



Understanding the MAOA gene

What is MAOA?

MAOA stands for monoamine oxidase A. The MAOA gene codes for an enzyme by the same name. (An enzyme is a protein that speeds up a biochemical reaction in the body.) This MAOA is an enzyme that helps break down neurotransmitters like dopamine, norepinephrine and serotonin. There are two versions of MAOA: MAOA “fast” and MAOA “slow.” This handout discusses slow MAOA, or low-activity MAOA (MAOA-L).

The MAOA gene is often called the “warrior” gene because it is linked to aggression and other behavior problems in children and teens. The MAOA gene codes for an enzyme by the same name. This enzyme is responsible for breaking down stimulating neurotransmitters (brain chemicals), including dopamine, norepinephrine (adrenaline) and serotonin.. A low-functioning MAOA means that a patient **may have difficulty breaking down these stimulating brain chemicals.** This leads to an excess of these brain chemicals. This creates something similar to a constant “adrenaline rush” that a patient cannot come down from.

It is very important to understand that not all patients with MAOA genes have behavior or aggression problems. Remember that all of these genes are highly influenced by the environment. However, once a patient has these genes they will always have the tendency toward having excess neurotransmitters, if not treated appropriately.

MAOA symptoms are usually worse in boys, as Testosterone tends to worsen behavioral issues and slow the enzyme. Estrogen and progesterone help the symptoms of MAOA. (Estrogen can actually speed up the enzyme.)

Some symptoms of MAOA:

1. Anxiety (too many neurotransmitters often creates anxiety)
2. ADHD (too much stimulation in the brain, makes it difficult to calm down and focus)
3. Behavior problems
4. Sudden outbursts
 - a. This one is very interesting. If a patient has too many stimulating neurotransmitters, sometimes the only way to “burn them off” is with a sudden explosive outburst of energy – like someone who has an adrenaline rush. Many parents notice that children seem calmer after this initial outburst.

5. Paradoxical depression (I often liken this to someone having too many cups of caffeine. Eventually having too much adrenaline will cause “burnout” fatigue.)
6. Intestinal issues
 - a. Too many of these stimulating neurotransmitters means the body has a hard time relaxing. We call this the “fight or flight” response, or sympathetic nervous system. On the opposite side, the body has a “rest and digest” nervous system called the parasympathetic nervous system. The body **must** be able to rest and have good parasympathetic tone in order to digest food properly. Many children and adults with MAOA end up with digestive imbalances and food intolerances because they are never able to get into a “rest and digest” state, instead they stay in a “fight or flight” response constantly.

How to “treat” MAOA.

First, remember that humans are not simply a product of genes or environment, or even environment + genes. We are complex! Social, environmental, spiritual, emotional, genetic and many, many other factors influence who we are as human beings.

1. **High intensity exercise** can help “burn off” norepinephrine and stimulating neurotransmitters by, essentially, using them up. I cannot stress this enough. Exercise is absolutely critical for MAOA patients, and your child will only be at their happiest when given ample time for exercise every single day. I recommend at least 60 minutes daily, with as much intense cardiovascular activity as possible. Outdoor time is preferred, as it tends to regulate children with MAOA.
2. **Some, but not all, MAOA patients tend to thrive in highly stressful situations.** MAOA is increased in times of stress, so some patients notice a sudden “clear head” in times of acute stress. This is why many MAOA patients have joined the military, or participate in athletics.
 - a. I highly encourage patients to find an appropriate athletic outlet. Focused individual sports are often good for MAOA patients, like Karate or other martial arts, running, swimming, biking, skiing, etc. (Biathlon, for example, is an event an MAOA patient would thrive in.)
3. **All children should be tested for iron deficiency and lead toxicity.** Iron plays a crucial role in brain health, and iron deficiency symptoms can lead to worsening of MAOA symptoms. Lead toxicity can lead to worsening of iron deficiency, and is also neurotoxic even in very small amounts.
4. **Minimum Supplements:**
 - a. **Riboflavin (vitamin B2)** – dosed according to weight. **MAO-A is FAD-dependent.** (FAD stands for flavin adenine dinucleotide, which is one of the active forms of Riboflavin.) We can speed up this enzyme by giving high doses of B2. Note that riboflavin will turn their urine bright yellow, which is harmless. Dose and form recommended for your child: _____
 - b. **Magnesium** - Magnesium plays a critical role in brain health and in mood regulation. It is essential for the formation of many neurotransmitters and to make membrane phospholipids. Magnesium threonate has the best brain effect, but it can be more expensive and is more difficult to find in a form that children will take.

Magnesium glycinate is the next most effective form, but again can be difficult to find in a form that children will take. Magnesium citrate is the least effective form that I recommend, and is easily available. Dose and form recommended for your child: _____

- c. **Omega 3 fatty acids** - Multiple studies have demonstrated the efficacy of omega-3 fatty acids in improving symptoms of behavioral disorders in children. I strongly recommend a good source of Omega 3 fatty acids. Dose and form recommended for your child: _____
 - d. **Iron**, if the child has iron deficiency. I prefer iron bisglycinate, as it is better tolerated and better absorbed. Dose and form recommended for your child: _____
 - e. **Zinc** - Zinc is involved in the synthesis and regulation of multiple neurotransmitters, is anti-inflammatory and protects against chronic inflammation. Dose and form recommended for your child: _____
 - f. I usually start with the above (B2, Magnesium, Omega 3 fatty acids, Iron if needed and Zinc). If no improvement we can try various other therapies, including L-Theanine, GABA, and Ginkgo biloba (Ginkgo has been studied in mice with MAOA problems and seems to block the stimulating neurotransmitters).
 - g. I would also consider a multivitamin/multimineral with LOW amounts of methylfolate & methylB12.
5. Diet:
- a. All children should be on a blood sugar balancing diet with plenty of protein, fiber and fat at each meal and snacks. See the handout “How to Balance your Child’s Blood Sugar.” Make sure to read the section on the signs of hypoglycemia, so you can recognize when your child is experiencing low blood sugar. Hypoglycemia will worsen the symptoms of MAOA.
6. If intestinal symptoms become a problem:
- a. Consider food sensitivity or allergy testing.
 - b. I highly recommend a “gluten-free, dairy-free” challenge. Gluten and casein proteins can be very hard for the body to digest, and can lead to overgrowth of non-beneficial bacteria in the intestines. (If you need more information on this please let me know, I can give extra citations.)
7. Support sleep
- a. Sleep can be a huge problem for MAOA patients, because they have a very hard time “winding down.” Again, high intensity exercise is key. Some, but not all, patients **worsen with melatonin** supplementation, as there is an upstream link between serotonin and melatonin. Children who get vivid dreams or nightmares with melatonin supplementation should lower their dosage or stop.
 - b. Consider mild herbs like passionflower, lavender or lemon balm. (Passionflower in particular acts on the GABA receptors, which can calm the brain before sleep, but be cautious as passionflower can also slow MAOA activity in high doses.)

Medications (and other supplements):

- 1. Most, but not all, patients **worsen on SSRI’s** (typical antidepressants like Prozac). These increase serotonin. (Remember that excess serotonin is one of the problems with MAOA

patients.) Sometimes SSRI's work in ways not clearly understood, so rarely a MAOA patient will do just fine, especially with low doses, or with certain brands. (Lexapro, for example, tends to be better tolerated.)

2. Most, but not all, patients worsen on Ritalin and other stimulants. Guanfacine tends to be much better tolerated for most, but not all patients.
3. **Many patients have paradoxical reactions to medications. Be very cautious when using new meds.** For example, I have one patient who requested Valium before her dental procedure, because she was so anxious for her dental work. She ended up having a very unusual response to Valium that actually increased her anxiety. Remember that MAOA patients have difficulty breaking down certain chemicals. Some patients become very aggressive after anesthesia.
4. **MAOI** medications are strongly contraindicated (NOT to be used).
5. Many MAOA patients are worse with caffeine.
6. Quetiapine (Seroquel) tends to be well-tolerated (but is very sedating and can have side effects like weight gain). Quetiapine is an antagonist of serotonin, dopamine, histamine and adrenergic alpha a1 and a2 receptors. This is a VERY strong medication, and extremely difficult to wean off of.
7. **MAOA patients should avoid over-medicating with methylfolate (5-MTHF)**, as this will “turn on” more neurotransmitters and exacerbate the problem.