

# Relevance of Visual Effects of Volatile Organic Compounds to Human Health Risk Assessment

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Healthy Communities and Ecosystems

## What Functional Changes Indicate Neurotoxicity?



- **Sensory**
  - Visual, olfactory, auditory, somatosensory etc
- **Motor**
  - Activity, ataxia, incoordination, tremor etc
- **Cognitive**
  - Confusion, memory, learning etc
- **General**
  - Anorexia, ChE inhibition narcosis etc
- **Affect/personality**
  - Apathy, depression, excitability, sleep disturbance etc

## Levels of Concern for Neurotoxic Outcomes

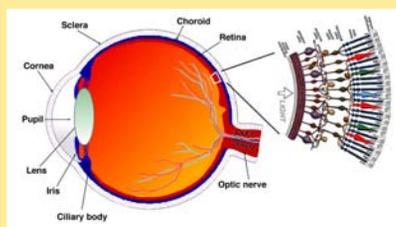
Lower Concern

- Rapidly reversible
- Only at high doses
- Confounded by toxicity to other organs

Higher Concern

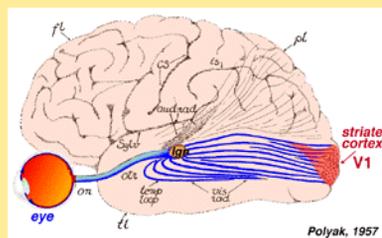
- Structural changes
- Non-reversible, permanent or progressive
- Delayed onset

## Anatomy of Visual System- Window to the nervous system



- Retina
  - high metabolic rate
  - high choroidal blood flow
  - daily turnover of rod and cone outer segments
  - melanin
  - light-toxicant interactions
  - e.g., Methanol

- Optic nerve
  - Susceptible to axonopathy
  - e.g., Carbon disulfide
- Thalamus & optic radiations
- Visual cortex
  - e.g., Methyl mercury



Polyak, 1957

## Are Visual Deficits Adverse?

### Contrast

- Contrast deficits correlate with
- Impaired mobility
  - Unable to drive at night
  - Poor distance judgment
  - Reading difficulty
  - Longer to perform tasks of daily living
  - Slow reactions

### Color

- Congenital (R/G) deficits correlate with
- Poor school performance
  - Slow stop light reaction times
  - Difficulty with color video monitors
  - Poor performance of color coded tasks
- Acquired (B/Y) deficits
- Little information regarding consequences
  - Associated with other health effects from exposure to organic solvents

## Visual Contrast Sensitivity



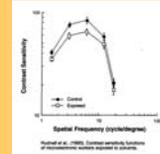
### Visual Contrast

- The luminance difference between light and dark parts of a visual pattern

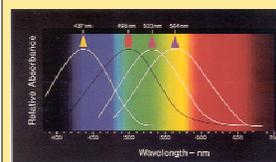
### Contrast Sensitivity

- Expressed as the inverse of the perceptual contrast threshold
- Reflects the ability to distinguish visual features on different spatial scales

Chronic Exposure to Organic Solvents Reduces Visual Contrast Sensitivity



## Color Vision



### 3 Types of Cones

- Red (long wavelength)
- Green (middle wavelength)
- Blue (short wavelength)
  - Fewer in number
  - Susceptible to damage



Original Deuteranope (red/green deficit) Tritanope (blue/yellow deficit)

### Color Vision Deficits

- |                   |                 |
|-------------------|-----------------|
| <u>Congenital</u> | <u>Acquired</u> |
| • R/G impairment  | • B/Y &/or R/G  |
| • ~8% of men      | • Either gender |

## Chemicals Currently Under Review for IRIS

### Toluene

Printers and other workers exposed to toluene show:

- Color vision deficits
- Contrast sensitivity deficits
- Additional neurological & neurobehavioral impairments

### Perchloroethylene

Dry Cleaners and/or residents in buildings with dry cleaners show:

- Contrast sensitivity deficits
- Color vision deficits
- Neurobehavioral impairments

### Styrene

Styrene workers show:

- Color vision deficits (17 studies)
- Contrast sensitivity deficits
- Changes in choice reaction time, impaired memory, auditory function and other neurobehavioral impairments

## Risk Assessment Issues

### Testing

- Luminance, practice etc.
- Confounders: age, alcohol, etc
- Congenital deficits
- Healthy worker effect

### Hazard ID/ Uncertainties

- Experimental design
  - Sample size, potential bias
- Content validity of data set
- Reliability of tests
- Null versus negative study

### Adversity

- Subtle magnitude of deficits
- Are effects reversible?
- Are effects progressive?