Health Effects of Pesticide Exposures for Infants and Children

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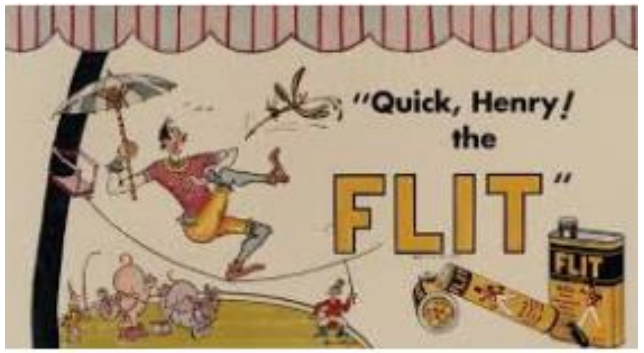
Pesticide classifications and functions

- **Herbicide** Destroy and prevent the spread of weeds or unwanted vegetation; some commonly used herbicides are **paraquat**, **glyphosate** and propanil
- **Fungicide** Control, destroy, make harmless or regulate the effect of a fungus
- **Rodenticide Insecticide** Used specifically for controlling rodents such as mice and rats
- **Insecticide** Destroy, suppress, stupefy, inhibit the feeding of, or prevent infestations or attacks by an insect; some commonly used insecticides are organochlorines, **organophosphates , pyrethroids,** and carbamates
- **Bactericide/ disinfectant** Destroy, suppress or prevent the spread of bacteria

Household & garden pesticides in groceries and home depots



These Ads Drawn By Dr Seuss Before He ...

1940s

Pesticide Exposure and Neurodevelopment

- Pesticides pass through the placenta and blood brain barrier
  - Organophosphate pesticides (OPs) inhibit acetylcholinesterase (AChE) allowing acetylcholine to build up at neuronal junctions
  - AChE inhibition disrupts cell replication, differentiation, synaptogenesis, axonogenesis
- Fetuses and young children more susceptible
  - Rapid brain development
  - Lower than adult levels of detoxifying enzymes to deactivate OPs

Neurobiological Model of Development

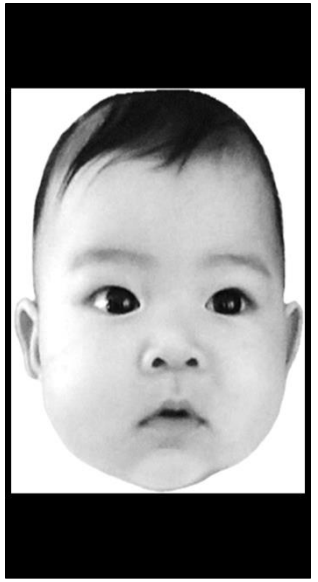
Insecticides not expected to selectively affect one specific brain region particularly if alter neurotransmitter system

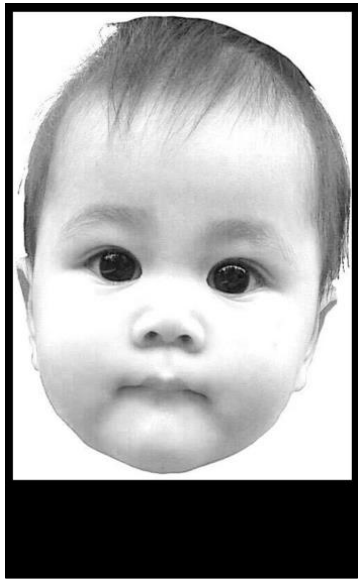
Nervous system is integrated vertically

Behaviors we can measure reflect development of underlying neural substrates of visual attention, regulation of emotion, memory, and inhibitory control

Neurodevelopmental Trajectory

0-18 mo	• Infant attention and processing speed lay groundwork for later cognitive skill development
12 & 24 mos	• Regulation of emotional reactivity (e.g., anger, fear) predicts the ability to inhibit responses (e.g., eating a marshmallow) and later cognitive ability.
Early childhood through adolescence	• Learning, Memory, and Executive Control become increasingly sophisticated with simple learning and memory at 12 months





Neurobehavioral Studies Evaluating Health Effects Among Organophosphate Pesticide Exposed Children

- Birth Cohorts in the U.S.
  - California Children's Environmental Health Research at University of California (Latino agricultural cohort; farmworker families)
  - Mt. Sinai (NYC multiethnic cohort: residential pesticide use)
  - Columbia University (NYC inner city minority: residential pesticide use)

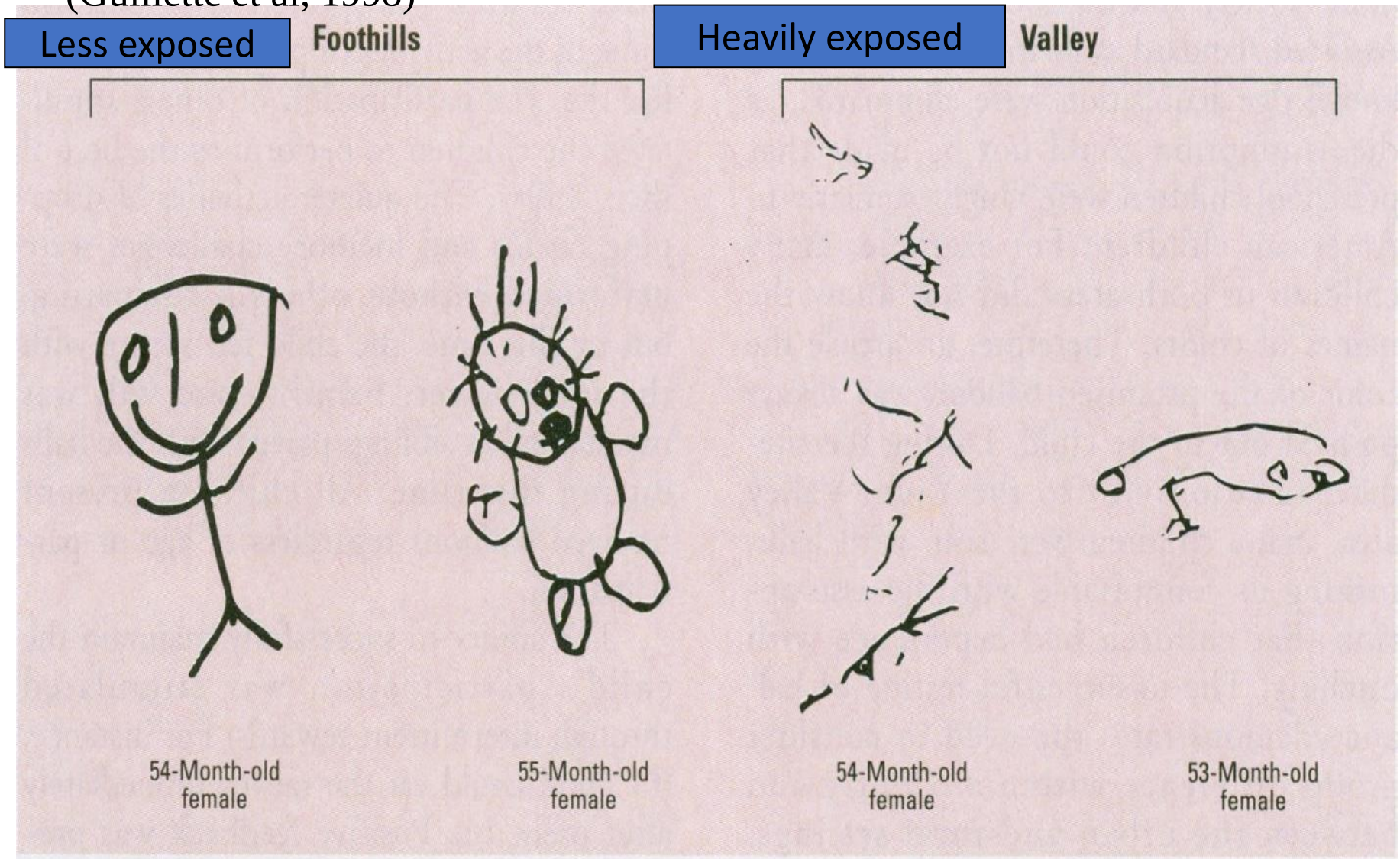
Health Effects in birth Cohorts: the importance of when exposure occurs

- CHAMACOS & Mt. Sinai:
  - DAPs in **maternal** urine associated with abnormal reflexes in neonates
  - DAPs in **maternal** urine associated with decreased Bayley mental development scores at 24 months
  - DAPS in 24 month old children from CHAMACOS positively associated with mental development

Health Effects: Birth cohorts

- Columbia cohort in NYC:
  - negative association between chlorpyrifos in cord plasma and motor and mental development evident at 36 months (not at 12 or 24 months)
  - Attention problems & ADHD from parental reports on Child Behavior Checklist) (Rauh et al., 2006)
- Columbia and CHAMACOS cohorts
  - Maternal reports of pervasive developmental disorder associated with maternal DAPs in CHAMACOS and Columbia cohorts at 24 and 36 months

Mexican children exposed and unexposed to organophosphates, pyrethroids, and organochlorines used on farms from 1940s to present (Guillette et al, 1998)



Pyrethroids and neurodevelopmental risk

Few studies evaluating the effects of maternal pyrethroid exposure on infant neurodevelopment

Studies from France and NYC show no effects on infant neurodevelopment

Studies from China and Mexico show decrements in infant cognition

Eskenazi et al., 2018 (South Africa)

10-fold increase in maternal pyrethroid metabolites associated with decrease in language and expressive communication on Bayley scales at 2 years

Birth Cohort follow-up studies of intelligence at 7 years

Columbia Cohort – residential exposure

- For each standard deviation increase in chlorpyrifos exposure, IQ declined by 1.4%
- working memory declined by 2.8%

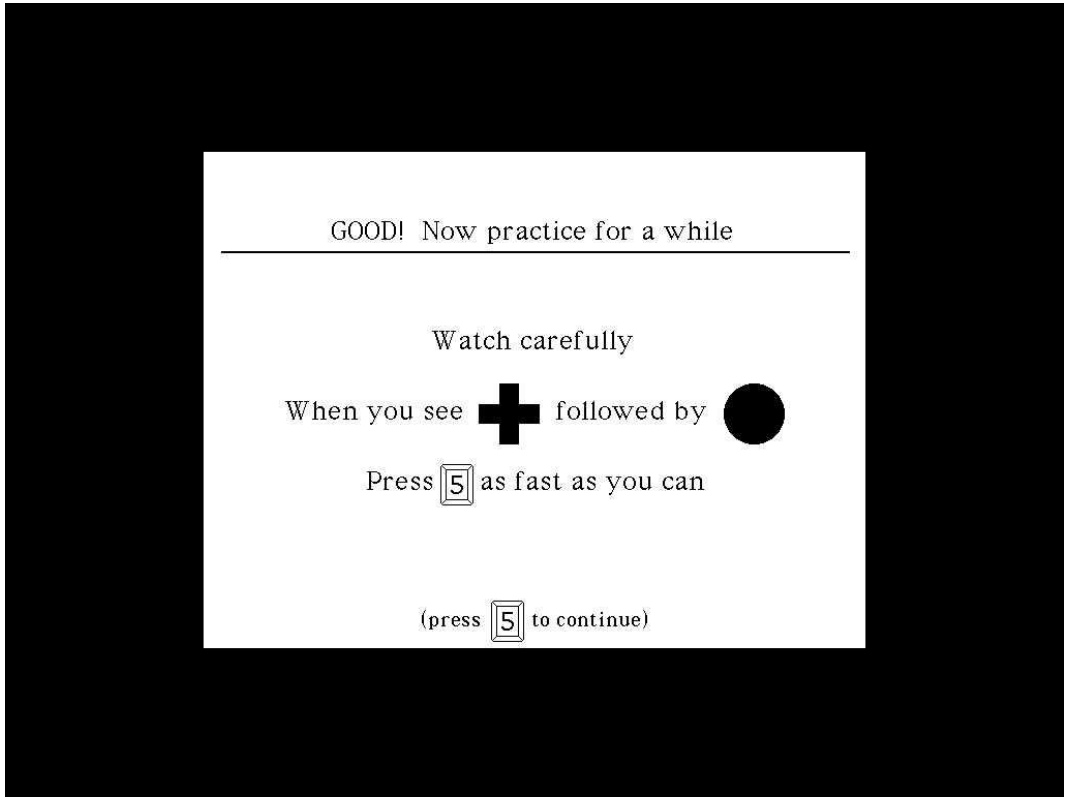
CHAMACOS cohort - agricultural exposure

Average **maternal** DAP concentrations associated with poorer scores for working memory, processing speed, verbal comprehension, perceptual reasoning and full scale IQ

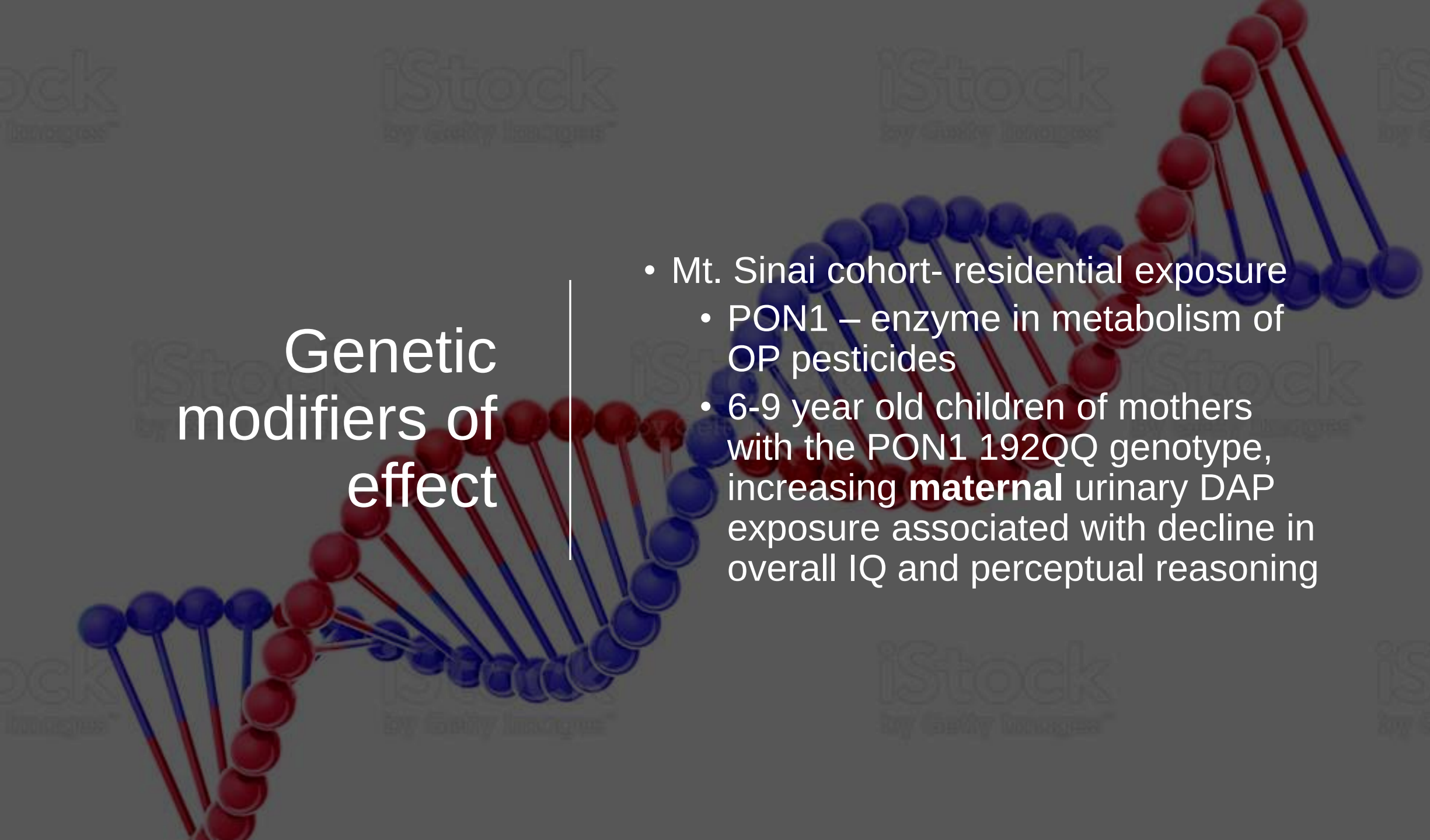
Average IQ deficit = 7 IQ points (highest vs. lowest quintile)

ADHD and maternal pesticide exposure

- Impaired development becomes more apparent with age
- Accomplishments diverge from expectations
- Prenatal OP exposure (urinary metabolites) associated with attention problems, continuous performance test, and ADHD scales at 5 years of age (Marks et al., 2010)
- Stronger association for boys and for 5 year old vs. 3.5 year old



Genetic modifiers of effect



- Mt. Sinai cohort- residential exposure
  - PON1 – enzyme in metabolism of OP pesticides
  - 6-9 year old children of mothers with the PON1 192QQ genotype, increasing **maternal** urinary DAP exposure associated with decline in overall IQ and perceptual reasoning

What can we do?

Control of pests is important, but we need to find healthier methods

EPA is now moving ahead to ban chlorpyrifos on food to protect children's health, but…..

Other chemicals will likely take its place, and this is only one of several chemicals applied to control pests

We are currently also investigating the health effects of pyrethroids and glyphosate, both of which were promised to have no adverse effects on humans