Neuroanatomical Effects of Alcohol Exposure in Development and Adulthood

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How does the regional pattern of abnormalities produced by fetal alcohol exposure differ from the pattern produced in the adult brain?
Regional Pattern of Brain Hypoplasia in FAS
( Archibald et al., 2001 )

- Cerebellar hypoplasia is relatively greater than cerebral hypoplasia.
- White matter hypoplasia exceeds gray matter hypoplasia.
- The parietal lobe is disproportionately smaller.
- Striatal structures are disproportionately smaller than hippocampus.
Decreases in Distance from Center in Fetal Alcohol Exposure

(Sowell et al., 2002)
Regional Pattern of Tissue Loss in Chronic Alcoholism

- Modest but widespread cortical gray matter and white matter losses in cerebrum.
- Loss of gray matter volume in striatal, diencephalic, and limbic structures.
- Significant volume loss in cerebellum.
- Disproportionate frontal neuron loss and white matter loss (in older patients).
- Evidence for reversibility of some changes, especially in white matter, with abstinence.
Regional Pattern of Tissue Loss in Korsakoff’s Syndrome

- Cerebellar losses are somewhat more pronounced than cerebral losses.
- White matter loss is more pronounced in both cerebrum and cerebellum.
- Temporal lobe is disproportionately affected (gray and white).
- Amygdala and diencephalic structures are relatively more affected than striatum.
Consistent Effects of Alcohol Exposure

- Vulnerability of cerebellum
- Disproportionate effects on white matter (may be reversible, but persist in Korsakoff’s Syndrome)
- Effects in diencephalic structures and amygdala are pronounced
Contrasting Effects

• Fetal Effects:
  – Are more pronounced in caudate than other subcortical structures (including hippocampus)
  – Are significantly more pronounced in parietal lobe gray and white

• Korsakoff Effects:
  – Are less severe in striatal structures than in other subcortical structures
  – Are absent in parietal lobe gray, but severe in temporal lobe gray and white
some conclusions...

– Given the pattern observed in FAS, the focus on hippocampal effects in animal studies and the presumption of a hippocampal basis for spatial learning deficits in FAS, should perhaps be reconsidered.

– The disproportionate effects of fetal alcohol exposure on caudate nucleus, and on parietal lobe (and perhaps orbitofrontal) structures within the cortex is unexpected and warrants further scrutiny.

– Since increased vulnerability of parietal lobe is not observed in adult populations, the mechanisms underlying this effect may depend on specific developmental cofactors.
more conclusions...

- White matter is highly vulnerable to the effects of heavy alcohol exposure in all contexts; however it appears that exposure very early in development, and very late in the course of alcoholism, may lead to more enduring effects than exposure earlier in adult alcoholism.

- Although the cerebellum appears to show increased vulnerability to alcohol effects in all contexts, there is still no explanation for this.

- The mechanisms by which diencephalic and temporal lobe structures are disproportionately affected in alcoholics who develop amnesia is also not understood.