (NAC)**, which your body uses to make ***glutathione***, one of your body's strongest natural antioxidant defenses [232, 233].

> *>>> To find out more about the harmful effects of oxidative stress and the steps you can take to protect yourself from them, see this SelfHacked post.*

> *>>> To read more about the many potential benefits you can get by supplementing with NAC, check out this SelfHacked post.*

>>> To learn more about glutathione, what makes it so good at counteracting oxidative stress, and the best ways to boost your levels of it, read this SelfHacked post.

Finally, another factor that can trigger abnormal *ZFHX3* gene activity is high *homocysteine* levels [206, 234]. Homocysteine is an amino acid that is naturally produced in your body, but which can have toxic effects in high amounts [116]. In addition to activating this gene, elevated homocysteine can also contribute to oxidative stress, inflammation, and cardiovascular damage [235, 236, 237].

Therefore, we highly recommend checking your levels of homocysteine, which you can do easily by using the Lab Test Analyzer. If your levels are not in the optimal range, this handy health tool will even give you personalized health recommendations to help you get to healthy homocysteine levels!

>>> To learn more about the negative effects of homocysteine and what you can do to prevent them, check out this SelfHacked post.

[ULK2 & ULK4]

Gene Snapshot:

- *ULK2* and *ULK4* promote the formation of new neurons and connections between neurons.
- Your genotypes for **rs150122** and **rs7627367** are linked to **reduced cognitive ability**.
- Some of the best biohacks for your genotype are **infrared light** or ***low-level laser therapy* (LLLT)**.
- Some of the best supplements for your genotype include **mTOR inhibitors** like **olive oil**, **grape seed extract**, and ***fisetin***.

The *ULK2* and *ULK4* genes code for *unc-like autophagy-activating kinase 2* and *4*. These proteins are involved in the **growth and development of new synapses** between neurons (*synaptogenesis*) [238]. They also **promote the creation of *neural stem cells* (NSCs)**, and help ensure that your brain has enough of these to continually create new neurons (as well as other important brain cells, such as *oligodendrocytes*) [239]. These two genes therefore play a critical role in **synaptic plasticity and neurogenesis**.

The significant impact these genes can have on brain structure and function is probably why SNPs in *ULK2* and *ULK4* have been associated with **overall cognitive ability** and **fluid intelligence (IQ)** [239, 240, 57, 53].

[rs150122]

Your genotype for the *ULK2* SNP **rs150122** ('TT'; *homozygous major*) is associated with **enhanced overall cognitive ability** [57]**!** This suggests that **your *ULK2* gene levels are optimal!**

[rs7627367]

However, your genotype for the *ULK4* SNP **rs7627367** ('GT'; *heterozygous*) is associated with **slightly lower levels of fluid intelligence** compared to people without the 'G' risk allele [53]. This suggests that your ULK4 gene levels may be slightly lower than optimal.

Together, these results suggest that your overall *ULK* gene levels may be slightly lower than optimal, which could result in reduced synaptic plasticity and neurogenesis. For example, animals that are deficient in *ULK* genes often have abnormal neural development and cognitive impairments [240, 241]. **Therefore, you may be able to boost your cognitive function further by stimulating neurogenesis and synaptic plasticity.**

One good way to accomplish this is to use an infrared light or *low-level laser therapy* (LLLT) device. These techniques—also known as ***photo-bio-modulation* (PBM) therapy**—involve shining certain wavelengths of light on different parts of the body to stimulate a variety of important biological processes [242, 243, 244].

When used on the head, these light therapy devices can **enhance synaptic plasticity** by increasing **BDNF** levels [245, 244, 246, 247]. They can also **boost neurogenesis** by increasing the number of stem cells your body produces [244, 246, 248].

The many health effects of light therapy can also directly translate to cognitive enhancements [244, 246]. Infrared and LLLT have been linked to **enhanced attention**, **learning**, **memory**, **cognitive flexibility**, and **processing speed** in healthy human subjects [242, 249, 250, 251, 252, 253].

Finally, PBM therapies can also help **give your mood a boost**, and even reduce symptoms of depression and anxiety [253, 250, 243, 242, 249]. **All together, this wide range of physical and psychological benefits make light therapy a great choice for your genotype!**

> *>>> To learn more about how infrared light therapy works, and the best ways to use it, check out this SelfHacked post.*

> *>>> To read more about the benefits of LLLT, its health effects, and the best strategies for using it at home, see this SelfHacked post.*

The *ULK* genes are also involved in stimulating *autophagy* [254, 255, 256, 257]. Autophagy is a kind of **"recycling process"** that cells go through to remove toxins, increase their energy efficiency, and regrow important parts of the cell (such as the *mitochondria*) [258, 259].

Autophagy is associated with many health benefits, and has even been linked to **increased overall lifespan** [260, 259]. However, **autophagy may be impaired in people with lower *ULK* gene levels** [261, 262, 263, 264]. **Therefore, it would also be a good idea to take supplements that can help you increase autophagy.**

One of the main factors that can reduce autophagy is your level of a compound called *mammalian target of rapamycin*, or mTOR for short. mTOR inhibits the *ULK* genes and prevents cells from undergoing autophagy [254, 265, 266]. If the neurons in your brain cannot undergo autophagy, synaptic plasticity and memory may be impaired [267].

Therefore, we recommend taking supplements that can reduce mTOR activity, such as:

- **Extra-virgin olive oil** [268]
- **Grapeseed extract** (which contains *anthocyanidins*, a type of *polyphenol*) [269]
- **Fisetin** [270]
- ***N-acetyl cysteine* (NAC)** [271]

- **Curcumin** [272, 273, 274]
- **Fish Oil** (contains *polyunsaturated fatty acids*, or PUFAs) [275]

>>> To learn more about autophagy and why it's so important for your overall health and longevity, check out this SelfHacked post.

>>> To read more about how mTOR works, its effects on your health, and a comprehensive list of all the different supplements you can take to reduce your mTOR levels, see this SelfHacked post.

[RELN]

Gene Snapshot:

- *RELN* codes for a protein that helps new neurons move to where they are needed and form connections with other cells.
- Your **rs2711870** genotype ('CT') is linked to **reduced cognitive flexibility and neurogenesis**.
- Some of the best lifestyle hacks for your genotype include **yoga**, **meditation**, and **regular exercise**.
- Some of the best supplements for your genotype include ***sodium butyrate*** and ***s-adenosyl methionine* (SAM)**.

The *RELN* gene codes for ***reelin***, a protein which helps new neurons move to where they are needed in the brain and form connections with other cells. **This gene therefore plays a key role in overall synaptic plasticity** [276, 277, 278, 279, 280].

Reelin is expressed in many regions throughout the brain, although it is particularly abundant in the **hippocampus** and **medial prefrontal cortex (mPFC)**. Carriers of certain *RELN* gene variants show abnormal structure and function of these regions, which is probably one of the main reasons why this gene has significant effects on cognition [281, 282, 283].

SNPs in the *RELN* gene have been linked to differences in **learning**, **memory**, and **cognitive flexibility** (executive function) [280, 64, 284, 285].

[rs2711870]

Your genotype for the *RELN* SNP **rs2711870** ('CT'; *heterozygous*) is associated with **slightly reduced cognitive flexibility** compared to people without the 'T' risk allele [64].

This suggests that your reelin levels may be a bit lower than optimal. Low *RELN* gene activity is associated with cognitive impairments and reduced synaptic plasticity in both humans and animals [286, 278, 287, 288, 279, 282]. Conversely, **boosting reelin levels leads to increased synaptic plasticity and enhanced cognitive performance** in mice, and may have **potential as a cognitive enhancer** in humans as well [280, 289].

Therefore, you can potentially boost your cognitive ability even further by increasing your levels of reelin.

One major factor that can suppress your reelin levels is stress. Whenever we experience stress, our brain releases *glucocorticoids*, a family of hormones that includes the well-known stress hormone ***cortisol***. Cortisol and other glucocorticoids can significantly reduce reelin levels [281, 290, 283].

Therefore, a good general recommendation would be to reduce your stress levels and improve your resilience to stress. Stress-busting hobbies like **yoga** [291, 292, 293], **meditation** [294, 295, 296], or **exercise** [297, 298, 299, 300] are great ways to do this.

> *>>> To read more about the many different techniques and lifestyle hacks you can use to reduce and counteract stress, check out this SelfHacked post.*

Another major reason your *RELN* gene activity can be low is due to epigenetic factors. Normally, your body uses a process called ***methylation*** to turn certain genes on or off. **People with low reelin levels often have *RELN* genes that have been deactivated ("*hypermethylated*")** [301, 302].

> *>>> To learn more about DNA methylation and how it works, see this SelfHacked post.*

Therefore, you may also be able to boost your *RELN* levels by supplementing with compounds that can prevent or reverse excessive DNA methylation.

One great supplement choice for your genotype is *sodium butyrate*, which can reduce methylation (by inhibiting *histone deacetylase*, or HDAC) [303, 304, 147, 305]. Sodium butyrate also has a number of significant cognitive benefits, such as **enhancing memory**, **increasing neurogenesis**, and **boosting synaptic plasticity** [148, 146].

> *>>> To read more about the many potential benefits of sodium butyrate and the best ways to supplement with it, check out this SelfHacked post.*

Another good supplement choice for you would be *glycine*, which also counteracts hypermethylation (by reducing levels of ***s-adenosyl methionine* (SAM)** and various types of *methyl groups*) [306, 307, 308]. Similar to butyrate, **glycine also acts as a cognitive enhancer** (by stimulating NMDA receptors) [309, 310, 311, 312].

> *>>> To learn more about glycine, how it works, and the potential benefits you can get by supplementing with it, read this SelfHacked post.*

Finally, one last factor that could be affecting your reelin levels are thyroid hormones such as T3. Rats with under-active thyroid glands (*hypothyroidism*) show decreased activity of the *RELN* and *BDNF* genes in the hippocampus, a key brain structure involved in learning and memory [313].

Conversely, **increasing T3 levels (with hormone injections, for example) increases the activity of *RELN* and *BDNF*** [314]. Therefore, **it would be a good idea to check your levels of T3 and other important thyroid hormones to see if they are optimal**, which you can do easily using the **Lab Test Analyzer**.

> *>>> To learn more about the different types of thyroid hormones and why they are important for many different aspects of your mental function, read this SelfHacked post.*

> *>>> To read more information about the T3 thyroid hormone and how it affects your health, check out this SelfHacked post.*

[NFKBIL1]

Gene Snapshot:

- *NFKBIL1* is part of a network of genes that regulate immunity and inflammation.
- Your **rs2230365** genotype ('CC') is linked to **relatively reduced processing speed** and **relatively increased sensitivity to inflammation**.
- One of the best biohacks for your genotype is ***low-level laser therapy*** **(LLLT)**.

The *NFKBIL1* gene is a part of the human ***major histocompatibility complex*** (MHC), a large network of genes that determine the overall function of the immune system [315].

This gene codes for *NF-kappa-B inhibitor-like protein 1*, a protein that suppresses the inflammatory response. This protein imitates a compound called *IkB*, which counteracts inflammation by inhibiting a pro-inflammatory protein called ***NF-kB*** [316, 317].

Carriers of low-activity genotypes for *NFKBIL1* are at generally increased risk for **disorders that involve excessive inflammation**, such as **arthritis** and **cardiovascular disease** [318, 316, 319].

The cognitive effects of low *NFKBIL1* activity most likely stem from **the brain's high sensitivity to inflammation**, which is probably why SNPs in this gene have also been associated with important cognitive functions such as **processing speed** [61].

[rs2230365]

Your genotype for the *NFKBIL1* SNP **rs2230365** ('CC'; *homozygous major*) is associated with **roughly normal processing speed** compared to people with the beneficial 'T' allele, who have increased resistance to inflammation [61].

This suggests that you may be able to further enhance your cognitive ability by improving your brain's ability to suppress and counteract inflammation.

One of the most effective ways to reduce inflammation is to use *low-level laser therapy* (LLLT). This involves shining a specially-designed set of lights (usually LEDs) on whatever part of the body you're trying to treat: in this case, the head. This light passes through your skin and bones to stimulate many different mechanisms related to inflammation, pain, blood flow, and other important systems.

> *>>> To learn more about how LLLT works, its potential benefits, and how to use it effectively, see this SelfHacked post.*

LLLT is especially good at treating inflammation. It can **directly counteract your genotype** by inhibiting **NF-kB** [320, 321, 322, 323]. It also decreases many other inflammatory markers, such as TNF-alpha, COX-2, *nitric oxide synthase* (NOS), and several types of *interleukins* (such as IL-1 and IL-6) [247, 324, 325].

LLLT also has other major health benefits, such as increasing your production of **BDNF** and **NGF** [247, 323], as well as reducing **oxidative stress** [324, 326]. Cumulatively, these many effects may explain why LLLT has also been associated with **significant cognitive benefits** such as **improved attention, learning,**

and memory [323, 327]. It also has other psychological benefits, such as **boosting your mood** [327, 328]**!**

>>> To learn more about how inflammation may be contributing to negative cognitive symptoms and what you can do about it, check out our comprehensive SelfHacked post on "brain fog".

>>> To find out more about how you can test yourself to find out if your body and brain are suffering from the effects of chronic inflammation, check out this SelfHacked post.

[RGS7]

Gene Snapshot:

- *RGS7* codes for a signaling protein that promotes learning, memory, reward processing, and motivation.
- Your **rs7730085** genotype ('AG') is linked to **relatively reduced** cognitive ability.
- One of the best lifestyle hacks for your genotype is **cold exposure** through **cryotherapy**.

The *RGS7* gene codes for *regulator of G-protein signaling 7*, a protein that supports *long-term depression* (LTD), one of the main mechanisms involved in **synaptic plasticity** [329].

Although *RGS7* is expressed throughout the whole brain, it is especially prominent in the hippocampus, giving this gene an important role in **learning and memory** [330, 331]. *RGS7* is also very active in brain areas related to **reward processing** (such as the striatum and the ventral tegmental area, or VTA), giving it a key role in **motivation and mood** [331].

SNPs in the *RGS7* gene have been associated with **unusually high general intelligence (IQ)** [332, 73] and **fluid intelligence** [53].

[rs7730085]

Your genotype for the *RGS7* SNP **rs7730085** ('AG'; *heterozygous*) is associated with **roughly average levels of general intelligence** compared to people with the beneficial 'AA' genotype, which has been linked to enhanced cognitive function [332, 53].

This suggests that your levels of the *RGS7* gene may be lower than optimal. For example, low *RGS7* activity has been found to impair learning and memory in several animal studies [329, 331]. In humans, *RGS7* activity is often reduced in people with disorders involving cognitive deficits (such as Alzheimer's disease). All of this suggests that low *RGS7* activity is related to cognitive decline [333, 334]. **Therefore, you may be able to boost your cognitive ability by increasing your *RGS7* gene activity.**

You can directly increase *RGS7* gene expression by being exposed to cold temperatures. For example, rats subjected to chronic cold stress showed significant increases in *RGS7* activity [335].

We generally think of stress as a bad thing, but **voluntarily putting your body under controlled amounts of physical stress can actually be very healthy!** Therefore, getting into the habit of taking **cold showers**, **ice baths**, or even undergoing **cryotherapy** can be a great way to boost *RGS7*. **Cold exposure can also increase your metabolism, reduce inflammation, strengthen your immune system, and improve your**

sleep [336, 337, 338, 339, 340].

> >>> *To learn more about the potential benefits of cold exposure, check out our series of SelfHacked posts on different forms of cold therapy here and here.*

[SLC19A1]

Gene Snapshot:

- *SLC19A1* codes for a carrier protein that transports folate.
- Your **rs1051266** genotype ('CT') is linked to **reduced cognitive ability**.
- One of the best supplements for your genotype is ***L-methylfolate***.

The *SLC19A1* gene codes for a protein called *solute carrier family 19A member 1*. This protein is a **folate transporter**, meaning that it is required for the **transport**, **absorption**, and **metabolism** of ***folate*** throughout your body.

Your levels of folate—as well as other closely-related compounds such as vitamin B12 and *homocysteine*—can have a significant impact on brain function [341, 342, 343, 344, 345, 346, 101, 347]. This is most likely why SNPs in this gene have been associated with **learning and memory**, **cognitive flexibility** (attention and executive function), and **overall cognitive ability** [52].

[rs1051266]

Your genotype for the *SLC19A1* SNP **rs1051266** ('CT'; *heterozygous*) is associated with **slightly reduced overall cognitive ability** compared to people without the 'C' risk allele [52]. **This suggests that you may be able to boost your cognitive function by increasing your overall levels of folate.**

By far the best way to give your folate levels a boost is to supplement with the active form of folate, *L-methylfolate*. Other common types of folate supplements typically contain *folic acid*, a synthetic form of folate which is far less effective and more difficult to absorb (less *bioavailable*) [348, 115].

Folic acid can also accumulate in the blood when your body can't metabolize it fast enough, which can interfere with your immune system. Therefore, we also recommend stopping folic acid supplements if you are already taking them [349, 350].

> >>> *To read more about the importance of folate and its effects on your health, see this SelfHacked post.*

> >>> *To find out more about the potential benefits of L-methylfolate and the best ways to supplement with it, check out this SelfHacked post.*

Many other factors can also affect your levels of folate, vitamin B12, and homocysteine, each of which can have negative effects on your brain if their levels are too low or too high. Therefore, **it would also be a good idea to get your levels of these important nutrients and compounds checked out to see if they are in the optimal range.** One of the easiest ways to do this is to use the **Lab Test Analyzer**, a handy health tool we developed to help track and optimize your levels of the most important compounds for

your overall health!

[ST8SIA6]

Gene Snapshot:

- *ST8SIA6* codes for an enzyme that promotes the growth of new neurons.
- Your **rs7897269** genotype ('TT') is linked to **relatively reduced** crystallized intelligence.
- One of the best lifestyle hacks for your genotype is **sun exposure**.
- Some of the best supplements for your genotype are **DHA-containing fats** like **fish oil**, **krill oil**, and **ghee**.

The *ST8SIA6* gene codes for codes for a type of ***sialyltransferase***, an enzyme that converts ***sialic acid*** into secondary products (such as *glycoproteins* and *gangliosides*) that your brain needs to develop properly [351, 352, 353].

These compounds are also needed to support **neurogenesis** [354] and **synaptic plasticity** [355, 356], which is probably why this gene affects cognitive ability in adults. For example, the *sialic acid* pathway plays a central role in activating ***nerve growth factor*** **(NGF)**, which, in turn, **encourages neuronal growth** [351].

[rs7897269]

Your genotype for the *ST8SIA6* SNP **rs7897269** ('TT'; *homozygous major*) is associated with **roughly average levels of crystallized intelligence** compared to carriers of the beneficial 'C' allele [48].

This suggests that your *ST8SIA6* gene activity may be reduced. You may therefore have low levels of *sialic acid*, which may be holding back some of your cognitive potential!

For example, higher levels of sialic acid (and its main byproducts) are associated with enhanced learning and memory [351], whereas low levels of these compounds may reduce cognitive ability by impairing the generation of new neurons from *pluripotent stem cells* (PSCs) [354]. **Therefore, you can potentially enhance your cognitive ability even further by increasing your *ST8SIA6* gene activity, as well as by boosting your overall levels of sialic acid.**

One potential way to directly increase your levels of this gene is to increase the amount of sunlight you get. This is because your *ST8SIA6* gene activity depends on your **circadian rhythm**, the "**internal clock**" that regulates important daily behaviors such as **appetite** and **sleep** [357, 358].

Although many factors can affect your circadian rhythm, one of the most important is how much light exposure you get [359, 360]. Researchers have found that **even brief exposure to light can provide a boost to *ST8SIA6* gene activity in your brain** [361].

> *>>> To learn more about the many physical and psychological health benefits of sunlight, check out this SelfHacked post.*

Another way to potentially boost your cognitive function is to supplement with sialic acid directly. A

large number of human and animal studies have shown that supplementation with sialic acid (or some of its closely-related products, such as *gangliosides*) can benefit brain health and cognitive function [351, 362, 363].

Finally, a number of other important compounds may strengthen the benefits of sialic acid on brain health and cognitive ability.

For example, **levels of sialic acid are correlated with levels of *omega-3 poly-unsaturated fatty acids* (PUFAs)**, such as **DHA** [351]. This suggests that these compounds may act together to support optimal brain function [355, 356, 351]. Therefore, it could be a good idea to **increase your dietary intake of DHA**. **Fish oil**, **krill oil**, and **ghee butter** are all great sources of DHA and other omega-3 fatty acids.

> *>>> To read more about DHA, its many potential health benefits, and the best ways to increase your intake of it, see this SelfHacked post.*

Another important compound is *albumin*, a major blood protein that helps sialic acid and its byproducts cross the *blood-brain barrier* (BBB) so that they can effectively boost brain function. Therefore, it would be a good idea to **get your albumin levels checked out to make sure that they are not too low**. One easy way to do this is to use the **Lab Test Analyzer**. This simple tool will not only tell you if your levels are optimal, but also provides you with personalized health and lifestyle tips to help you maximize your health!

> *>>> To learn more about albumin and the roles it plays in supporting the health of your body and brain, check out this SelfHacked post.*

[COMT]

Gene Snapshot:

- *COMT* breaks down the neurotransmitters dopamine, epinephrine, and norepinephrine.
- Your **rs4680** genotype ('AG') is linked to **somewhat increased cognitive flexibility and working memory** -- but you can probably boost these benefits even further!
- Some of the best supplements for your genotype include ***fisetin*** and ***quercetin***.

The *COMT* gene codes for an enzyme called *catechol-o-methyltransferase* (COMT), which breaks down the neurotransmitters **dopamine**, **epinephrine**, and **norepinephrine** [364].

Some people carry genetic variants that reduce the activity of the COMT enzyme by up to 75%. This means that carriers of these variants have **significantly higher levels of dopamine** in the prefrontal cortex (because much less of it gets broken down by COMT) [364, 365, 366, 367].

This impressive variation in dopamine activity is probably the reason for this gene's significant cognitive effects. People who produce less COMT often have **higher IQs**, enhanced **cognitive flexibility**, and better **working memory** [66, 365, 366, 364, 368].

[rs4680]

Your genotype for the *COMT* SNP **rs4680** ('AG'; *heterozygous*; also known as the '*val/met*' polymorphism) is associated with **slightly enhanced cognitive ability** [369, 365, 66]**!**

While you produce slightly less COMT than the average person, the highest level of cognitive ability is associated with people who carry the 'AA' ('*met/met*') genotype, whose COMT levels are the lowest of all genotypes [364]. **This suggests that you may be able to further enhance your cognitive potential by reducing your COMT activity.**

> >>> *To learn more about this gene and its many important roles in your body and brain, check out our detailed SelfHacked post on COMT.*

Fisetin **is a plant flavonoid that can inhibit COMT activity** [370]. It also fights inflammation, prevents cancer, and promotes brain growth by increasing BDNF [371, 372, 373].

Fisetin also enhances learning and memory, reduces oxidative stress, fights against age-related cognitive decline, and acts as **a general cognitive enhancer** [374, 373, 375].

This amazing compound may even increase overall lifespan: it activates *SIRT-1* [376], a gene associated with longevity [377, 378].

Fisetin is found in many fruits and vegetables -- such as strawberries, apples, persimmons, grapes, onions, and cucumbers -- and can also be taken as a supplement [371].

> >>> *To learn more about the many potential benefits of fisetin, check out this SelfHacked post.*

Another flavonoid that inhibits COMT is ***quercetin*** [379, 370, 380]. Quercetin is a potent antioxidant that fights inflammation, boosts the immune system, protects the cardiovascular system, and may even help prevent cancer [381, 382, 383, 384, 385]. Quercetin also improves learning and memory in mice [384, 386], and reduces cognitive dysfunction in mouse models of Alzheimer's disease [387].

Quercetin is safe when taken as a supplement [388, 383]. It can be found in many fruits and vegetables, nuts, honey, raw capers, and black and green tea [389].

> >>> *To find out more about the many potential benefits of quercetin, read this SelfHacked post.*

[DRD2]

Gene Snapshot:

- *DRD2* codes for a type of receptor that inhibits dopamine activity in the brain.
- Your **rs1800497** genotype ('GG') is linked to **relatively reduced** cognitive ability.
- One of the best lifestyle hacks for your genotype is **regular exercise**.
- Some of the best supplements for your genotype include **tyrosine**, ***Bacopa monnieri*** and ***Mucuna pruriens***.

The *DRD2* gene codes for the **D2 dopamine receptor** [59]. Unlike several other major types of dopamine receptor, **DRD2 receptors are** ***inhibitory*** [390, 391]. **This means that having more of them results in lower overall dopamine levels in the brain, and vice-versa** [392, 393, 394, 395].

Because dopamine is highly involved in **reward processing**, **motivation**, and many other processes critical for proper cognitive function, SNPs in the *DRD2* gene can have a significant impact on overall cognitive ability [396, 397, 398, 399].

In this light, it is not too surprising that SNPs in this gene have been associated with **cognitive flexibility** [400, R, 401], **learning and memory** [402, 397, 403], **working memory** [404, 392, 405], **problem-solving ability**, **creativity**, and **overall intelligence (IQ)** [59, 33].

[rs1800497]

Your genotype for the *DRD2* SNP **rs1800497** ('GG'; *homozygous major*) is associated with **roughly normal levels of cognitive ability** compared to carriers of the beneficial 'A' allele, who show increased cognitive ability [59, 403, 405].

The beneficial 'A' allele enhances cognitive function by elevating dopamine levels [403, 405, 395]. This suggests that **you can potentially boost your own cognitive ability even further by increasing your brain's levels of dopamine.**

Getting plenty of regular exercise is one of the best ways to boost your dopamine levels. Exercise increases the production (*synthesis*) and release of dopamine, as well as reduces the rate at which it is broken down (*metabolized*) [395, 406, 407, 408].

These dopamine-boosting effects are particularly prominent in the prefrontal cortex (PFC) [409, 407], which is probably what accounts for exercise's significant benefits on cognition and mood [407, 410].

Better yet, **the cognitive benefits of exercise tend to be even stronger in people with lower baseline levels of dopamine** [411, 412, 413]. In fact, it **may directly counteract the negative effects of your *DRD2* genotype**. Exercise doesn't just reduce ("*down-regulate*") the number of inhibitory DRD2 receptors; it also increases ("*up-regulates*") other dopamine receptors, such as the D1 type. In other words, **exercise makes your brain more sensitive to dopamine** [391, 414, 415].

> *>>> To learn more about the many diverse physical and mental health benefits of exercise, read this SelfHacked post.*

Many different natural supplements can increase your dopamine levels. One particularly good choice is *tyrosine*. This amino acid is a *metabolic precursor* of dopamine; that is, your brain uses tyrosine to make dopamine [416].

Supplementing with tyrosine therefore gives your brain the critical building blocks it needs to create dopamine and directly increases overall dopamine levels [417, 418, 416]. These increases, in turn, can **enhance several important cognitive functions**, such as **cognitive flexibility** [419, 420, 421].

> *>>> To learn more about tyrosine and its many potential health benefits, read this SelfHacked post.*

Two other handy, all-natural supplements for your genotype are *Bacopa monnieri* and *Mucuna pruriens*. *Bacopa* **enhances cognitive function** by boosting dopamine levels, and is widely used as a cognitive enhancer (or "*nootropic*") [422, 423, 424, 425].

Mucuna contains **L-DOPA** (*levodopa*) which, like tyrosine, is an important metabolic precursor of dopamine [426]. L-DOPA can be especially beneficial because it readily crosses the *blood-brain barrier* (BBB), allowing it to easily and effectively reach the brain [427]. It has also been found to **enhance**

learning and memory [428, 429, 430].

>>> For a detailed list of over 54 different ways you can further boost your dopamine levels, check out our comprehensive SelfHacked post on increasing dopamine.

>>> To learn more about DRD2 and other genes related to dopamine function, have a look at this SelfHacked post.

[HOMER1]

Gene Snapshot:

- *HOMER1* codes for part of a glutamate receptor that supports learning and memory.
- Your **rs7713917** genotype ('AG') is linked to **decreased cognitive function**.
- One of the best lifestyle hacks for your genotype is **regular exercise**.
- One of the best supplements for your genotype is ***Semax***.

The *HOMER1* gene codes for a protein that helps create *metabotropic glutamate receptors* (mGluRs). These receptors allow calcium to flow into cells, which is one of the main triggers of **synaptic plasticity** between neurons. This gene therefore plays an important role in **learning and memory** [431, 432, 433, 434].

SNPs in the *HOMER1* gene have also been associated with **processing speed**, **cognitive flexibility**, **fluid intelligence (IQ)**, and **overall brain size** (grey matter volume) [74, 48, 435].

[rs7713917]

Your genotype for the *HOMER1* SNP **rs7713917** ('AG'; *heterozygous*) is associated with **slightly reduced cognitive ability** compared to people without the 'A' risk allele [74, 435]. **This suggest that your *HOMER1* levels may be lower than optimal.**

Lower levels of *HOMER1* and fewer mGluRs are both associated with impairments in learning, memory, and synaptic plasticity [436, 433, 437]. Conversely, **higher *HOMER1* and more mGluRs have been linked with superior learning and memory** in rat studies [436, 438].

Therefore, this suggests that you can potentially enhance your cognitive ability by stimulating your brain's glutamate system.

One great way to stimulate your brain's glutamate system is through exercise. For example, vigorous exercise (defined as reaching about 85% of your maximum heart rate) increases the combined levels of glutamate and glutamine (a major metabolic precursor of glutamate) by up to **around 20%** [439, 440].

Exercise also causes your body to produce *lactate*. Lactate is an important ingredient for creating glutamate and therefore can help boost this important neurotransmitter even further [440]. Lactate is also a major energy source for the brain, and even **enhances cognitive performance by promoting synaptic plasticity and memory formation** (by stimulating NMDA receptors) [441, 442, 443].

>>> To learn more about the many benefits that exercise can have on your cognition and mood, read this SelfHacked post.

You may also want to consider supplementing with the nootropic compound *Semax*, which can directly counteract the effects of your genotype in two ways.

First, it **increases *HOMER1* expression** by increasing the *BDNF* gene, boosting your overall synaptic plasticity [444, 445, 446].

Second, Semax also **directly stimulates mGluR receptors**, giving your glutamate system even more of a boost [447]!

These two effects are probably why Semax has been linked with **cognitive benefits** such as **improved memory** [448, 449, 450]. It also has additional benefits, such as **improving blood flow to the brain** [451] and **fighting against oxidative stress** [452, 453, 454].

>>> To learn more about Semax and its many potential benefits, check out this SelfHacked post.

Conclusion

The following is a prioritized list of all of the gene-specific suggestions made throughout your report:

1. Get plenty of regular **exercise**.
2. Use the **Lab Test Analyzer** to make sure that your levels of **folate**, **vitamin B12**, and ***homocysteine*** are not causing problems.
3. Use ***photo-bio-modulation*** (PBM) therapy devices, such as ***low-level laser therapy*** **(LLLT)** or **infrared light**.
4. Supplement with ***sodium butyrate*****,** and/or increase your dietary consumption of **resistant starch**.
5. Increase your levels of **folate** by supplementing with ***L-methylfolate***.
6. Get regular **cold exposure**, such as by taking cold showers, ice baths, or other forms of **cryotherapy**.
7. Increase the amount of **natural sunlight** you get.
8. Supplement with ***glycine***.
9. Test out if you have **lectin sensitivities** by trying the ***lectin avoidance diet***, and supplement with **CBD oil**.
10. Supplement with ***pyrroloquinoline quinone*** **(PQQ)**.
11. Ensure that your blood levels of **albumin** are optimal by using the **Lab Test Analyzer**.
12. Get your levels of **T3** and other important **thyroid hormones** checked out, such as by using the **Lab Test Analyzer**.
13. Supplement with ***fisetin***.
14. Increase your consumption of ***resveratrol***, or supplement with it directly.
15. Increase your consumption of **omega-3** ***poly-unsaturated fatty acids*** **(PUFAs)**, such as by supplementing with **fish oil** or **krill oil**, or by consuming ***ghee*** **butter**.
16. Supplement with the *nootropic* ***piracetam***.
17. Make sure you get plenty of **cognitive stimulation**, whether by learning and practicing new skills, or using cognitive training programs (such as the "***n-back***" task).
18. Supplement with ***n-acetyl cysteine*** **(NAC)**.
19. Stimulate your body's ability to undergo **autophagy** by **inhibiting mTOR** (such as by consuming **olive oil** or supplementing with **grapeseed extract**).

20. Supplement with **bioavailable curcumin**.
21. Supplement with the dopamine precursor ***tyrosine***.
22. Supplement with ***creatine***.
23. Supplement with ***Semax***.
24. Take steps to **reduce your stress levels**, such as by building a habit of **yoga** or **meditation**.
25. Supplement with ***Quercetin***.
26. Supplement with ***serine***.
27. Supplement with products made from the ***Mucuna pruriens*** plant.
28. Increase your consumption of the omega-3 fatty acid ***docosahexaenoic acid*** **(DHA)**, for example by supplementing with **fish oil**.
29. Use supplements and foods to boost your levels of ***sialic acid***.
30. Increase your consumption of **caffeine**, such as by drinking more tea or coffee.
31. Supplement with products made from the ***Bacopa monnieri*** plant.
32. Supplement with vitamins **B6** and **B12**, or increase your dietary consumption of these nutrients.
33. Supplement with ***lithium orotate***.

This concludes your SelfDecode Cognitive Function DNA Wellness Report -- we hope you found it informative and enlightening!

The goals of this report were:

1. To introduce you to the basic science of what your genes are, and how they work.
2. To show how your genotype for different SNPs are associated with a variety of cognitive processes, such as learning, memory, and general intelligence.
3. To illustrate how individual SNPs and genes may be impacting the way your brain functions, which can affect how effectively you are able to use your cognitive abilities to their fullest potential.
4. To demonstrate how having access to this information can help you make more educated decisions about your lifestyle, diet, and supplements to live a healthier and happier life.

If you'd like to learn more, we encourage you to:

- Use **SelfDecode** to explore your genetics further.
- Check out our **Gene Reports** page to learn more about the other specialized DNA Wellness Reports we offer.
- Check back in with us to receive updated versions of the reports you have already purchased.
- Get in touch! We'd love it if you let us know how this report helped you improve your health, as well as what new information or features you would like to see in future versions.

The science behind personalized genetics is rapidly growing and is making new discoveries every day. **At SelfDecode, we are committed to staying on the cutting edge of all of the latest science.** This exciting field is constantly producing new findings and challenging existing ideas -- and for this reason, **we encourage all our readers to check back regularly as we continue to incorporate the latest findings into our Gene Reports!** No report on the market will have 100% of all the existing scientific information, but we strive to provide the most comprehensive reports available. Email alerts regarding new versions of this report will be sent so you can continue to access the latest scientific information about your genetics and your health.

References

1. https://doi.org/10.1016/S0160-2896(97)90014-3
2. https://www.ncbi.nlm.nih.gov/pubmed/22614288
3. https://www.ncbi.nlm.nih.gov/pubmed/29335645
4. https://www.ncbi.nlm.nih.gov/pubmed/23358156
5. https://www.ncbi.nlm.nih.gov/pubmed/30093342
6. https://www.ncbi.nlm.nih.gov/pubmed/26766880
7. https://www.ncbi.nlm.nih.gov/pubmed/19234402
8. https://www.ncbi.nlm.nih.gov/pubmed/26213105
9. https://www.ncbi.nlm.nih.gov/pubmed/30828294
10. https://www.ncbi.nlm.nih.gov/pubmed/23501967
11. https://www.nature.com/articles/mp2014105
12. https://www.ncbi.nlm.nih.gov/pubmed/20145623
13. https://www.ncbi.nlm.nih.gov/pubmed/19294424
14. https://www.ncbi.nlm.nih.gov/pubmed/29942086
15. https://www.ncbi.nlm.nih.gov/pubmed/30104425
16. https://www.ncbi.nlm.nih.gov/pubmed/25224258
17. https://www.ncbi.nlm.nih.gov/pubmed/25251485
18. https://www.ncbi.nlm.nih.gov/pubmed/17593874
19. https://www.ncbi.nlm.nih.gov/pubmed/23746839
20. https://www.ncbi.nlm.nih.gov/pubmed/29307494
21. https://www.ncbi.nlm.nih.gov/pubmed/30106033
22. https://www.ncbi.nlm.nih.gov/pubmed/23871744
23. https://www.ncbi.nlm.nih.gov/pubmed/19452287
24. https://www.ncbi.nlm.nih.gov/pubmed/29365026
25. https://www.ncbi.nlm.nih.gov/pubmed/26067345
26. https://www.ncbi.nlm.nih.gov/pubmed/25892258
27. https://www.ncbi.nlm.nih.gov/pubmed/25797440
28. https://www.ncbi.nlm.nih.gov/pubmed/26695382
29. https://www.ncbi.nlm.nih.gov/pubmed/28259169
30. https://www.ncbi.nlm.nih.gov/pubmed/25033177
31. https://www.ncbi.nlm.nih.gov/pubmed/28433458
32. https://www.ncbi.nlm.nih.gov/pubmed/26404710
33. https://www.ncbi.nlm.nih.gov/pubmed/30166545
34. https://www.ncbi.nlm.nih.gov/pubmed/24791916
35. https://www.ncbi.nlm.nih.gov/pubmed/25560816
36. https://www.ncbi.nlm.nih.gov/pubmed/9754879
37. https://www.ncbi.nlm.nih.gov/pubmed/16829138
38. https://www.ncbi.nlm.nih.gov/pubmed/6639008
39. https://www.ncbi.nlm.nih.gov/pubmed/11838536
40. https://www.ncbi.nlm.nih.gov/pubmed/27315762
41. https://doi.org/10.1016/j.paid.2015.04.046

42. https://www.ncbi.nlm.nih.gov/pubmed/26400233
43. https://www.ncbi.nlm.nih.gov/pubmed/19828780
44. https://www.ncbi.nlm.nih.gov/pubmed/26343956
45. https://www.ncbi.nlm.nih.gov/pubmed/30555214
46. https://www.ncbi.nlm.nih.gov/pubmed/27641830
47. https://www.ncbi.nlm.nih.gov/pubmed/23978501
48. https://www.ncbi.nlm.nih.gov/pubmed/24975275
49. https://www.ncbi.nlm.nih.gov/pubmed/26303664
50. https://www.ncbi.nlm.nih.gov/pubmed/25961639
51. https://www.ncbi.nlm.nih.gov/pubmed/24286185
52. https://www.ncbi.nlm.nih.gov/pubmed/27783031
53. https://www.ncbi.nlm.nih.gov/pubmed/21826061
54. https://www.ncbi.nlm.nih.gov/pubmed/15733200
55. https://www.ncbi.nlm.nih.gov/pubmed/26534905
56. https://www.ncbi.nlm.nih.gov/pubmed/26695942
57. https://www.ncbi.nlm.nih.gov/pubmed/24342994
58. https://www.ncbi.nlm.nih.gov/pubmed/17053149
59. https://www.ncbi.nlm.nih.gov/pubmed/27933030
60. https://www.ncbi.nlm.nih.gov/pubmed/9719624
61. https://www.ncbi.nlm.nih.gov/pubmed/21130836
62. https://www.ncbi.nlm.nih.gov/pubmed/22449649
63. https://www.ncbi.nlm.nih.gov/pubmed/21130223
64. https://www.ncbi.nlm.nih.gov/pubmed/20727978
65. https://www.ncbi.nlm.nih.gov/pubmed/25860228
66. https://www.ncbi.nlm.nih.gov/pubmed/24853458
67. https://www.ncbi.nlm.nih.gov/pubmed/19376182
68. https://www.ncbi.nlm.nih.gov/pubmed/16818862
69. https://www.ncbi.nlm.nih.gov/pubmed/14566344
70. https://www.ncbi.nlm.nih.gov/pubmed/17072305
71. https://www.ncbi.nlm.nih.gov/pubmed/22504417
72. https://www.ncbi.nlm.nih.gov/pubmed/17601350
73. https://www.ncbi.nlm.nih.gov/pubmed/25712083
74. https://www.ncbi.nlm.nih.gov/pubmed/29079138
75. https://www.ncbi.nlm.nih.gov/pubmed/22198673
76. https://www.ncbi.nlm.nih.gov/pubmed/28099629
77. https://www.ncbi.nlm.nih.gov/pubmed/21690345
78. https://www.ncbi.nlm.nih.gov/pubmed/18213623
79. https://www.ncbi.nlm.nih.gov/pubmed/21745190
80. https://www.ncbi.nlm.nih.gov/pubmed/12517253
81. https://www.ncbi.nlm.nih.gov/pubmed/20195480
82. https://www.ncbi.nlm.nih.gov/pubmed/17684478
83. https://www.ncbi.nlm.nih.gov/pubmed/17976922
84. https://www.ncbi.nlm.nih.gov/pubmed/18047561
85. https://www.ncbi.nlm.nih.gov/pubmed/15159677
86. https://www.ncbi.nlm.nih.gov/pubmed/18833429

87. https://www.ncbi.nlm.nih.gov/pubmed/6285406
88. https://www.ncbi.nlm.nih.gov/pubmed/19729208
89. https://www.ncbi.nlm.nih.gov/pubmed/19442536
90. https://www.ncbi.nlm.nih.gov/pubmed/21238581
91. https://www.ncbi.nlm.nih.gov/pubmed/9653176
92. https://www.ncbi.nlm.nih.gov/pubmed/3169967
93. https://www.ncbi.nlm.nih.gov/pubmed/21426373
94. https://www.ncbi.nlm.nih.gov/pubmed/20829306
95. https://www.ncbi.nlm.nih.gov/pubmed/22729452
96. https://www.ncbi.nlm.nih.gov/pubmed/22129319
97. https://www.ncbi.nlm.nih.gov/pubmed/18523009
98. https://www.ncbi.nlm.nih.gov/pubmed/30397195
99. https://www.ncbi.nlm.nih.gov/pubmed/24452011
100. https://www.ncbi.nlm.nih.gov/pubmed/18950248
101. https://www.ncbi.nlm.nih.gov/pubmed/26376956
102. https://www.ncbi.nlm.nih.gov/pubmed/15582752
103. https://www.ncbi.nlm.nih.gov/pubmed/12796225
104. https://www.ncbi.nlm.nih.gov/pubmed/20078877
105. https://www.ncbi.nlm.nih.gov/pubmed/27106592
106. https://www.ncbi.nlm.nih.gov/pubmed/30826501
107. https://www.ncbi.nlm.nih.gov/pubmed/27431367
108. https://www.ncbi.nlm.nih.gov/pubmed/27840145
109. https://www.ncbi.nlm.nih.gov/pubmed/31111977
110. https://www.ncbi.nlm.nih.gov/pubmed/16370225
111. https://www.ncbi.nlm.nih.gov/pubmed/28597528
112. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2430358/
113. https://www.ncbi.nlm.nih.gov/pubmed/7647779/
114. https://www.ncbi.nlm.nih.gov/pubmed/1974941
115. https://www.ncbi.nlm.nih.gov/pubmed/19193337
116. https://www.ncbi.nlm.nih.gov/pubmed/19967264
117. https://www.ncbi.nlm.nih.gov/pubmed/10448523
118. https://www.ncbi.nlm.nih.gov/pubmed/18521531
119. https://www.ncbi.nlm.nih.gov/pubmed/27593095
120. https://www.ncbi.nlm.nih.gov/pubmed/28367454
121. https://www.ncbi.nlm.nih.gov/pubmed/25117994
122. https://www.ncbi.nlm.nih.gov/pubmed/11595668
123. https://www.ncbi.nlm.nih.gov/pubmed/25853877
124. https://www.ncbi.nlm.nih.gov/pubmed/23869894
125. https://www.ncbi.nlm.nih.gov/pubmed/29704637
126. https://www.ncbi.nlm.nih.gov/pubmed/28669409
127. https://www.ncbi.nlm.nih.gov/pubmed/22488909
128. https://www.ncbi.nlm.nih.gov/pubmed/21505516
129. https://www.ncbi.nlm.nih.gov/pubmed/11101851
130. https://www.ncbi.nlm.nih.gov/pubmed/10932176
131. https://www.ncbi.nlm.nih.gov/pubmed/11381257

132. https://www.ncbi.nlm.nih.gov/pubmed/12627456
133. https://www.ncbi.nlm.nih.gov/pubmed/16894623
134. https://www.ncbi.nlm.nih.gov/pubmed/18781504
135. https://www.ncbi.nlm.nih.gov/pubmed/17765329
136. https://www.ncbi.nlm.nih.gov/pubmed/10195220
137. https://www.ncbi.nlm.nih.gov/pubmed/19936256
138. https://www.ncbi.nlm.nih.gov/pubmed/27253067
139. https://www.ncbi.nlm.nih.gov/pubmed/21722657
140. https://www.ncbi.nlm.nih.gov/pubmed/11991541
141. https://www.ncbi.nlm.nih.gov/pubmed/21282661
142. https://www.ncbi.nlm.nih.gov/pubmed/25483019
143. https://www.ncbi.nlm.nih.gov/pubmed/16411242
144. https://www.ncbi.nlm.nih.gov/pubmed/27462210
145. https://www.ncbi.nlm.nih.gov/pubmed/24818140
146. https://www.ncbi.nlm.nih.gov/pubmed/23615664
147. https://www.ncbi.nlm.nih.gov/pubmed/26868600
148. https://www.ncbi.nlm.nih.gov/pubmed/19549282
149. https://www.ncbi.nlm.nih.gov/pubmed/18362141
150. https://www.ncbi.nlm.nih.gov/pubmed/26114940
151. https://www.ncbi.nlm.nih.gov/pubmed/24712702
152. https://www.ncbi.nlm.nih.gov/pubmed/22898496
153. https://www.ncbi.nlm.nih.gov/pubmed/23996382
154. https://www.ncbi.nlm.nih.gov/pubmed/17326538
155. https://www.ncbi.nlm.nih.gov/pubmed/16533499
156. https://www.ncbi.nlm.nih.gov/pubmed/27867257
157. https://www.ncbi.nlm.nih.gov/pubmed/23184506
158. https://www.ncbi.nlm.nih.gov/pubmed/23350956
159. https://www.ncbi.nlm.nih.gov/pubmed/29877128
160. https://www.ncbi.nlm.nih.gov/pubmed/24068831
161. https://www.ncbi.nlm.nih.gov/pubmed/24030361
162. https://www.ncbi.nlm.nih.gov/pubmed/22796429
163. https://www.ncbi.nlm.nih.gov/pubmed/29459833
164. https://www.ncbi.nlm.nih.gov/pubmed/25294127
165. https://www.ncbi.nlm.nih.gov/pubmed/29699895
166. https://www.ncbi.nlm.nih.gov/pubmed/30452956
167. https://www.ncbi.nlm.nih.gov/pubmed/12589194
168. https://www.ncbi.nlm.nih.gov/pubmed/24144057
169. https://www.ncbi.nlm.nih.gov/pubmed/23366470
170. https://www.ncbi.nlm.nih.gov/pubmed/16224578
171. https://www.ncbi.nlm.nih.gov/pubmed/24754494
172. https://www.ncbi.nlm.nih.gov/pubmed/23825613
173. https://www.ncbi.nlm.nih.gov/pubmed/21943600
174. https://www.ncbi.nlm.nih.gov/pubmed/23778582
175. https://www.ncbi.nlm.nih.gov/pubmed/21106762
176. https://www.ncbi.nlm.nih.gov/pubmed/20552044

177. https://www.ncbi.nlm.nih.gov/pubmed/30729420
178. https://www.ncbi.nlm.nih.gov/pubmed/19606085
179. https://www.ncbi.nlm.nih.gov/pubmed/23926262
180. https://www.ncbi.nlm.nih.gov/pubmed/26156558
181. https://www.ncbi.nlm.nih.gov/pubmed/29375362
182. https://www.ncbi.nlm.nih.gov/pubmed/24642126
183. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5639574/
184. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4368891/
185. https://www.ncbi.nlm.nih.gov/pubmed/25791529
186. https://www.ncbi.nlm.nih.gov/pubmed/18291098
187. https://www.ncbi.nlm.nih.gov/pubmed/22254006
188. https://www.ncbi.nlm.nih.gov/pubmed/15180479
189. https://www.ncbi.nlm.nih.gov/pubmed/1372342
190. https://www.ncbi.nlm.nih.gov/pubmed/8199398
191. https://www.ncbi.nlm.nih.gov/pubmed/17284293
192. https://www.ncbi.nlm.nih.gov/pubmed/17504104
193. https://www.ncbi.nlm.nih.gov/pubmed/20163115
194. https://www.ncbi.nlm.nih.gov/pubmed/826948
195. https://www.ncbi.nlm.nih.gov/pubmed/6483933
196. https://www.ncbi.nlm.nih.gov/pubmed/12006732
197. https://www.ncbi.nlm.nih.gov/pubmed/19383789
198. https://www.ncbi.nlm.nih.gov/pubmed/21435346
199. https://www.ncbi.nlm.nih.gov/pubmed/27407143
200. https://www.ncbi.nlm.nih.gov/pubmed/20570600
201. https://www.ncbi.nlm.nih.gov/pubmed/19189040
202. https://www.ncbi.nlm.nih.gov/pubmed/19861415
203. https://www.ncbi.nlm.nih.gov/pubmed/24231099
204. https://www.ncbi.nlm.nih.gov/pubmed/18231627
205. https://www.ncbi.nlm.nih.gov/pubmed/28078253
206. https://www.ncbi.nlm.nih.gov/pubmed/21729327
207. https://www.ncbi.nlm.nih.gov/pubmed/19597492
208. https://www.ncbi.nlm.nih.gov/pubmed/28007413
209. https://www.ncbi.nlm.nih.gov/pubmed/19597491
210. https://www.ncbi.nlm.nih.gov/pubmed/23041239
211. https://www.ncbi.nlm.nih.gov/pubmed/26930642
212. https://www.ncbi.nlm.nih.gov/pubmed/22544366
213. https://www.ncbi.nlm.nih.gov/pubmed/19362884
214. https://www.ncbi.nlm.nih.gov/pubmed/26806700
215. https://www.ncbi.nlm.nih.gov/pubmed/10404910
216. https://www.ncbi.nlm.nih.gov/pubmed/25052319
217. https://www.ncbi.nlm.nih.gov/pubmed/15477508
218. https://www.ncbi.nlm.nih.gov/pubmed/10472985
219. https://www.ncbi.nlm.nih.gov/pubmed/23460057
220. https://www.ncbi.nlm.nih.gov/pubmed/23739229
221. https://www.ncbi.nlm.nih.gov/pubmed/22371515

222. https://www.ncbi.nlm.nih.gov/pubmed/16534088
223. https://www.ncbi.nlm.nih.gov/pubmed/26538582
224. https://www.ncbi.nlm.nih.gov/pubmed/3337013
225. https://www.ncbi.nlm.nih.gov/pubmed/15165657
226. https://www.ncbi.nlm.nih.gov/pubmed/27009261
227. https://www.ncbi.nlm.nih.gov/pubmed/21299297
228. https://www.ncbi.nlm.nih.gov/pubmed/17167157
229. https://www.ncbi.nlm.nih.gov/pubmed/28317317
230. https://www.ncbi.nlm.nih.gov/pubmed/18220780
231. https://www.ncbi.nlm.nih.gov/pubmed/17444418
232. https://www.ncbi.nlm.nih.gov/pubmed/28367412
233. https://www.ncbi.nlm.nih.gov/pubmed/10517533
234. https://www.ncbi.nlm.nih.gov/pubmed/14980204
235. https://www.ncbi.nlm.nih.gov/pubmed/26318987
236. https://www.ncbi.nlm.nih.gov/pubmed/19261978
237. https://www.ncbi.nlm.nih.gov/pubmed/25802182
238. https://www.ncbi.nlm.nih.gov/pubmed/25329151
239. https://www.ncbi.nlm.nih.gov/pubmed/28596978
240. https://www.ncbi.nlm.nih.gov/pubmed/24284070
241. https://www.ncbi.nlm.nih.gov/pubmed/29893844
242. https://www.ncbi.nlm.nih.gov/pubmed/27752476
243. https://www.ncbi.nlm.nih.gov/pubmed/26989758
244. https://www.ncbi.nlm.nih.gov/pubmed/29131369
245. https://www.ncbi.nlm.nih.gov/pubmed/25196192
246. https://www.ncbi.nlm.nih.gov/pubmed/29564977
247. https://www.ncbi.nlm.nih.gov/pubmed/23003120
248. https://www.ncbi.nlm.nih.gov/pubmed/24994540
249. https://www.ncbi.nlm.nih.gov/pubmed/28580093
250. https://www.ncbi.nlm.nih.gov/pubmed/29310710
251. https://www.ncbi.nlm.nih.gov/pubmed/27220529
252. https://www.ncbi.nlm.nih.gov/pubmed/28039085
253. https://www.ncbi.nlm.nih.gov/pubmed/23200785
254. https://www.ncbi.nlm.nih.gov/pubmed/22025673
255. https://www.ncbi.nlm.nih.gov/pubmed/21460635
256. https://www.ncbi.nlm.nih.gov/pubmed/18443221
257. https://www.ncbi.nlm.nih.gov/pubmed/19225151
258. https://www.ncbi.nlm.nih.gov/pubmed/20225336
259. https://www.ncbi.nlm.nih.gov/pubmed/25654554
260. https://www.ncbi.nlm.nih.gov/pubmed/25654553
261. https://www.ncbi.nlm.nih.gov/pubmed/28029600
262. https://www.ncbi.nlm.nih.gov/pubmed/25833948
263. https://www.ncbi.nlm.nih.gov/pubmed/26118643
264. https://www.ncbi.nlm.nih.gov/pubmed/21258367
265. https://www.ncbi.nlm.nih.gov/pubmed/23052213
266. https://www.ncbi.nlm.nih.gov/pubmed/23325216

267. https://www.ncbi.nlm.nih.gov/pubmed/24379984
268. https://www.ncbi.nlm.nih.gov/pubmed/23370395
269. https://www.ncbi.nlm.nih.gov/pubmed/21042741
270. https://www.ncbi.nlm.nih.gov/pubmed/23517912
271. https://www.ncbi.nlm.nih.gov/pubmed/22549432
272. https://www.ncbi.nlm.nih.gov/pubmed/16550606
273. https://www.ncbi.nlm.nih.gov/pubmed/19176385
274. https://www.ncbi.nlm.nih.gov/pubmed/20812900
275. https://www.ncbi.nlm.nih.gov/pubmed/24096482
276. https://www.ncbi.nlm.nih.gov/pubmed/22705982
277. https://www.ncbi.nlm.nih.gov/pubmed/15583703
278. https://www.ncbi.nlm.nih.gov/pubmed/18842893
279. https://www.ncbi.nlm.nih.gov/pubmed/16376115
280. https://www.ncbi.nlm.nih.gov/pubmed/21852430
281. https://www.ncbi.nlm.nih.gov/pubmed/19477232
282. https://www.ncbi.nlm.nih.gov/pubmed/20035841
283. https://www.ncbi.nlm.nih.gov/pubmed/19357777
284. https://www.ncbi.nlm.nih.gov/pubmed/17684500
285. https://www.ncbi.nlm.nih.gov/pubmed/19922905
286. https://www.ncbi.nlm.nih.gov/pubmed/20438765
287. https://www.ncbi.nlm.nih.gov/pubmed/27803648
288. https://www.ncbi.nlm.nih.gov/pubmed/16893304
289. https://www.ncbi.nlm.nih.gov/pubmed/25573715
290. https://www.ncbi.nlm.nih.gov/pubmed/31014819
291. https://www.ncbi.nlm.nih.gov/pubmed/24049209
292. https://www.ncbi.nlm.nih.gov/pubmed/25558129
293. https://www.ncbi.nlm.nih.gov/pubmed/22891145
294. https://www.ncbi.nlm.nih.gov/pubmed/22377965
295. https://www.ncbi.nlm.nih.gov/pubmed/24395196
296. https://www.ncbi.nlm.nih.gov/pubmed/23541163
297. https://www.ncbi.nlm.nih.gov/pubmed/11148895
298. https://www.ncbi.nlm.nih.gov/pubmed/17560731
299. http://file.scirp.org/Html/3-8203099_51245.htm
300. https://doi.org/10.1002/smi.1094
301. https://www.ncbi.nlm.nih.gov/pubmed/16113080
302. https://www.ncbi.nlm.nih.gov/pubmed/17065238
303. https://www.ncbi.nlm.nih.gov/pubmed/17360583
304. https://www.ncbi.nlm.nih.gov/pubmed/28364391
305. https://www.ncbi.nlm.nih.gov/pubmed/30304709
306. https://www.ncbi.nlm.nih.gov/pubmed/28337245
307. https://www.ncbi.nlm.nih.gov/pubmed/26598833
308. https://www.ncbi.nlm.nih.gov/pubmed/31086990
309. https://www.ncbi.nlm.nih.gov/pubmed/30738126
310. https://www.ncbi.nlm.nih.gov/pubmed/29459050
311. https://www.ncbi.nlm.nih.gov/pubmed/8037263

312. https://www.ncbi.nlm.nih.gov/pubmed/14732596
313. https://www.ncbi.nlm.nih.gov/pubmed/20600205
314. https://www.ncbi.nlm.nih.gov/pubmed/20018181
315. https://www.ncbi.nlm.nih.gov/pubmed/12509789
316. https://www.ncbi.nlm.nih.gov/pubmed/17544510
317. https://www.ncbi.nlm.nih.gov/pubmed/16644022
318. https://www.ncbi.nlm.nih.gov/pubmed/16720219
319. https://www.ncbi.nlm.nih.gov/pubmed/19165231
320. https://www.ncbi.nlm.nih.gov/pubmed/25207838
321. https://www.ncbi.nlm.nih.gov/pubmed/18328453
322. https://www.ncbi.nlm.nih.gov/pubmed/21142721
323. https://www.ncbi.nlm.nih.gov/pubmed/29116611
324. https://www.ncbi.nlm.nih.gov/pubmed/16706694
325. https://www.ncbi.nlm.nih.gov/pubmed/23807510
326. https://www.ncbi.nlm.nih.gov/pubmed/23281261
327. https://www.ncbi.nlm.nih.gov/pubmed/24672439
328. https://www.ncbi.nlm.nih.gov/pubmed/19995444
329. https://www.ncbi.nlm.nih.gov/pubmed/24755289
330. https://www.ncbi.nlm.nih.gov/pubmed/10723068
331. https://www.ncbi.nlm.nih.gov/pubmed/26364547
332. https://www.ncbi.nlm.nih.gov/pubmed/26324102
333. https://www.ncbi.nlm.nih.gov/pubmed/17174450
334. https://www.ncbi.nlm.nih.gov/pubmed/20405009
335. https://www.ncbi.nlm.nih.gov/pubmed/18461718
336. https://www.ncbi.nlm.nih.gov/pubmed/19237924
337. https://www.ncbi.nlm.nih.gov/pubmed/12079880
338. https://www.ncbi.nlm.nih.gov/pubmed/19779735
339. https://www.ncbi.nlm.nih.gov/pubmed/25338085
340. https://www.ncbi.nlm.nih.gov/pubmed/18192289
341. https://www.ncbi.nlm.nih.gov/pubmed/24091066
342. https://www.ncbi.nlm.nih.gov/pubmed/16155278
343. https://www.ncbi.nlm.nih.gov/pubmed/19019492
344. https://www.ncbi.nlm.nih.gov/pubmed/16155277
345. https://www.ncbi.nlm.nih.gov/pubmed/17284751
346. https://www.ncbi.nlm.nih.gov/pubmed/11333847
347. https://www.ncbi.nlm.nih.gov/pubmed/16210718
348. https://www.ncbi.nlm.nih.gov/pubmed/23482308
349. https://www.ncbi.nlm.nih.gov/pubmed/28724658
350. https://www.ncbi.nlm.nih.gov/pubmed/27012626
351. https://www.ncbi.nlm.nih.gov/pubmed/14576748
352. https://www.ncbi.nlm.nih.gov/pubmed/22585917
353. https://doi.org/10.1533/9781845697198.2.308
354. https://www.ncbi.nlm.nih.gov/pubmed/30478534
355. https://www.ncbi.nlm.nih.gov/pubmed/17658613
356. https://www.ncbi.nlm.nih.gov/pubmed/10715576

357. https://www.ncbi.nlm.nih.gov/pubmed/28977444
358. https://www.ncbi.nlm.nih.gov/pubmed/26166747
359. https://www.ncbi.nlm.nih.gov/pubmed/23910656
360. https://www.ncbi.nlm.nih.gov/pubmed/23929553
361. https://www.ncbi.nlm.nih.gov/pubmed/23298785
362. https://www.ncbi.nlm.nih.gov/pubmed/30332832
363. https://www.ncbi.nlm.nih.gov/pubmed/17284758
364. https://www.ncbi.nlm.nih.gov/pubmed/16878403
365. https://www.ncbi.nlm.nih.gov/pubmed/11381111
366. https://www.ncbi.nlm.nih.gov/pubmed/11925305
367. https://www.ncbi.nlm.nih.gov/pubmed/16026865
368. https://www.ncbi.nlm.nih.gov/pubmed/18755576
369. https://www.ncbi.nlm.nih.gov/pubmed/19077115
370. https://www.ncbi.nlm.nih.gov/pubmed/27826992
371. https://www.ncbi.nlm.nih.gov/pubmed/23121441
372. https://www.ncbi.nlm.nih.gov/pubmed/22234339
373. https://www.ncbi.nlm.nih.gov/pubmed/23688860
374. https://www.ncbi.nlm.nih.gov/pubmed/19756810
375. https://www.ncbi.nlm.nih.gov/pubmed/17050681
376. https://www.ncbi.nlm.nih.gov/pubmed/26499075
377. https://www.ncbi.nlm.nih.gov/pubmed/19713122
378. https://www.ncbi.nlm.nih.gov/pubmed/24011076
379. https://www.ncbi.nlm.nih.gov/pubmed/29281938
380. https://www.ncbi.nlm.nih.gov/pubmed/22438067
381. https://www.ncbi.nlm.nih.gov/pubmed/12074969
382. https://www.ncbi.nlm.nih.gov/pubmed/15019969
383. https://www.ncbi.nlm.nih.gov/pubmed/26393898
384. https://www.ncbi.nlm.nih.gov/pubmed/17312997
385. https://www.ncbi.nlm.nih.gov/pubmed/28082789
386. https://www.ncbi.nlm.nih.gov/pubmed/16707173
387. https://www.ncbi.nlm.nih.gov/pubmed/29736217
388. https://www.ncbi.nlm.nih.gov/pubmed/18187018
389. https://www.ncbi.nlm.nih.gov/pubmed/26999194
390. https://www.ncbi.nlm.nih.gov/pubmed/21303898
391. https://www.ncbi.nlm.nih.gov/pubmed/30171838
392. https://www.ncbi.nlm.nih.gov/pubmed/18077373
393. https://www.ncbi.nlm.nih.gov/pubmed/15900211
394. https://www.ncbi.nlm.nih.gov/pubmed/24734235
395. https://www.ncbi.nlm.nih.gov/pubmed/26474929
396. https://www.ncbi.nlm.nih.gov/pubmed/10611493
397. https://www.ncbi.nlm.nih.gov/pubmed/20631684
398. https://www.ncbi.nlm.nih.gov/pubmed/12649346
399. https://www.ncbi.nlm.nih.gov/pubmed/26967530
400. https://www.ncbi.nlm.nih.gov/pubmed/17230034
401. https://www.ncbi.nlm.nih.gov/pubmed/28085950

402. https://www.ncbi.nlm.nih.gov/pubmed/28507526
403. https://www.ncbi.nlm.nih.gov/pubmed/27647283
404. https://www.ncbi.nlm.nih.gov/pubmed/25563748
405. https://www.ncbi.nlm.nih.gov/pubmed/24001007
406. https://www.ncbi.nlm.nih.gov/pubmed/12758062
407. https://www.ncbi.nlm.nih.gov/pubmed/27956050
408. https://www.ncbi.nlm.nih.gov/pubmed/30998993
409. https://www.ncbi.nlm.nih.gov/pubmed/28877102
410. https://www.ncbi.nlm.nih.gov/pubmed/26162004
411. https://www.ncbi.nlm.nih.gov/pubmed/31035583
412. https://www.ncbi.nlm.nih.gov/pubmed/28935933
413. https://www.ncbi.nlm.nih.gov/pubmed/31009571
414. https://www.ncbi.nlm.nih.gov/pubmed/28883047
415. https://www.ncbi.nlm.nih.gov/pubmed/26464310
416. https://www.ncbi.nlm.nih.gov/pubmed/2496199
417. https://www.ncbi.nlm.nih.gov/pubmed/25797188
418. https://www.ncbi.nlm.nih.gov/pubmed/3214752
419. https://www.ncbi.nlm.nih.gov/pubmed/25598314
420. https://www.ncbi.nlm.nih.gov/pubmed/24433977
421. https://www.ncbi.nlm.nih.gov/pubmed/30094335
422. https://www.ncbi.nlm.nih.gov/pubmed/17321089
423. https://www.ncbi.nlm.nih.gov/pubmed/19903380
424. https://www.ncbi.nlm.nih.gov/pubmed/22747190
425. https://www.ncbi.nlm.nih.gov/pubmed/18611150
426. https://www.ncbi.nlm.nih.gov/pubmed/24716148
427. https://www.ncbi.nlm.nih.gov/pubmed/24653659
428. https://www.ncbi.nlm.nih.gov/pubmed/15236398
429. https://www.ncbi.nlm.nih.gov/pubmed/25900350
430. https://www.ncbi.nlm.nih.gov/pubmed/24642289
431. https://www.ncbi.nlm.nih.gov/pubmed/24167026
432. https://www.ncbi.nlm.nih.gov/pubmed/29238619
433. https://www.ncbi.nlm.nih.gov/pubmed/16734773
434. https://www.ncbi.nlm.nih.gov/pubmed/18184796
435. https://www.ncbi.nlm.nih.gov/pubmed/20673876
436. https://www.ncbi.nlm.nih.gov/pubmed/27163751
437. https://www.ncbi.nlm.nih.gov/pubmed/16011574
438. https://www.ncbi.nlm.nih.gov/pubmed/16829144
439. https://www.ncbi.nlm.nih.gov/pubmed/21640838
440. https://www.ncbi.nlm.nih.gov/pubmed/29765853
441. https://www.ncbi.nlm.nih.gov/pubmed/25071212
442. https://www.ncbi.nlm.nih.gov/pubmed/26973477
443. https://www.ncbi.nlm.nih.gov/pubmed/22180782
444. https://www.ncbi.nlm.nih.gov/pubmed/20095391
445. https://www.ncbi.nlm.nih.gov/pubmed/26641965
446. https://www.ncbi.nlm.nih.gov/pubmed/16996699

447. https://www.ncbi.nlm.nih.gov/pubmed/21476267
448. https://www.ncbi.nlm.nih.gov/pubmed/19662538
449. https://www.ncbi.nlm.nih.gov/pubmed/16996037
450. https://www.ncbi.nlm.nih.gov/pubmed/9173745
451. https://www.ncbi.nlm.nih.gov/pubmed/15792140
452. https://www.ncbi.nlm.nih.gov/pubmed/27411820
453. https://www.ncbi.nlm.nih.gov/pubmed/26591577
454. https://www.ncbi.nlm.nih.gov/pubmed/11517472