Brain Development and Vulnerability to Addictive Disorders

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The emerging science of brain development suggests that the maturing brain of the adolescent does not give rise to optimal assessment of risk and careful decision making.
#2 Conclusion

The adolescent developing brain, in conjunction with numerous social, attitudinal and economic factors, reinforce the potential health concerns of youth problem gambling and related addictions, particularly drug abuse.
Most adults that have an addiction problem began their “indulgence” during adolescence.
1. Background – gambling

Just because you’re sixteen doesn’t mean you can’t be up to your eyeballs in debt.
Youth Access to Gambling

- First generation of youth exposed to ready access and varied gambling venues.
- Minimum legal age to place a bet varies across states, but many opportunities for youth in the United States and Canada.
U.S.: Minimum Legal Age

Gambling and the Law, Nelson Rose, Whitier Law School

- 39 states with a lottery
  - 37 states with 18 as legal age
  - 3 states may switch to 21

- 31 states with casinos/slots
  - 20 states with 18 as legal age
  - 4 states may switch to 21
U.S.: If you are 16 and want to bet legally, live in...

<table>
<thead>
<tr>
<th>State</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>Mississippi</td>
</tr>
<tr>
<td>Delaware</td>
<td>Montana</td>
</tr>
<tr>
<td>Georgia</td>
<td>New Mexico</td>
</tr>
<tr>
<td>Idaho</td>
<td>New York</td>
</tr>
<tr>
<td>Iowa</td>
<td>North Carolina</td>
</tr>
<tr>
<td>Kentucky</td>
<td>North Dakota</td>
</tr>
<tr>
<td>Maine</td>
<td>Pennsylvania</td>
</tr>
<tr>
<td>Maryland</td>
<td>Texas</td>
</tr>
<tr>
<td>Virginia</td>
<td>Washington</td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
</tr>
</tbody>
</table>
U.S. Youth Participation in All Forms of Gambling (age 14 – 21)  (Welte et al., 2008)
Internet Gambling in America:
Another “Wave” of Gambling Expansion
Internet Gambling With Money by Gambling Group (Derevensky et al., 2006)
University journalism student Mike Schneider won top prize - $1 million - in the Limit Hold'em PartyPoker.com Million V tournament.

Photo by Charlie Knutson, from The Minnesota Daily, March 22, 2006
Estimates of Problem Gambling-Lifetime (National Research Council, 1999)

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>&lt;1 - 3%</td>
<td>1.5%</td>
</tr>
<tr>
<td>College</td>
<td>3 - 11%</td>
<td>5%</td>
</tr>
<tr>
<td>Adolescent</td>
<td>1 - 7%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Estimates based on meta-analysis of surveys conducted 1988-1997 (National Research Council, 1999). Problem gambling defined in most studies by the SOGS/SOGS-RA.
Clinical Issues: Youth and Treatment

- Since 1999 in Minnesota:
  - over 9,000 calls to the problem gambling hotline ...
  - 15 calls from teenagers (< 19 years old)
  - over 3,100 referrals into the treatment system.....
  - 0 referrals of teenagers (< 19 years old)
Clinical Issues: Youth and Treatment

- Since 1999 in Minnesota:
  - over 9,000 calls to the problem gambling hotline ...
    - 14 calls from teenagers (<19 years)
  - over 3,100 referrals into the treatment system.....
    - 14 referrals of 19 – 25-years old
Clinical Issues: Youth and Treatment

• Reasons?

• Low problem recognition

• Weak public awareness

• No youth-specific services

• Other, more observable problems are viewed as more pressing

• No or minimal financial losses
But there are cases...

- Minnesota High School Football Star; was an honor student and had a football scholarship to a Division I school.
- Became an habitual blackjack player at the local casino after he turned 18.
- To finance his habit, he fenced stolen property.
- Was arrested for the thefts.
Do Not Forget...
Developmental Link of Problem Gambling

Adolescent → Adult
Onset of Gambling Variables and Number of Lifetime Symptoms (Kessler et al., in press)

Earlier onset among those 5+

Age Onset: $F = 15.4, p < .001$
Onset of Gambling Variables and Number of Lifetime Symptoms (Kessler et al., in press)

<table>
<thead>
<tr>
<th>Number of Lifetime Symptoms</th>
<th>Mean Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Sym</td>
<td>23.9</td>
</tr>
<tr>
<td>1-2 Sym</td>
<td>26.7</td>
</tr>
<tr>
<td>3-4 Sym</td>
<td>23.8</td>
</tr>
<tr>
<td>5+ Sym</td>
<td>24.3</td>
</tr>
</tbody>
</table>

Age Onset Prb: *non sig.*
Youth Problem Gambling as a Component of Problem Behaviors
Cross-Sectional Study of Adolescents: Association of Psychosocial Problems and Gambling Involvement
(Faregh & Derevensky, under review)
These variables measured in the kindergarten sample:

- Impulsivity
- Emotional distress
- Family functioning
- Maternal education
- Parental gambling
- Sex

Measured gambling behavior when they were sixth graders.

Pagani et al., 2009
1. Background – drug abuse
Evidence from Epidemiological Studies

Drug use starts early and peaks in the teen years

(Grant, B.F., et al., Drug and Alcohol Dependence, 74, 223-234, 2004)
Percentages of Past Year Alcohol Use Disorder (Abuse or Dependence) Among Adults Aged 21 or Older, by Age of First Use (SAMHSA, 2005)

Fewer Problems in Those Who Start Later
Childhood Self-Control as a Predictor of Adult Substance Use Dependence (Moffitt et al., in press)

Outcomes were converted to Z-Scores and childhood self-control is represented in quintiles.
- Adolescence is a period of profound brain maturation.
- We *thought* brain development was complete by adolescence.
- We now know... maturation is not complete until about **age 25!!!**
An Immature Brain = Less Brakes on the “Go” System
Brain Development

- Myelination
- Synaptic Refinement
- Volume
- Metabolism
- Blood Flow
- Receptors

Rate of Change →

Adolescence

Tapert & Schweinsburg (2005)
When the pruning is complete, the brain is faster and more efficient.  

But... during the pruning process, the brain’s activity is not the same compared to a mature brain.
Maturation Occurs from Back to Front of the Brain
Images of Brain Development in Healthy Youth
(Ages 5 – 20)

Earlier:
Motor Coordination
Emotion
Motivation

Later:
Judgment

Blue represents maturing of brain areas

Implications of Brain Development for Adolescent Behavior

- **Preference for ....**
  1. physical activity
  2. high excitement and rewarding activities
  3. activities with peers that trigger high intensity/arousal
  4. novelty
- **Less than optimal..**
  5. control of emotional arousal
  6. consideration of negative conseq.
- **Greater tendency to...**
  7. be attentive to social information
  8. take risks and show impulsiveness
Risk-Taking

- Based on science of brain development, a modern view of risk taking in adolescence is...
  - normative; important to development
  - evolutionarily adaptive
  - is due primarily to emotional and contextual, not cognitive, factors
Implications of Brain Development for Adolescent Behavior

• Preference for ....
  1. physical activity
  2. high excitement and rewarding activities
  3. activities with peers that trigger high intensity/arousal
  4. novelty

• Less than optimal..
  5. control of emotional arousal
  6. consideration of negative conseq.

• Greater tendency to...
  7. be attentive to social information
  8. take risks and show impulsiveness
Cautions about what to infer regarding the “Immature Brain”
An Immature Brain ≠ Low Brain Power
Taking the Same Ability Test at Age 11 & Age 80: Scottish Mental Survey 1932

An Immature Brain ≠ Absence of Understanding Risk
Risk Assessment

• Adolescents understand dangers and consequences associated with risk.

• But adolescents tend to be more sensitive to contextual factors when applying risk knowledge to decision making.
1. Background

2. Neurodevelopment

3. Neurodevelopment and gambling
   - youth in general
   - ADHD youth

Just because you’re sixteen doesn’t mean you can’t be up to your eyehalls in debt.
Does normal brain development contribute to adolescent susceptibility to gambling?

INDIRECT SUPPORT:

1. > risk taking (particularly in groups) (gambling?)

2. > propensity toward low effort - high excitement activities (gambling?)

3. < capacity for good judgment & weighing consequences (gambling?)

4. > sensitivity to novel stimuli (gambling?)
Are youth with ADHD at heightened risk?

These youth suffer from problems with judgment and self-regulation, believed to be linked to pre-frontal cortex deficits.

- ADHD, as defined by DSM-IV, is a constellation of symptoms related to
  - Inattention
  - Hyperactivity

- Prevalence: about 3%
  - boys > girls
ADHD as heightened risk

• Growing evidence that ADHD ...........
  • is a dysfunction in the brain’s regulatory systems that manifests as a deficit in behavioral dysregulation,

• this dysregulation is mediated by deficits in the pre-frontal cortex, and

• these deficits in pre-frontal cortex contribute to a disorder likely related to self-regulation - drug abuse

(Barkley, 1997; Martin, Earlywine, Blackson et al., 1994)
### Link of ADHD and drug abuse

Among children with ADHD (some with CD also), compared to comparison......

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUD</td>
<td>1.8 - 3.2</td>
</tr>
<tr>
<td>Elevated alcohol use</td>
<td></td>
</tr>
<tr>
<td>Elevated marijuana use</td>
<td>2.2 - 4.6</td>
</tr>
<tr>
<td>Elevated tobacco use</td>
<td></td>
</tr>
</tbody>
</table>

adapted Molina et al., in press
The ADHD - PG connection: adult data

<table>
<thead>
<tr>
<th>PG</th>
<th>non-PG psych.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of childhood ADHD</td>
<td>15-36%</td>
</tr>
</tbody>
</table>

(Carlton et al., 1987; Rugle & Melamed, 1993)
Supportive Data

The ADHD - PG connection: adult data

<table>
<thead>
<tr>
<th></th>
<th>PG</th>
<th>normals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of adulthood ADHD</td>
<td>21%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

(Specker et al., 1995)
Suggestive Data

The ADHD - PG connection: adolescent and young adult data
### Association of Adolescent Gambling and Dimensional Measures of Hyperactivity and ADHD

(Derevensky et al., 2007)

<table>
<thead>
<tr>
<th>Gambling Groups</th>
<th>Non gambler</th>
<th>Social gambler</th>
<th>At-risk gambler</th>
<th>Probable pathological gambler</th>
</tr>
</thead>
</table>
| **CASS-L Subscales**{

<table>
<thead>
<tr>
<th>Hyperactivity</th>
<th>N</th>
<th>M</th>
<th>M</th>
<th>M</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>boys</td>
<td>978</td>
<td>47.08</td>
<td>48.41</td>
<td>49.49</td>
<td>52.53</td>
</tr>
<tr>
<td>girls</td>
<td>1321</td>
<td>47.20</td>
<td>49.49</td>
<td>54.55</td>
<td>57.32</td>
</tr>
<tr>
<td>ADHD Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>boys</td>
<td>978</td>
<td>49.73</td>
<td>50.86</td>
<td>53.41</td>
<td>57.65</td>
</tr>
<tr>
<td>girls</td>
<td>1321</td>
<td>49.16</td>
<td>50.43</td>
<td>57.91</td>
<td>63.82</td>
</tr>
</tbody>
</table>

Note: All one-way ANOVA’s significant, $p < .01$; nearly all SNK sig.: NG<SG<AR<PPG

1 Conners-Wells’ Adolescent Self-Report Scale: Long Version (Conners & Wells, 1997)
## Association of Adolescent Gambling and Probable ADHD Status

*(Derevensky et al., 2007)*

<table>
<thead>
<tr>
<th>Groups</th>
<th>“ADHD”+ (n = 231)</th>
<th>“ADHD”- (n = 2105)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Nongamblers (30%)</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>Social (54%)</td>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td>At-Risk (8%)</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Prob. Path. (5%)</td>
<td>34</td>
<td>66</td>
</tr>
</tbody>
</table>

Based on the ADHD Index (Conners & Wells, 1997)

\[ \chi^2 = 113, \ p < .001 \]

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## Minnesota ADHD Study
(Breyer, Winters, August, & Realmuto, 2009)

<table>
<thead>
<tr>
<th></th>
<th>ADHD-persis</th>
<th>ADHD-desist</th>
<th>Controls</th>
<th>sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>47</td>
<td>95</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td><strong>Gender (% male)</strong></td>
<td>85</td>
<td>79</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td><strong>Mean age at last follow-up</strong></td>
<td>20.0</td>
<td>20.4</td>
<td>19.9</td>
<td></td>
</tr>
<tr>
<td><strong>% grad high school or current</strong></td>
<td>80.9</td>
<td>90.5</td>
<td>95.7</td>
<td>(p &lt; .05)</td>
</tr>
<tr>
<td><strong>Mean IQ (KBIT) (baseline)</strong></td>
<td>102</td>
<td>102</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td><strong>Mean SES (baseline)</strong></td>
<td>46.6</td>
<td>46.8</td>
<td>50.3</td>
<td></td>
</tr>
</tbody>
</table>

**Attrition:** ADHD, 87% of eligible; Controls, 91% of eligible.

**Ethnicity:** 88% Caucasian

* Hollingshead, 1975, (occupation code x 5) x (education code x 3); Range 17 - 66
## Minnesota ADHD Study
(Breyer, Winters, August, & Realmuto, 2009)

<table>
<thead>
<tr>
<th></th>
<th>ADHD-persis</th>
<th>ADHD-desist</th>
<th>Controls</th>
<th>sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>any gambling (%)</td>
<td>79</td>
<td>77</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>PG among all¹ (%)</td>
<td>19</td>
<td>5</td>
<td>5</td>
<td>(p &lt; .05)</td>
</tr>
<tr>
<td>PG among gamb¹ (%)</td>
<td>24</td>
<td>7</td>
<td>7</td>
<td>(p &lt; .01)</td>
</tr>
<tr>
<td>SOGS-RA score (mean)</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
<td>(p &lt; .05)</td>
</tr>
<tr>
<td>Count games played (mean)</td>
<td>3.0</td>
<td>2.4</td>
<td>2.7</td>
<td></td>
</tr>
</tbody>
</table>

¹ PG = SOGS-RA 2+
1. Background

2. Neurodevelopment and alcohol abuse
Adolescents may have different sensitivity to alcohol than adults

Adolescent rats are **less sensitive** to the sedative and motor impairment effects of **intoxication**.

Adolescent rats are **more sensitive** to the social disinhibition effects of alcohol.
The Water Maze Test

- Saline vs alcohol
- Measures
  - Swimming speed
  - Time to find platform

Slide courtesy
Sion Kim Harris, Ph.D.
Adolescents may have different sensitivity to alcohol than adults.

Adolescent rats are less sensitive to the sedative and motor impairment effects of intoxication.

Adolescent rats are more sensitive to the social disinhibition effects of alcohol.
Wanna look for some cheese with me? Sure!
1. Background

3. Neurodevelopment and gambling

2. Neurodevelopment

4. Summary
Summary

• Adolescence is an extended period of transition from reliance on adults to independence

• Normal adolescence is characterized by:
  • increase in conflicts with family members
  • desire to be with one’s friends
  • resistance to messages from authority
  • irritability
  • risk taking
  • proclamations of sheer boredom
Summary

- The brain undergoes a considerable amount of development during the teen years.

- The last area to mature is the prefrontal cortex region; involved in planning, decision making and impulse control.
Summary

reward incentives > perception of consequences

Gray Matter Maturation, Age 4-21
Gogtay et al., 2004
Evidence is accumulating that...

- youth gambling occurs on a continuum
- most youth gamble, yet do so infrequently
- the prevalence of “problem gambling” is noteworthy
Summary

- Possible links between neurodevelopment and addictive behaviors
Summary
Clinical Implications PG Field

- Screen target groups for gambling
  - Drug-abusing youth
  - Youth with ADHD
Lie/Bet Screen
(Johnson et al., 1997)

2-question version of the DSM-IV criteria:

1. Have you ever had to lie to people important to you about how much you gambled?

2. Ever felt the need to bet more and more money?

Score of 1+ is a red flag.
Measures

SOGS-RA

• Winters, Stinchfield, & Fulkerson, 1989/1993
• Adapted from the SOGS
• 12 yes/no items
• Prior 12-months time frame
• Psychometrics favorable
• Cut score for “Problem Gambling” not empirically established
Measures

DSM-IV-J

- Fisher, 1992
- Reflect 9 dimensions of DSM-IV
- 12 yes/no items
- Prior 12-months time frame
- Psychometrics favorable
- Cut score for “Pathological Gambling” not empirically established
Summary
Clinical Implications PG Field

- Treatment issues
- Drug-abusers
  - raise insights that gambling is another source of “intoxication”
  - educate that gambling may be a source of relapse (gambling urges can be powerful)
Summary
Clinical Implications PG Field

- Treatment issues
- Youth with ADHD
  - raise insights that gambling is a source of excitement
  - teach limits, if the person gambles
Working with Parents

**P** = **Promote** activities that capitalize on the strengths of the developing brain.

**A** = **Assist** children with challenges that require planning.

**R** = **Reinforce** their seeking advice from adults; teach decision making.

**E** = **Encourage** lifestyle that promotes good brain development.

**N** = **Never** underestimate the impact of a parent being a good role model.

**T** = **Tolerate** the “oops” behaviors due to an immature brain.
THANK YOU!

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