Neurobiological Advances in Addiction Science: Implications For Prevention and Treatment

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Drugs of abuse increase DA in the Nucleus Accumbens, which is believed to trigger the neuroadaptions that result in addiction.

Di Chiara et al.
Repeated Drug Use Changes the Brain Weakens the Brain Dopamine System

Control

Cocaine Abuser

REPEATED USE OF COCAINE OR OTHER DRUGS REDUCES LEVELS OF DOPAMINE D2 RECEPTORS
Dopamine D2 Receptors are Lower in Addiction

Volkow et al., Neuro Learn Mem 2002.
Addiction Involves *Multiple Factors*

**DEVELOPMENT/Genes**

**ENVIRONMENT**

**DRUG**

**Brain Mechanisms**

**Addiction**
The Brain Undergoes Major Changes From Childhood Through Adulthood

Age at cannabis use disorder as per DSM IV

NIAAA National Epidemiologic Survey on Alcohol and Related Conditions, 2003
Social Rank & Vulnerability to Drugs

Social Deprivation Interferes with Brain Connectivity

Social Neglect During Early Childhood Decreases Brain Connectivity

Decreased connectivity between amygdala and OFC was proportional to time in orphanage.


Govindan et al., Cereb Cortex 2010.
Prevention Programs Should Enhance Protective Factors & Reduce Risk Factors

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Domain</th>
<th>Protective Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Aggressive Behavior</td>
<td>Individual</td>
<td>Self-Control</td>
</tr>
<tr>
<td>Poor Social Skills</td>
<td>Individual</td>
<td>Positive Relationships</td>
</tr>
<tr>
<td>Lack of Parental Supervision</td>
<td>Family</td>
<td>Parental Monitoring and Support</td>
</tr>
<tr>
<td>Substance Abuse</td>
<td>Peer</td>
<td>Academic Competence</td>
</tr>
<tr>
<td>Drug Availability</td>
<td>School</td>
<td>Anti-Drug Use Policies</td>
</tr>
<tr>
<td>Poverty</td>
<td>Community</td>
<td>Strong Neighborhood Attachment</td>
</tr>
</tbody>
</table>

Reduce these | Elevate these

Examples of Risk and Protective Factors
Partial Recovery of Brain Dopamine Transporters in Methamphetamine (METH) Abuser After Protracted Abstinence

Medications Assisted Therapies

Opioid Agonist Treatments Decreased Heroin OD Deaths
Baltimore, Maryland, 1995-2009

Methadone Promotes Initiation Of Antiretroviral Therapy in IDU


Around the World...

247 million people used drugs in the past year

29 million suffer from drug use disorders
but only 1 in 6 people with drug use disorders is in treatment
Challenge: How to Integrate Drug Abuse & Addiction Screening, Prevention & Treatment into the Healthcare System
Improving Treatments for Addiction: Implementing Medication-Assisted Treatment

- Emergency department-initiated buprenorphine
  - Reduced self-reported, illicit opioid use
  - Increased engagement in addiction treatment; decreased use of inpatient addiction treatment services
Children with low self-control had poorer health outcomes and higher problems with substance use disorders than those with high self-control

Moffitt et al., PNAS 2011.

All successful programs involved repeated practice and progressively increase challenge to executive function


Self-control can be improved by:

• Computerized training
• Non-computerized games
• Aerobics
• Martial Arts
• Yoga
• Mindfulness
• School Curricula

Interventions that Aid Executive Function In 4 to 12 Years Olds

Childhood Self-Control Predicts Health
(Dunedin Study; 1000 children)
Medications are Underused

In 48 states and D.C., Opioid Abuse and Dependence Rates Exceed Buprenorphine Treatment Capacity

Nearly all U.S. states do not have sufficient treatment capacity to provide medication assisted treatment to all patients with an opioid use disorder.

In 2014, the proportion of opioid admissions with tx plans that included receiving medications was 25%.


Microstructural Abnormalities in Language and Limbic Pathways in Orphanage-Reared Children: A Diffusion Tensor Imaging Study

Association of mean diffusivity of the left arcuate fasciculus and time spent in the adoptive home
Mean diffusivity decreased with increasing time spent in the adoptive environment

Relationship between language function and Fractional Anisotropy (FA) for the left arcuate fasciculus in children with early deprivation
Increases in FA are associated with better language function

Duration Of Early Adversity and Structural Brain Development In Post-institutionalized Adolescents

Prefrontal gray matter volume (age & sex adjusted) is reduced in PI youth

Duration of early adversity predicts hippocampal volume reduction (age and sex adjusted)

Duration of adversity over first year of life predicts hippocampal volume (age, sex, and ICV adjusted) in early adolescence (right hippocampal effect is equivalent).

Neglect in early life was associated with alterations in white matter microstructure throughout the brain, specifically involving the body of the corpus callosum, cingulum, fornix, anterior and superior corona radiata, external capsule, retrolenticular internal capsule, and medial lemniscus.

The foster care group did not significantly differ from the never-institutionalized group in measurements of these tracts, with the exception of the body of the corpus callosum and superior corona radiata.

These findings suggest a potential for remediation of specific white matter pathways for children removed from institutional care and placed in responsive families early in life.

**Bick J et al., JAMA Pediatr 2015 Mar; 169(3): 211-219.**
Chronic Drug Use Reduces DA D2 Receptors Impairing Frontal Function

DA D2 Receptors

Metabolism

Frontal Metabolism

D2 Receptors (BP_{ND})