



# **Pesticides in Paradise: The Science Behind the Risk**

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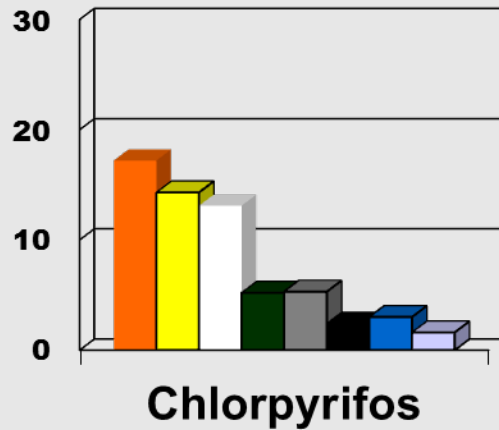
# Why worry about the effects of pesticides on human health?

- 5000 new chemicals/year; at least 25% are neurotoxic
- High vulnerability of the developing brain
- Some widely used pesticides (organophosphates) were developed as nerve gas, specifically designed to attack the mammalian central nervous system
- In June 2000-2001 EPA banned indoor residential use
- Despite these restrictions, CPF remains one of the most heavily used insecticides world-wide
- The EPA indoor residential use ban was highly effective

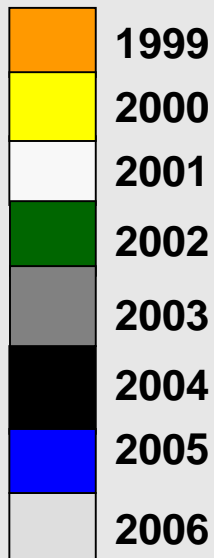
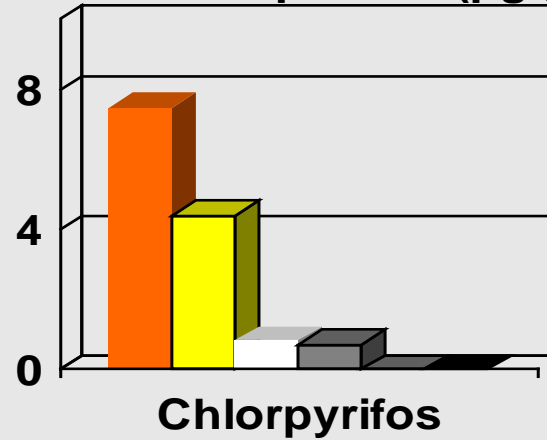
# Chlorpyrifos levels in personal air and blood declined after EPA ban

(Columbia Center for Children's Environmental Health; Wyatt et al., EHP, 2009)

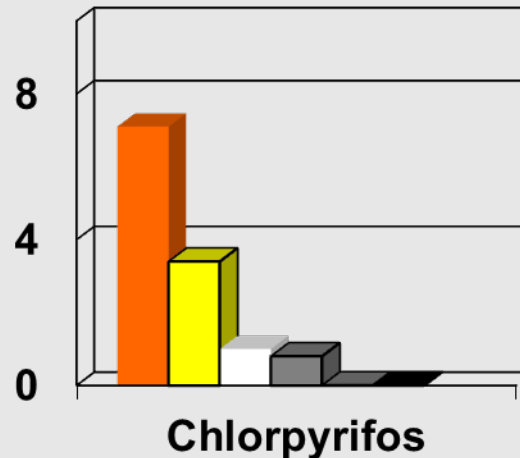
Personal air (ng/m<sup>3</sup>, n=621)



Maternal plasma (pg/gm, n=424)



Cord plasma (pg/gm, n=395)



## Prenatal Exposure to Organophosphate Pesticides and IQ in 7-Year-Old Children

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## Prenatal Exposure to Organophosphate Pesticides and Child Development in Childhood

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## Seven-Year Neurodevelopmental Scores and Prenatal Exposure to Chlorpyrifos, a Common Agricultural Pesticide

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# Convergence of Observational Evidence

- All 3 papers reported significant 7 year cognitive deficits on WISC subscales associated with prenatal organophosphate insecticide exposure
- The studies used three different populations: two urban, one rural/agricultural
- The studies used different biomarkers of exposure: one used measure of the compound in blood; two used urinary metabolites

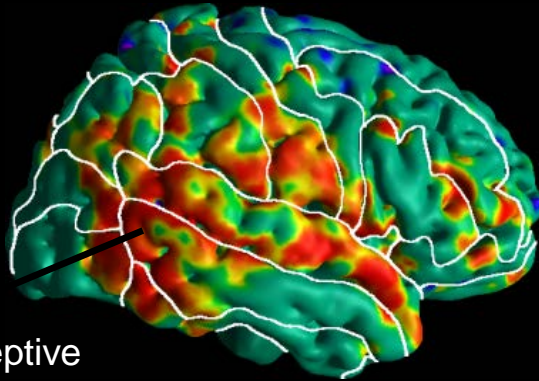
# Brain Imaging Results:

## Anomalies in Morphology of the Cerebral Surface

- Overall brain size did not differ significantly across exposure groups, unadjusted or adjusted for age, sex, and height;
- There were volumetric differences and deformations in specific brain regions, with or without correction for overall brain size;
- Enlargements at the cerebral surface derived primarily from enlarged underlying white matter.

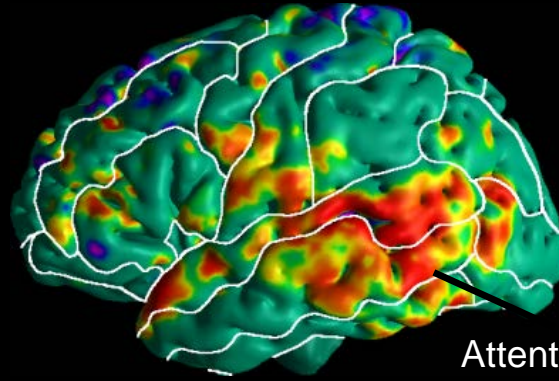
*Rauh et al., PNAS, 2012*

# Effects of Pesticide Exposure on Regional Brain Volumes and Associated Cognitive Processes



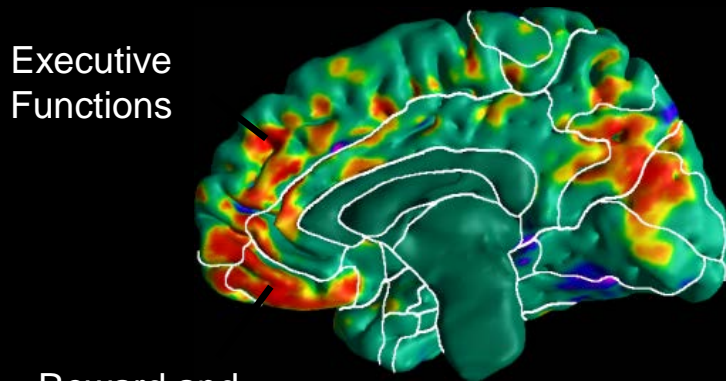
Attention/Receptive  
Language

right lateral side



Attention/Receptive  
Language

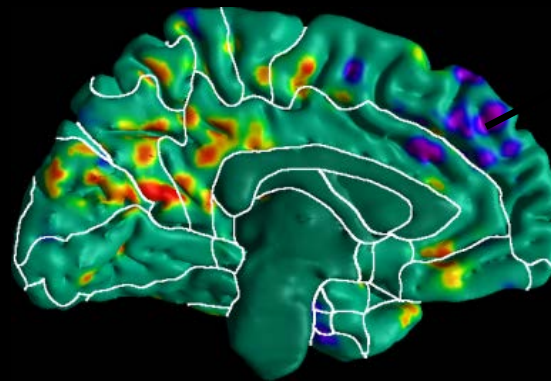
left lateral side



Executive  
Functions

Reward and  
Emotion

right middle



Executive  
Functions

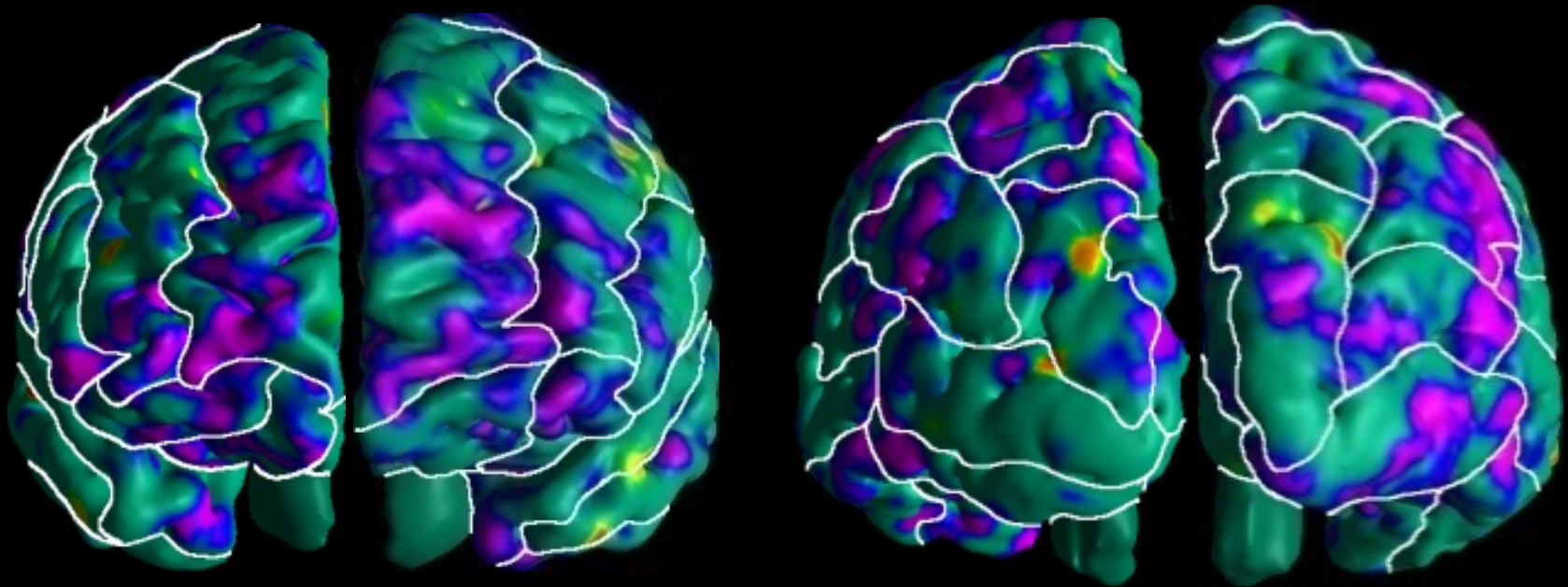
left middle

# **Brain Imaging Results: CPF Association with Cortical Thinning**

- CPF associated with reduced thickness of dorsal parietal and frontal cortices
- Cortical thinning may be associated with increase risk of cognitive, behavioral and mental health symptom severity



**Typical child's brain showing locations  
(pink color) where pesticide exposure is associated  
with cortical thinning**



## **To summarize the MRI findings:**

Prenatal exposure, even at low levels consistent with standard usage and comparable to current agricultural exposures, is significantly associated with structural changes in the developing brain, that persist into middle childhood, and may be related to longer term neuro-psychological and motor problems.