

Roundup and Autism: Why Correlation *IS* Causation This Time



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Outline

- Correlation between glyphosate and autism
- Glyphosate's general mechanisms of toxicity
- Metal chelation, especially manganese
- Glyphosate's potential substitution for glycine during protein synthesis: broad consequences
- Summary

Correlation between glyphosate and autism

THIS IS THE NEW CHILDHOOD IN AMERICA:

- 1 in 3 is overweight
- 1 in 6 has learning disabilities
- 1 in 9 has asthma
- 1 in 10 has ADHD
- 1 in 12 has food allergies
- 1 in 20 has seizures
- 1 in 54 males has autism

1 in 45! ^{tism}

50% (half) of all children have chronic illness or are overweight.

This is the NEW NORMAL in our country.

Are you concerned yet?!
Because if you're not,
then you are not paying attention!



Roundup and GMO Crops

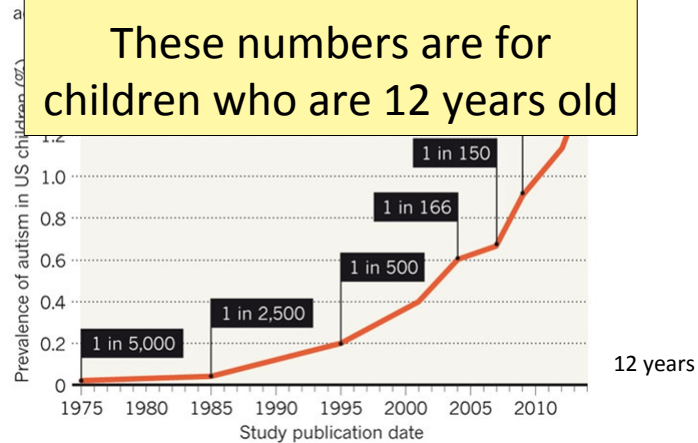
GMO Roundup-Ready corn, soy, canola, sugar beets
cotton, tobacco and alfalfa



A Frightening Trend*

AUTISM DIAGNOSES RISING

Almost 1.5% of US children are now diagnosed with autism.

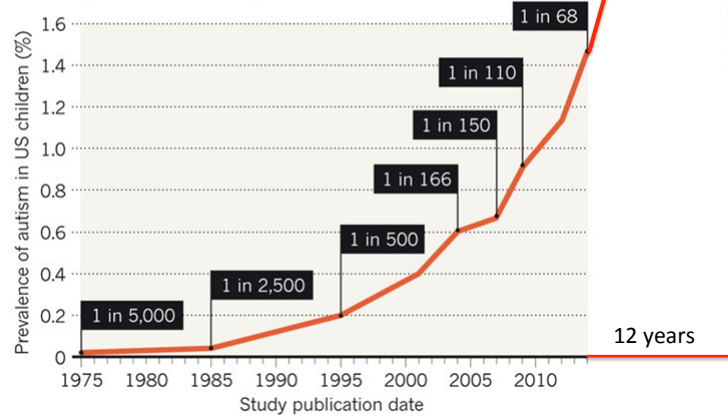


*K. Weintraub, Nature 479, Nov. 3 2011, 22-24.

A Frightening Trend* ?

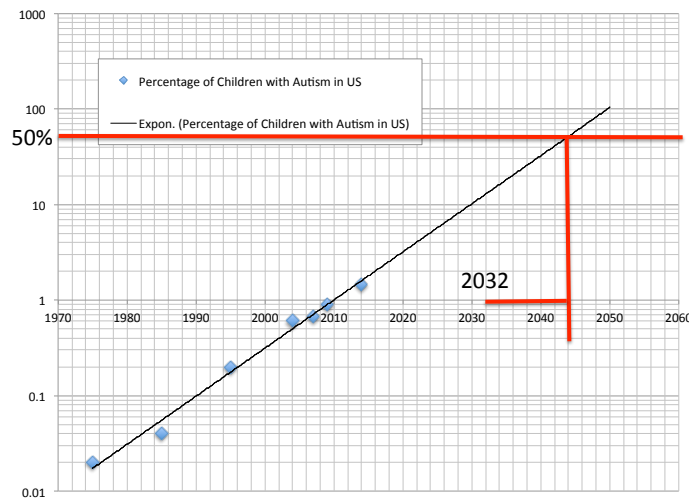
AUTISM DIAGNOSES RISING

Almost 1.5% of US children are now diagnosed with autism, according to data from 11 regions in the United States.

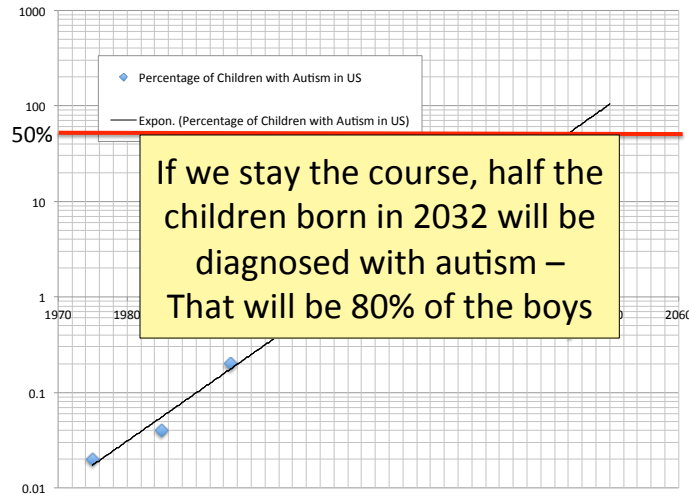


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Percentage of children with Autism in the US

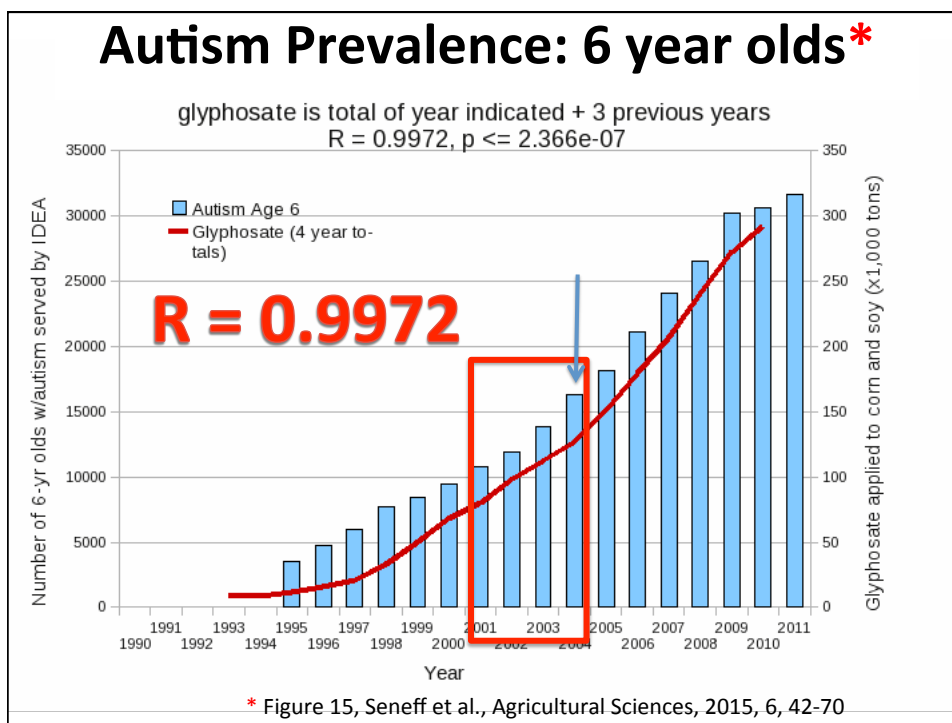


Percentage of children with Autism in the US



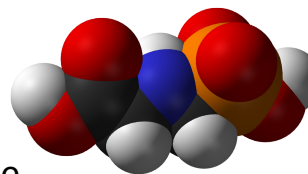
Is glyphosate a major factor in the autism epidemic?





Glyphosate's general mechanisms of toxicity

Is Glyphosate Toxic?



- Monsanto has argued that glyphosate is harmless to humans because our cells don't have the shikimate pathway, which it inhibits
- However, our gut bacteria DO have this pathway
 - We depend upon them to supply us with essential amino acids (among many other things)
- Other ingredients in Roundup greatly increase glyphosate's toxic effects
- Insidious effects of glyphosate accumulate over time
 - Most studies are too short to detect damage

Growth of GM Corn, Soy and Cotton in US, 1996-2012*

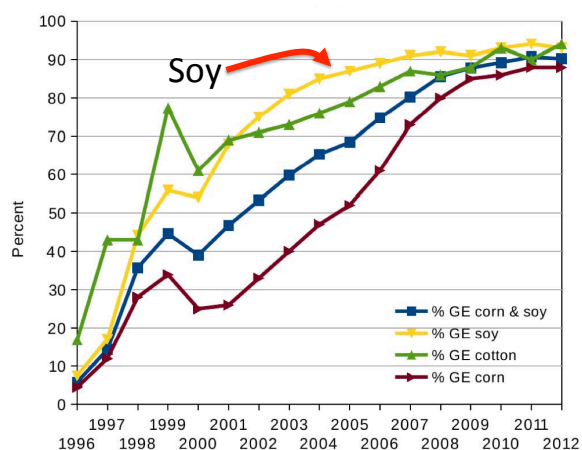
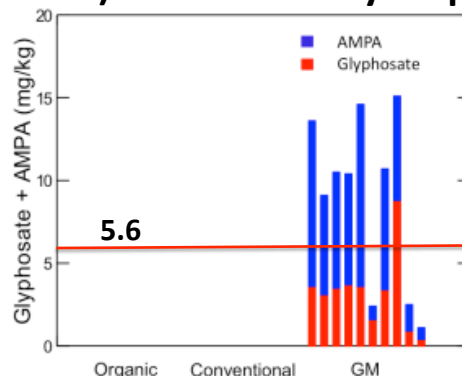


Figure 1. Adoption of GE crops in US.

*N. Swanson et al., Journal of Organic Systems, 9(2), 2014, 6-37.

Study of glyphosate and AMPA (breakdown product) residues in soy crops*



Another claim of Monsanto's has been that residue levels of up to 5.6 mg/kg in GM-soy represent "...*extreme levels*, and far higher than those typically found" (Monsanto 1999).

www.greenmedinfo.com/blog/how-extreme-levels-roundup-food-became-industry-normal

Soy Formula Linked to Seizures in Autism*

"There was a 2.6-fold higher rate of febrile seizures, a 2.1-fold higher rate of epilepsy comorbidity and a 4-fold higher rate of simple partial seizures in the autistic children fed soy-based formula"



*CJ Westmark, PLOSOne March 12, 2014, DOI: 10.1371/journal.pone.0080488.

Nutrients, Hormones and Neurotransmitters Disrupted by Glyphosate

- Vitamins:
 - Folate, niacin, cobalamin, vitamins A, K, and D
- Proteins:
 - Aromatic amino acids, glycine, methionine
 - Cytochrome P450 enzymes in the liver
- Minerals:
 - Iron, manganese, cobalt, selenium, zinc, sulfur
- Neurotransmitters:
 - Serotonin, melatonin, dopamine, thyroid hormone
- Melanin (skin tanning agent)
- Glutathione (antioxidant defenses)

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Many of these deficiencies have been linked to autism

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Glyphosate and Autism: Some Biological Mechanisms

- Disruption of gut microbes¹
 - Children with autism suffer from many digestive issues
- Disruption of sulfur metabolism, glutathione deficiency, impaired methylation pathways¹
- Metal chelation (especially manganese)²
 - Manganese deficiency leads to impaired mitochondrial function and glutamate toxicity in the brain
- Inhibition of pituitary release of thyroid stimulating hormone → hypothyroidism³
 - Moms with hypothyroidism have 4-fold increased risk to autism in the fetus

1. Samsel and Seneff, Entropy 2013;15(4):1416-1463.

2. Samsel and Seneff, Surg Neurol Int. 2015;6:45.

3. Beecham and Seneff, Journal of Autism 2016;3:1.

**Metal chelation,
especially manganese**

Glyphosate Depletes Iron, Manganese and Zinc in Plants*

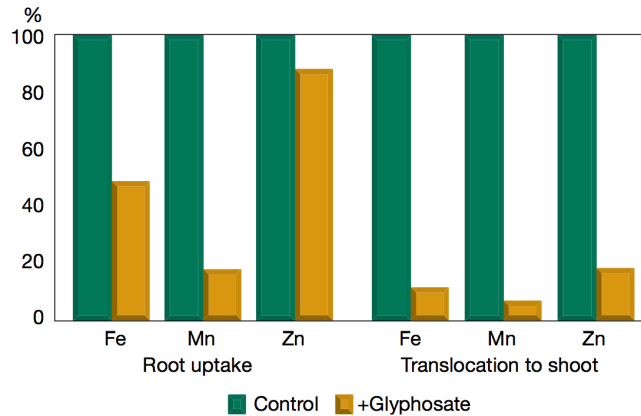
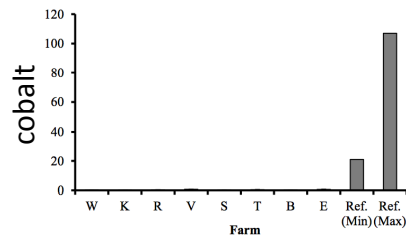


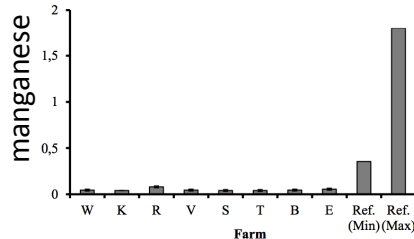
Figure 1. Effect of glyphosate* on nutrient uptake and translocation by "non-target" plants, Eker, et al. 2006. (* 2.5% of recommended herbicidal rate of glyphosate.)

*D Huber, What About Glyphosate-Induced Manganese Deficiency? Fluid Journal, 20-22.

Severe Deficiency in Serum Cobalt and Manganese in Cows*



Cows at 8 different farms consumed GM Roundup-Ready corn and soy feed



All cows tested had glyphosate in the urine

*M. Krüger et al., J Environ Anal Toxicol 2013, 3:5

Low Manganese in Teeth Linked to Autism*

- Studied lead, mercury and manganese levels in tooth enamel of shed primary teeth in 84 children
- Manganese accumulated after birth was down by 60% in autistic children
- *No other result was statistically significant*



*MM Abdullah et al., *J Autism Dev Disord.* 2012 Jun;42(6):929-36.

Low Manganese in Teeth Linked to Autism*

- Studied lead, mercury and manganese levels in tooth

Other studies have shown low serum manganese and low manganese in urine samples in association with autism

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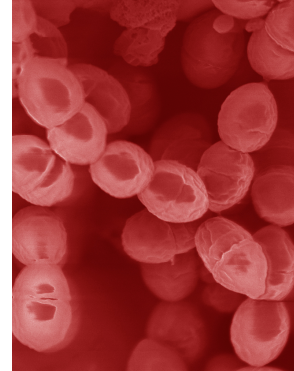
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Lactobacillus Depends on Manganese!*

- Many lactic acid bacteria contain very high intracellular manganese levels
 - Scavenges toxic oxygen species, particularly superoxide
- Manganese deprivation suppresses growth

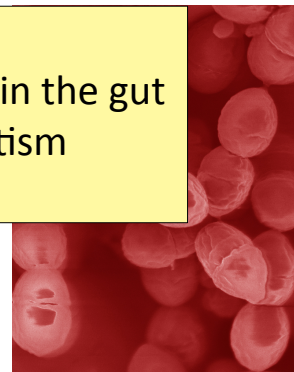


* FS Archibald and M-N Duong. Journal of Bacteriology Apr 1084, 1-8.

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Lactobacillus levels are low in the gut in association with autism



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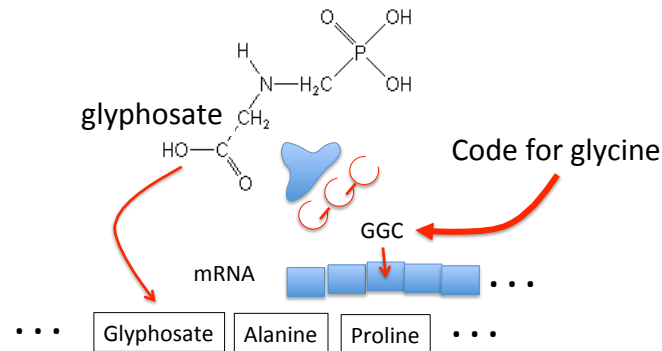
Impaired Thyroid Function

- Low thyroid hormone in mother → 4-fold increased risk to autism in child*
- Thyroid hormone is derived from tyrosine, a product of the shikimate pathway
- Thyroid depends on selenium (chelated by glyphosate) to protect it from oxidative damage and for hormone activation
- Thyroid stimulating hormone (pituitary) depends on manganese

*GC Román et al., Ann Neurol. 2013 Nov;74(5):733-42.

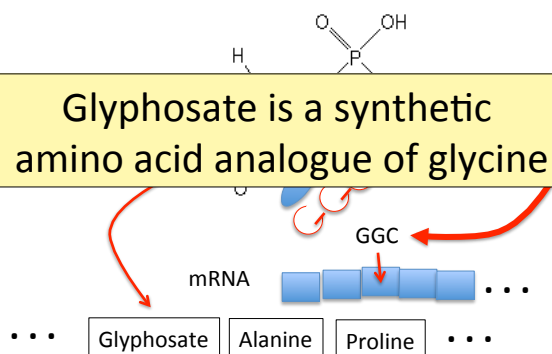
Glyphosate's potential substitution for glycine during protein synthesis: broad consequences

What If Glyphosate Could Insert Itself Into Protein Synthesis???



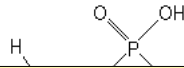
Any proteins with conserved glycine residues are likely to be affected in a major way

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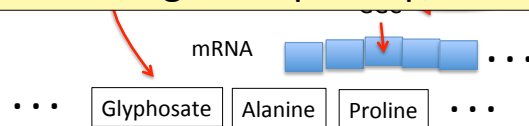


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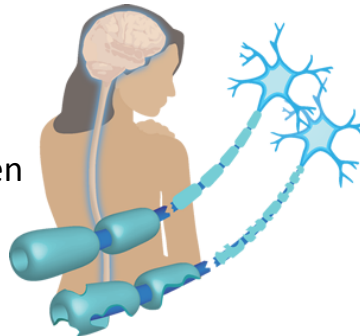
Damaged proteins would slowly accumulate throughout the body over time, causing widespread pathologies



Any proteins with conserved glycine residues are likely to be affected in a major way

An Analogy: Multiple Sclerosis & Sugar Beets*

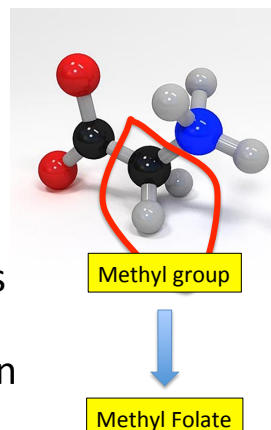
- Sugar beets contain an analogue of proline called Aze
- Remarkable correlation between MS frequency and proximity to sugar beet agriculture
- Myelin basic protein contains a cluster of proline residues that are absolutely essential for its proper function



*E. Rubenstein, J Neuropathol Exp Neurol 2008;67(11): 1035-1040.

Glycine, Methyl-folate and One-carbon Metabolism

- Glycine is a key source of methyl groups for the one-carbon cycle (methylation pathway) via the glycine cleavage system
- A glycine-rich region maintains shape and flexibility of glycine decarboxylase, a key enzyme in the glycine cleavage system*

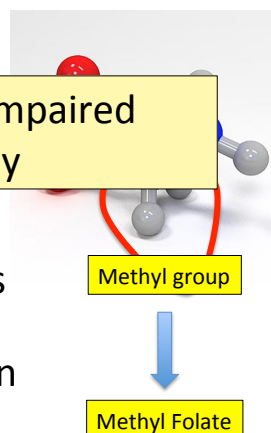


*A Kume et al., JBC 1991; 266(5): 3323-3329.

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Autism is associated with impaired methylation pathway



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Celiac Disease and Prolyl Aminopeptidase

- Gluten intolerance and Celiac disease result from inability to break down gluten, which is enriched in proline*
- Prolyl aminopeptidase, the enzyme that breaks down proline-containing peptides, depends on manganese as a catalyst
- Prolyl aminopeptidase also contains a highly conserved GxSxGG motif plus two other regions with conserved glycines**
- Malabsorption due to celiac disease can lead to nutritional deficiencies and symptoms of autism***

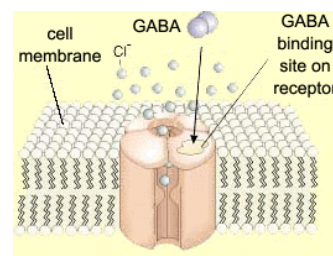
*G. Janssen et al., PLoS One 2015; 10(6): e0128065

**F Morel et al., Biochimica et Biophysica Acta 1999;1429: 501-505

***SJ Genuis and TP Bouchard, J Child Neurol. 2010;25(1):114-9

Impaired GABA Receptor Activity and Autism

- Autism has been linked to a weakened response of the inhibitory GABA receptor to stimuli*
- The GABA receptor has a conserved glycine at the entrance to the first membrane-spanning domain that is essential for its function**



*CD Robertson et al., Current Biology 2016;26: 80-85

**BX Carlson et al., Mol Pharmacol. 2000;57(3):474-84

Summary

- Contrary to Monsanto's claims, glyphosate is toxic to humans
- Mineral chelation, disruption of gut microbes, and inhibition of liver enzymes have broad consequences
 - Causes deficiencies in vitamins, minerals, amino acids, neurotransmitters, melatonin and antioxidants
 - Makes other toxic agents more toxic (synergy)
- Glyphosate may insert erroneously into protein synthesis
 - Multiple proteins with conserved glycines would be severely affected, causing widespread disease