Do I Like Blue Because of my Shampoo?

How Everyday Chemicals Affect our Health and Behavior

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Objective

Convince you that chemicals not only are affecting your health, but who you are.
Outline

• A chemicals that is definitely affecting us
  • Lead
• Chemicals capable of affecting us with low exposure
  • PFAS
    • Bisphenol-A family
    • Chlorpyrifos
• Chemicals that may affect us with low exposure
• Recent regulatory changes
• How can we reduce our exposure to chemicals?
Lead – A Chemical that is Definitely Affecting Us

Blood lead level in μg/dL (children under 6)

Sources: Rick Nevin, CDC

Six Point Increase
Lead Emissions in USA

Source: EPA
Economists hypothesize that regulation of leaded gasoline and lead paint in the 1970s caused crime rates to drop in the U.S. about 20 years later. CPSC = Consumer Product Safety Commission. SOURCES: Rick Nevin, FBI Uniform Crime Reporting Statistics

Source: Drum, K. 2018, Mother Jones
Other Chemicals that we Know Chemicals Affect our Behavior

• Pharmaceuticals (antidepressants, dopamine agonists for movement disorders) Illicit drugs (Methamphetamine, Cocaine, LSD, etc.)
• Hormones such as estrogens
• Caffeine
Pharmaceuticals in Drinking Water

## Illicit Drugs in Tap Water

Non-controlled and illicit drugs in tap water from cities of other countries (n = 26). Surrogate 95th percentiles. All values are expressed in ng L⁻¹.

<table>
<thead>
<tr>
<th>Name</th>
<th>No. &gt;LOQ*</th>
<th>%Freq.</th>
<th>Mean Global</th>
<th>Mean Europe</th>
<th>Mean Japan</th>
<th>Mean Lat. Am.</th>
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</thead>
<tbody>
<tr>
<td><strong>Non-controlled</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caffeine</td>
<td>21</td>
<td>81</td>
<td>19</td>
<td>7.0</td>
<td>33</td>
<td>38</td>
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<tr>
<td>Nicotina</td>
<td>23</td>
<td>88</td>
<td>18</td>
<td>5.9</td>
<td>7.0</td>
<td>40</td>
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<tr>
<td>Cotinine</td>
<td>14</td>
<td>54</td>
<td>2.2</td>
<td>0.4</td>
<td>4.5</td>
<td>4.0</td>
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<tr>
<td><strong>Cocainics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cocaine</td>
<td>12</td>
<td>46</td>
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<td>0.1</td>
<td>&lt;LOQ</td>
<td>0.6</td>
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<td>Cocaethylene</td>
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<td>11</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
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<tr>
<td>Benzoylecgonine</td>
<td>9</td>
<td>35</td>
<td>1.8</td>
<td>0.2</td>
<td></td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Opiates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methadone</td>
<td>5</td>
<td>19</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>EDDP</td>
<td>15</td>
<td>58</td>
<td>0.3</td>
<td>0.4</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>0</td>
<td>0</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
</tr>
<tr>
<td><strong>Amphetamines</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>AMP</td>
<td>0</td>
<td>0</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
</tr>
<tr>
<td>MDA</td>
<td>4</td>
<td>15</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
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<tr>
<td>METH</td>
<td>1</td>
<td>4</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
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<tr>
<td>MDMA (ecstasy)</td>
<td>4</td>
<td>15</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
</tr>
<tr>
<td>MDEA</td>
<td>2</td>
<td>8</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td></td>
</tr>
</tbody>
</table>

Lithium can Decrease Violence and Suicide
Chemicals That May be Affecting us at Low Doses - Perfluoroalkyl Compounds

- Surfactants
- Lubricants
- Coatings
- Fire-Fighting Foams
- Adhesives
- Stain Repellents
- Insecticides

Global Production >10,000 tons/year
Most common repellents:

8:2 Fluorotelomer Alcohol

\[
\begin{align*}
N\text{-EtFOSE} & \quad N\text{-ethyl perfluorooctane sulfonamido ethanol} \\
N\text{-MeFOSE} & \quad N\text{-methyl perfluorooctane sulfonamido ethanol}
\end{align*}
\]
PFAS Human Health Effects

• Kidney cancer
• Increased time to pregnancy
• Low birth weight
• Pregnancy-induced hypertension
• Thyroid disease
• Later puberty onset
• High LDL Cholesterol and lipid metabolism
• ADHD
PFOS in Wildlife

4000 ppb in liver

1 ppt in arctic snow

40 ppb in liver

Giesy and Kannan 2001, Young et al. 2007
Potential PFAS Fates

1. Deposition
2. Atmospheric conversion to PFOS or PFOA
3. Biotransformation to PFOS or PFOA
4. Local Aquatic Discharge
5. Waste Solids (Land Application or Incineration)
How are we exposed to PFASs?

<table>
<thead>
<tr>
<th>PFOA</th>
<th>concentration (pg/g product)</th>
<th>intake (pg/kg bw/day)</th>
<th>percentage of individual daily intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>fatty fish</td>
<td>8</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>lean fish</td>
<td>23</td>
<td>2.2</td>
<td>0.9</td>
</tr>
<tr>
<td>crustaceans</td>
<td>46</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>butter</td>
<td>16</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>cheese</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>milk</td>
<td>0.5</td>
<td>3.9</td>
<td>1.6</td>
</tr>
<tr>
<td>eggs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>pork</td>
<td>15</td>
<td>14.9</td>
<td>5.9</td>
</tr>
<tr>
<td>beef</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>chicken/poultry</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bakery products</td>
<td>5</td>
<td>3.7</td>
<td>1.5</td>
</tr>
<tr>
<td>vegetables/fruit</td>
<td>5</td>
<td>47.4</td>
<td>18.9</td>
</tr>
<tr>
<td>flour</td>
<td>17</td>
<td>38.4</td>
<td>15.3</td>
</tr>
<tr>
<td>vegetable oil</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>industrial oil</td>
<td>6</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>drinking water</td>
<td>9*</td>
<td>137.9</td>
<td>55.0</td>
</tr>
</tbody>
</table>

*Note: The values in the table are approximate and may vary based on different studies and measurements.

How do we know?
Perfluorinated Chemicals are Toxic

*N-EtFOSE*

- rabbit weight loss or death > 5 kg/mg/day\(^1\)
- detected in air

**PFOS**

- Monkey death (100%) > 4.5 mg/kg day\(^2\)
- Detected in human blood (~35 ppb)
- Detected in wildlife (up to 4000 ng/g in liver)

**PFOA**

- Likely Human Carcinogen\(^3\)
- Detected in human blood (~5 ppb)
- Detected in wildlife (up to 500 ng/g)

\(^1\) Case et al. 2001 \(^2\)3M 2001 \(^3\)US EPA 2005
Bisphenol A

BPA is an Endocrine Disruptor
# BPA Linked to Obesity

<table>
<thead>
<tr>
<th>BPA level Percentile</th>
<th>Weight &gt;90\textsuperscript{th}</th>
<th>Adjusted Odds Ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentile (( \mu g/L ))</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>&lt;50\textsuperscript{th} (0.98)</td>
<td>95 (79.17%)</td>
<td>25 (20.83%)</td>
</tr>
<tr>
<td>50\textsuperscript{th}–75\textsuperscript{th} (0.98–4.13)</td>
<td>43 (70.49%)</td>
<td>18 (29.51%)</td>
</tr>
<tr>
<td>75\textsuperscript{th}–90\textsuperscript{th} (4.13–10.04)</td>
<td>24 (64.86%)</td>
<td>13 (35.41%)</td>
</tr>
<tr>
<td>&gt;90\textsuperscript{th} (10.04)</td>
<td>14 (58.33%)</td>
<td>10 (41.67%)</td>
</tr>
</tbody>
</table>

*Trend test: p = 0.006.

*Adjusted for those factors listed in Table 1 (age, gender, school, residence, paternal and maternal education and overweight, playing video games, unbalanced diet, eating junk food, vegetables or fruit, depression scores and sports/activities).

doi:10.1371/journal.pone.0065399.t003

Li et al. 2013. PLoS ONE.
BPA Affects Behavior of Offspring at Doses 10x less than Drinking Water Limit

“...three-chamber test, in which a mouse is given the choice to interact with an unfamiliar [mouse]. The researchers found that mice whose mothers consumed both high and low doses of BPA were much more active and were more likely to interact with others than controls.”

Replacement May be Just as Harmful

Bisphenol A

Bisphenol S
Endocrine Disruptors Can Make Birds More Attractive

…but they die earlier
Chlorpyrifos

Court Orders E.P.A. to Ban Chlorpyrifos, Pesticide Tied to Children’s Health Problems

~10 million pounds applied in the USA

Developmental Neurotoxin
• Lower IQ
• ADHD
• Impaired cognitive, behavior and motor problems
Recent Changes in Chemical Regulation

*Pesticide Studies Won E.P.A.’s Trust, Until Trump’s Team Scorned ‘Secret Science’*

Backed by agrochemical companies, the current administration and Congress are moving to curb the role of human health studies in regulation.
How can we reduce our exposure?
How can we reduce our exposure?

• Consume less things
• Use vinegar and soap instead of cleaning products
• Use products with safer chemicals
  • Environmental Working Group [https://www.ewg.org/skinddeep/](https://www.ewg.org/skinddeep/)
• Test paint and water for lead
• Buy organic produce
Beware

• Organic dry cleaning
• Substituting for products labelled, “safe”, “eco friendly”, or “green”
### Essential Tips and Facts

See that long list of ingredients on the back of the bottle? Some probably aren’t as safe as you’d hope.

1. **Top tips for safer products**
2. **Frequently asked questions (FAQs)**
3. **Why Skin Deep?**
4. **Myths on cosmetic safety**
5. **User’s guide to Skin Deep**

### Dental/oral l Lip Balm

<table>
<thead>
<tr>
<th>Product</th>
<th>Product Type(s)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>381. Maybelline Baby Lips Dr. Rescue Medicated Balm, Soothing Scrub</td>
<td>Lip Balm</td>
<td>3</td>
</tr>
<tr>
<td>382. Maybelline Baby Lips Dr. Rescue Medicated Balm, Too Cool</td>
<td>Lip Balm</td>
<td>3</td>
</tr>
<tr>
<td>383. Maybelline Baby Lips Dr. Rescue Medicated Lip Balm</td>
<td>Lip Balm</td>
<td>3</td>
</tr>
<tr>
<td>384. Maybelline Baby Lips Electro Lip Balm, Berry Bomb</td>
<td>Lip Balm</td>
<td>5</td>
</tr>
</tbody>
</table>
Takeaway Messages

• Chemicals that we are exposed to every day are affecting our health and changing our fundamental character
• We should try to reduce our chemical exposures