Glyphosate and Autism: Connecting the Dots

Stephanie Seneff
MIT CSAIL

Autism Recovery Telesummit, 2016
How did you come to realize that the pervasive herbicide Roundup (active ingredient glyphosate) is a major factor in the autism epidemic?
“When future historians write about our time, they're not going to write about the tons of chemicals that we did or didn't apply. When it comes to glyphosate, they're going to write about our willingness to sacrifice our children and jeopardize our existence, while threatening and jeopardizing the very basis of our existence: the sustainability of our agriculture.”
Is there a correlation between glyphosate use and autism rates?
US Health Status

* US makes up 5% of the world’s population but consumes more than 50% of the world’s pharmaceutical drugs
* We spend more on health care than Japan, France, China, UK, Italy, Canada, Brazil, Spain, and Australia, combined
* US ranks last or near last among developed nations on infant mortality and life expectancy
* We also suffer from more chronic illnesses
* We consume 25% of the world supply of glyphosate
A Frightening Trend*

Percentage of children with Autism in the US

- Percentage of Children with Autism in US
- Expon. (Percentage of Children with Autism in US)

- 1970: 0.01
- 1980: 0.1
- 1990: 1
- 2000: 10
- 2010: 100
- 2020: Exponential increase continues
- 2032: Projected 50% increase

Autism Recovery Telesummit
80% of the boys
Autism Prevalence: 6 year olds

glyphosate is total of year indicated + 3 previous years
R = 0.9972, p <= 2.366e-07

R = 0.9972

*Plot provided by Nancy Swanson, with permission

Data sources: autism: US Department of Education; Glyphosate: US Department of Agriculture
What crops are suspected to be contaminated with glyphosate?
GMO “Roundup Ready” Crops

- Corn
- Canola Oil
- Sugar
- Soy
- Beets

Autism Recovery Telesummit
Adoption of “Roundup Ready” Crops*

Crops sprayed with Roundup just before harvest

- Wheat
- Sugar Cane
- Beans and Peas
- Sunflowers
- Barley
Toxic Food!!
Is Glyphosate in Our Food?

- Wheat desiccated with Roundup
- High fructose GMO corn syrup
- GMO soy protein filler
- GMO Canola Oil
- Cows fed GMO corn and soy
- Potatoes desiccated with herbicides
Glyphosate and Human Health*

*M. Krüger et al., J Environ Anal Toxicol 2014, 4:2
Why is the use of glyphosate on core crops going up over time?
The dramatic increase in glyphosate usage reflects the widespread appearance of Roundup-resistant weeds growing among the GMO Roundup-Ready core crops (corn, soy, canola, sugar beets, alfalfa, cotton)

*Plot provided by Nancy Swanson, with permission*
Glyphosate and Superweeds

Roundup Ready crops introduced

Plot provided by Dr. Nancy Swanson
“Herbicide Resistant Ryegrass Troubling for Wheat Growers”*

“If you see ryegrass at harvest following an Axial XL application, it may be resistant. And you can scatter seed all over the field with the combine.”

“A reduced-tillage approach, using a *burndown herbicide* ahead of planting in a stale seedbed, also holds promise for improved control.”

“‘We may be able to knock out 80% to 90% of the resistant ryegrass with glyphosate.’ ”

-- Jim Swart, integrated pest management specialist

*Ron Smith, Western Farm Press, Mar. 23, 2013*
Hospital Discharge Diagnosis (any) of Celiac Disease ICD-9 579
and glyphosate applications to wheat (R = 0.9759, p <= 1.862e-06)
sources: USDA:NASS; CDC

Graph provided by Nancy Swanson, with permission
Glyphosate was the predominant new herbicide detected in both air (86%) and rain (77%) in 2007 (not measured in 1995)

- Study conducted by the US Geological Survey in Mississippi
- 18-fold increase in glyphosate application since 1995

*M.S Majewski et al., Environ Toxicol Chem. 2014 Feb 19. Epub ahead of print*
What are the major adverse health effects of glyphosate?
Main Toxic Effects of Glyphosate*

* Kills beneficial gut bacteria and allows pathogens to overgrow
* Interferes with function of cytochrome P450 (CYP) enzymes
* Chelates important minerals (iron, cobalt, manganese, etc.)
* Interferes with synthesis of aromatic amino acids and methionine
  * Leads to shortages in critical neurotransmitters
* Disrupts sulfate synthesis and sulfate transport

*Samsel and Seneff, Entropy 2013, 15, 1416-1463
Nutrients, Hormones and Neurotransmitters Disrupted by Glyphosate

* Folate, vitamin K, vitamin A, vitamin D, cobalamin
* Aromatic amino acids, methionine
* Iron, manganese, cobalt, copper, zinc, sulfur
* Serotonin, melatonin, dopamine, epinephrine
* Melanin (skin tanning agent), thyroid hormone
* NAD, glutathione (antioxidant defenses)
Glyphosate disrupts the body’s ability to distribute the minerals safely: Everybody walks a tight rope between deficiency and toxicity.
WHO Labels Glyphosate as “Probable Carcinogen”*

*Reviewed evidence and decided that the evidence justified the change

*Anthony Samsel has now acquired thousands of pages of “secret” documents from the EPA and he is finding damning evidence of carcinogenicity in Monsanto’s own studies**


**Interview with Tony Mitra: http://www.tonu.org/2015/06/06/glyphosate_tradesecretfiles/
How does glyphosate lead to manganese deficiency, and what is the evidence that this is a factor in autism?
Glyphosate Depletes Iron, Manganese and Zinc in Plants*

![Bar chart showing the effect of glyphosate on nutrient uptake and translocation in plants.](chart.png)

*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.)*

Severe Deficiency in Manganese and Cobalt in Cows*

Eight different farms: 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

Low Manganese in Teeth Linked to Autism*

* Studied lead, mercury and manganese levels in tooth enamel of shed primary teeth in 84 children

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

Hypothyroidism and Autism

* Children born to women with hypothyroidism (under-producing thyroid gland) have a 4-fold increased risk to autism

* Pituitary gland releases thyroid stimulating hormone to induce thyroid activity
  * This depends on manganese

* Lactobacillus microbes produce selenoproteins which protect thyroid from oxidative damage
  * Lactobacillus are strongly dependent on manganese for survival, and glyphosate preferentially harms Lactobacillus
Many lactic acid bacteria contain very high intracellular manganese levels
  - Scavenges toxic oxygen species, particularly superoxide
Manganese deprivation suppresses growth

Autism and Mitochondrial Impairment*

* Mitochondrial impairment is a key feature of autism, especially in the brain
  * Impaired detox of glutamate by astrocytes (requires manganese)
  * Excess stimulation of NMDA receptors in neurons
* Glyphosate excites NMDA receptors and prevents glutamate metabolism

*Dayan Goodenowe and Elodie Pastural, Chapter 4
intechopen.com/books/autism-a-neurodevelopmental-journey-from-genes-to-behaviour/
the-biochemical-basis-of-autistic-behavior-and-pathology
“Taken together, these results demonstrated that Roundup® might lead to excessive extracellular glutamate levels and consequently to glutamate excitotoxicity and oxidative stress in rat hippocampus." - quote from abstract

*D Cattani et al., Toxicology 320 (2014) 34-45
How does glyphosate exposure lead to vitamin D deficiency?
Vitamin D Deficiency Epidemic*

Vitamin D Deficiency Epidemic*

Glyphosate disrupts CYP enzymes in the liver: Vitamin D activation depends on CYP enzymes

Increases in Vitamin D Supplements and Increases in Autism*

*Figure 1. Vitamin D consumption (IU/day)\(^1\) vs Natural log (Autism per 10,000+5 yrs)\(^2\).
\(^1\)Average vitamin D consumption in IU/day through 30 months of age per vitamin D consumption model.
\(^2\)Natural log of estimated autism prevalencer per 10,000 among those entering school five years later. Estimates based on data from California Departmental Services through year 2000 and from National Center for Education Statistics after 2000.

Can glyphosate explain the various digestive problems that kids are having today?
Glyphosate Kills Beneficial Bacteria*

* Examined effect of glyphosate and Roundup on three food microorganisms widely used as starters in dairy technologies
  * Two are species of *Lactobacillus*

* Roundup is always more potent than glyphosate, and in all cases, toxic from levels 10-100 times below the lowest agricultural uses (10,000 ppm).

* Unpredictable consequences of Roundup on soil microorganisms have to be considered

Autism and Gut Microbes: The Gut-Brain Connection

* Autistic children have an altered gut microbiome
  * Less diverse; more pathogens
* Pathogens excrete dangerous metabolites that can alter brain function
* Autistic children had high levels of free glutamate in their fecal samples* → neurotoxin
* Autistic children have abnormally high glutamate and low glutamine levels in their blood**

**C Shimmura et al, 2011; PLOS ONE 6: e25340.
“Deformities, sickness and livestock deaths: the real cost of GM animal feed?”*

“When using GM feed I saw symptoms of bloat, stomach ulcers, high rates of diarrhoea, pigs born with the deformities … but when I switched [to non GM feed] these problems went away, some within a matter of days.”

Quote from Ib Pedersen, producer of 13,000 pigs a year supplying Europe's largest pork company, Danish Crown

Pigs Fed GMOs Develop Inflamed Gut*

- Blind autopsies conducted
- Inflamed stomach
  - Male pigs were 4x more likely to get severe stomach inflammation on GMO diet
  - Females were 2.2x more likely
- Female pigs' uterus 25% larger in GMO-fed pigs

Photos kindly provided by Howard Vlieger

**Human Digestive System Disorders**

* We are seeing an alarming increase in the US in many diseases related to the gut
  * Crohn’s disease, inflammatory bowel disease, colitis, acid reflux disease, gluten and casein intolerance, celiac disease, leaky gut
* The gut-brain axis links neurological disorders with gut disorders
* I believe that glyphosate is a major cause
CHECK OUT OUR NEW GLUTEN FREE AISLE!
Celiac Disease, Glyphosate and Non-Hodgkin’s Lymphoma

*Bifidobacteria are depleted in celiac disease*
  *They convert gluten to less toxic form*
*Glyphosate preferentially kills bifidobacteria**
*Celiac disease is associated with increased risk to non-Hodgkin’s lymphoma***
*Glyphosate itself is also linked directly to non-Hodgkin’s lymphoma****

****M. Eriksson et al., Int J Cancer. 2008 Oct 1;123(7):1657-63.
What is the connection between glyphosate and vaccines?
Glyphosate and Vaccines

* MMR, Varicella, flu vaccine and rabies vaccine contain **glutamate** (a neurotoxin)
  * Glyphosate disrupts conversion of glutamate to glutamine (detox)
* DTaP, HEP-B, Gardasil and others contain **aluminum** (a neurotoxin)
  * Glyphosate escorts aluminum to the pineal gland where it accumulates, causing sleep disorder and many associated neurological diseases*

*S Seneff et al., Agricultural Sciences, 2015, 6, 42-70*
Autism, Glyphosate, Vaccine Reactions*

*Collaboration with Dr. Nancy Swanson
### Symptoms of Adverse Reactions to MMR before and after 2002*

#### More Common Before 2002

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Count Before 2002</th>
<th>Count After 2002</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>joint pain</td>
<td>126</td>
<td>65</td>
<td>0.036</td>
</tr>
</tbody>
</table>

#### More Common After 2002

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Count Before 2002</th>
<th>Count After 2002</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>hospitalization</td>
<td>71</td>
<td>319</td>
<td>0.00037</td>
</tr>
<tr>
<td>seizures</td>
<td>203</td>
<td>462</td>
<td>0.0014</td>
</tr>
<tr>
<td>shortness of breath</td>
<td>100</td>
<td>216</td>
<td>0.010</td>
</tr>
<tr>
<td>hives</td>
<td>324</td>
<td>504</td>
<td>0.011</td>
</tr>
<tr>
<td>mumps</td>
<td>5</td>
<td>51</td>
<td>0.014</td>
</tr>
<tr>
<td>abscess</td>
<td>51</td>
<td>120</td>
<td>0.022</td>
</tr>
<tr>
<td>autism</td>
<td>69</td>
<td>143</td>
<td>0.024</td>
</tr>
<tr>
<td>eczema</td>
<td>4</td>
<td>36</td>
<td>0.026</td>
</tr>
<tr>
<td>ear infection</td>
<td>16</td>
<td>56</td>
<td>0.031</td>
</tr>
<tr>
<td>anaphylactic shock</td>
<td>16</td>
<td>54</td>
<td>0.034</td>
</tr>
<tr>
<td>facial swelling</td>
<td>45</td>
<td>95</td>
<td>0.040</td>
</tr>
<tr>
<td>swelling</td>
<td>860</td>
<td>1018</td>
<td>0.048</td>
</tr>
</tbody>
</table>

*Data analyzed from the VAERS database*
“Alteration of Plasma Glutamate and Glutamine Levels in Children with High-Functioning Autism”*

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>Control</th>
<th>HFA</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alanine</td>
<td>326.1 ± 61.6</td>
<td>300.3 ± 55.0</td>
<td>0.145</td>
</tr>
<tr>
<td>α-Aminobutyric acid</td>
<td>18.8 ± 3.8</td>
<td>18.7 ± 5.4</td>
<td>0.971</td>
</tr>
<tr>
<td>Arginine</td>
<td>89.1 ± 19.0</td>
<td>95.3 ± 18.5</td>
<td>0.279</td>
</tr>
<tr>
<td>Asparaginone</td>
<td>40.8 ± 8.3</td>
<td>43.1 ± 7.0</td>
<td>0.311</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glutamate</th>
<th>20.9 ± 4.5</th>
<th>27.9 ± 7.4</th>
<th>&lt;0.002*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glutamine</td>
<td>513.1 ± 48.5</td>
<td>445.8 ± 50.6</td>
<td>&lt;0.0004**</td>
</tr>
</tbody>
</table>

* C. Shimmura et al. PLoSOne October 2011 6(1):e25340
What actions can a mother take to try to protect her child from autism?
Sustainable Organic Foods are the Only Pathway back to a Healthy Planet
Go Organic!
“Victory Gardens”

VICTORY! VICTOIRE!
Don’t Use Roundup in your Yard!!
Foods High in Sulfur
Foods High in Manganese
Hang Out in the Water at the Seashore
Escape to a Tropical Place in Winter
What is one myth you’d like to bust about autism recovery?
Autism is a genetic disease so there’s no hope of recovery.
What is the biggest mistake people can avoid making on the path to recovering their child from autism?
Any last nuggets of wisdom you’d like to leave with our listeners today?
“How could we have ever believed that it was a good idea to grow our food with poisons?”

-- Jane Goodall