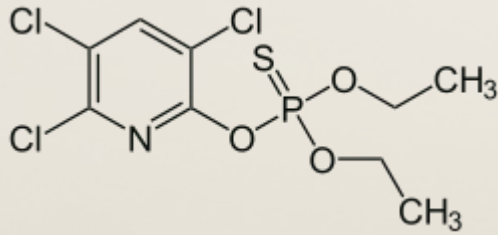


Brain Anomalies in Children Exposed Prenatally to a Common Organophosphate Pesticide

Shreya Ganapathy



Background on Chlorpyrifos

- Chlorpyrifos (CPF) is a pesticide used since 1965, for agriculture and pest control
- CPF was heavily used in urban areas, exposing pregnant women, residential use was banned in 2001
- It remains in widespread use in agriculture, exposing both workers and communities
- Potential to harm brain development, particularly in unborn children
- CPF disrupts key brain cell processes, leading to developmental and behavioral issues

Previous Research on Organophosphates

- Low-level exposure to organophosphate pesticides (like CPF) has been linked to brain development problems in animals and humans
 - Studies with animals show CPF exposure can change the thickness of the brain cortex
 - Specific effect on human brains is unknown
- Organophosphates can pass through the placenta and affect the developing fetus
- Studies have shown that prenatal exposure to CPF is associated with smaller head sizes, lower birth weight, and developmental problems
- Research consistently shows that prenatal organophosphate exposure affects cognitive and behavioral development in both rural and urban populations

Research Question and Hypothesis

Question

Does prenatal CPF exposure affect brain structure and intellectual functioning in children?

Does prenatal CPF exposure disrupt typical sex differences in brain structure in children?

Hypothesis

Children exposed to more CPF before birth will show altered brain structure in regions responsible for higher cognitive functions

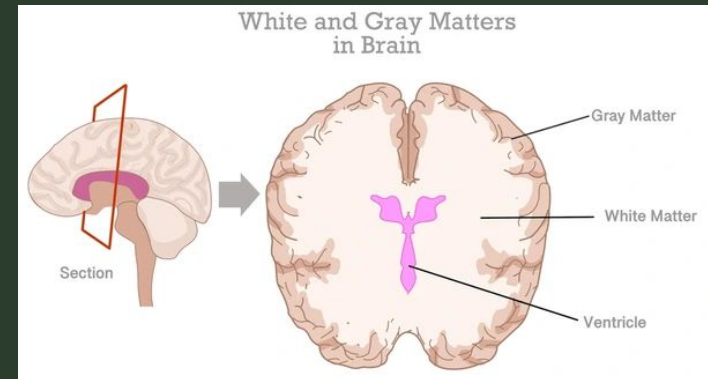
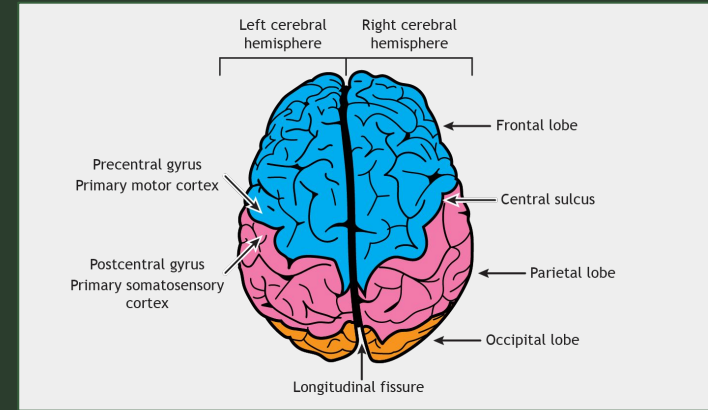
Methods

- Focus on 369 African American and Dominican women aged 18–35 who lived in low-income urban communities for at least a year
 - Author Robin M. Whyatt focuses on environmental justice in previous research
- At delivery, researchers collected blood from the umbilical cord to measure CPF levels
 - Two groups: higher exposure and lower exposure
 - Also tested for smoking, air pollution exposure, and lead exposure as a part of a larger study
- The children's brain images were taken using high-resolution MRI scans
- The MRI data was processed using software, analyzed brain gray matter (where info is processed) in frontal, temporal, occipital, and parietal lobes
- At ~age 7, the children's IQ was measured for verbal comprehension, perceptual reasoning, processing speed, and working memory

Results

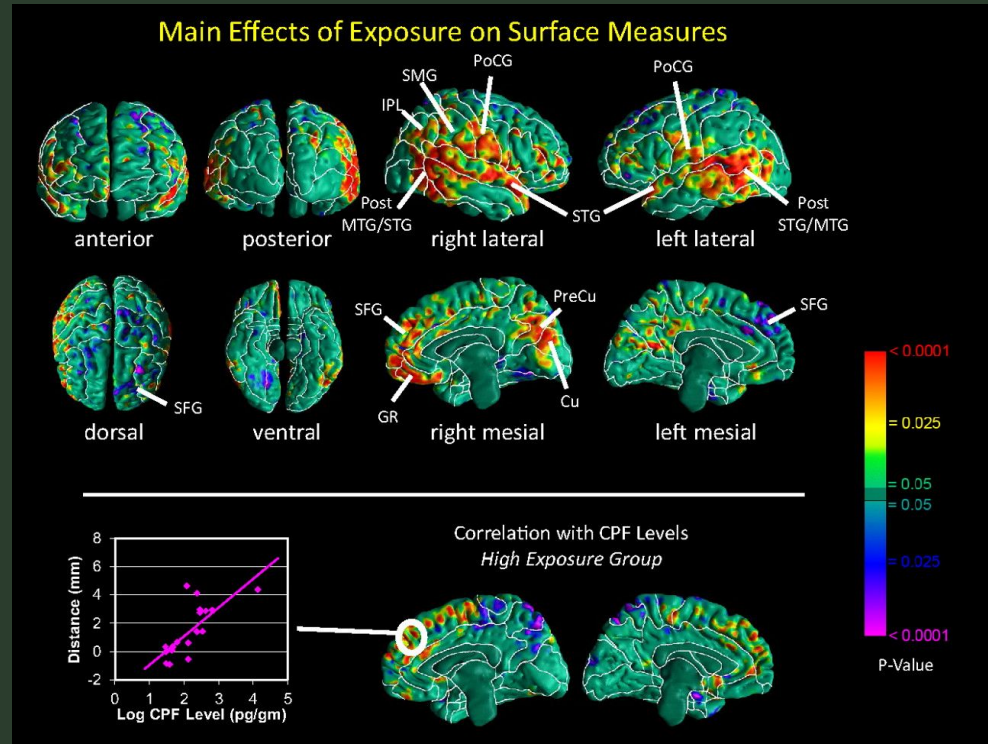
Structural Effects

- No overall brain size difference between high-CPF and low-CPF exposure groups
- Enlargement primarily due to underlying white matter (network that connects processing centers and speeds up communication) rather than overall brain size
- Cortical thickness (outer layer of the brain) reductions were found in frontal cortices in children with high CPF exposure
 - Thicker cortical areas are linked to brain health and higher cognitive ability



Results

- High-CPF group showed significant enlargement in certain parts of the brain
 - Superior temporal, posterior middle temporal (sound, touch, motor functions)
 - Supramarginal gyrus (language, sensory, spatial awareness)
 - Superior frontal gyrus, gyrus rectus, cuneus, and precuneus (decision-making, memory, attention)



Discussion

- Even low levels of CPF can affect brain structure in kids 5.9-11.2 yrs old
- Significant shape changes in Superior temporal, Superior frontal gyrus, and Cortical thickness
- CPF exposure might impact the brain's white matter development
- The levels of CPF exposure causing these effects in humans are comparable to those in animal models, reinforcing the toxicity of CPF during brain development
- Even though CPF use in homes has been banned, general population exposure continues due to CPF residues remaining on agricultural products
 - low-level exposure persists for the general population through CPF residues on food, which remains a public health concern

Current Situation

- EPA proved there is no safe level of CPF in agriculture in 2016, but did not ban it under the current administration
- In 2021, EPA called for a ban but was later revoked in 2023, meaning CPF is still in use in the U.S.

Sources

Earthjustice. (2025, March 20). *What you need to know about chlorpyrifos - Earthjustice.*

<https://earthjustice.org/feature/chlorpyrifos-what-you-need-to-know>

Frequently Asked Questions about the Current Status of Chlorpyrifos and Anticipated Path Forward | US EPA. (2024, December 12). US EPA.

<https://www.epa.gov/ingredients-used-pesticide-products/frequently-asked-questions-about-current-status-chlorpyrifos#grow>

Rauh, V. A., Perera, F. P., Horton, M. K., Whyatt, R. M., Bansal, R., Hao, X., Liu, J., Barr, D. B., Slotkin, T. A., & Peterson, B. S. (2012). Brain anomalies in children exposed prenatally to a common organophosphate pesticide. *Proceedings of the National Academy of Sciences*, 109(20), 7871–7876.

<https://doi.org/10.1073/pnas.1203396109>

THANK YOU

Any questions?
