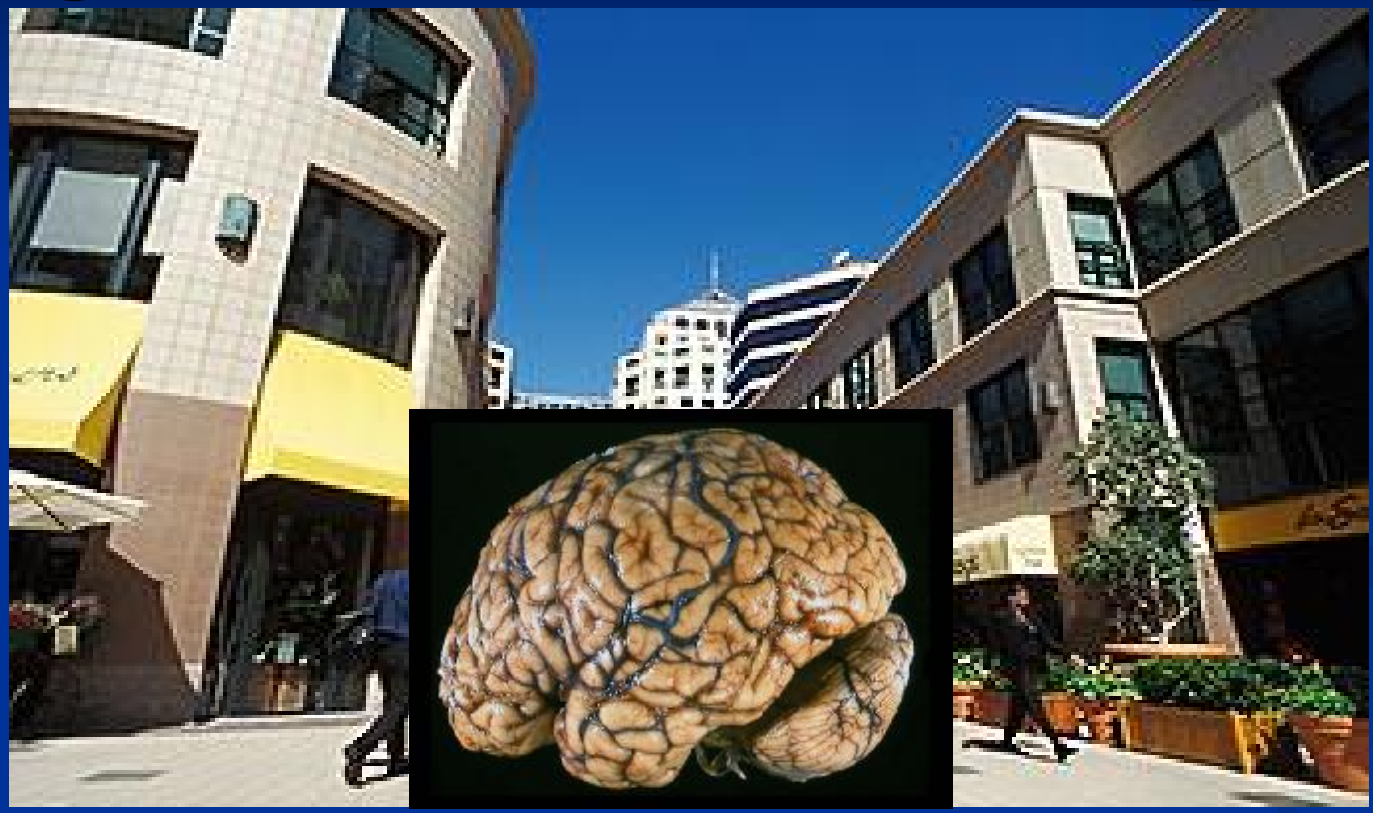
Brain Function in a Social Context: Drug Abuse Risk and Tx Responsivity



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Supported by the National Institute of Drug Abuse, grant no. 1 R21 DA14060-01

Conducted in partnership with the Johns Hopkins Prevention Research Program, Baltimore, MD

Research Questions Re Linkages Between Neuroscience & Prevention

- What are the ***neural substrates*** of relevant forms of psychopathology: drug abuse, risk taking, ASPD?
  - Provides a mechanistic account of how interventions mediate their effects
- How does the ***social environment impact*** these neurobiological mechanisms?
- What are the critical ***stages of development*** during which psychosocial conditions (e.g., stress) differentially exerts its effects?
- Can understanding brain-environment interactions help ***design interventions*** that impact at critical points in the developmental trajectory to alter risk status?
- Can psychosocial interventions alter: ***neurobiological mechanisms*** and ***behavioral phenotype*** ?

What is the role of *social contexts* in adolescent risk behaviors?

- **As an Impact**
  - Risk factor: stress, adversity, role modeling
  - Protector factor: attachment, neighborhood cohesion
- **As a Facilitator**
  - Circumstance, opportunity, relationship, expectation
- **As a Manipulation**
  - Prevention
  - Treatment
  - Policy: e.g., harm reduction strategy

Overall morbidity and mortality rates increase 200% from childhood to late adolescence

Primary sources of death/disability related to problems with *control of behavior and emotion*

- Increasing rates of accidents, suicide, homicide, depression, AOD use, violence, reckless behaviors, eating disorders, health problems related to risky sexual behaviors
- Onset of problems with later health consequences

Tendency to excess based on brain function in a social context

EXECUTIVE FUNCTIONS
At the Intersection between the Brain and Social Environment

- Forethought
- Attention / Concentration
- Verbal Ability
- Abstract Reasoning
- Problem Solving
- Programming and Planning Goal Oriented Behavior
- Behavioral Inhibition
- Learning from Experience
- Interpreting Social Cues
- Using Socially Adaptive Behavioral Responses
- Avoiding Negative Consequences or Situations
- Regulating Emotional Responses
- Sensitivity to Penalties

Focal Point: Prefrontal Deficits

- Heightened Sensitivity to Rewards
- Insensitivity to Consequences
- Impulsivity
- Inattention
- Misattributing Social Cues
- Negative States Dominate

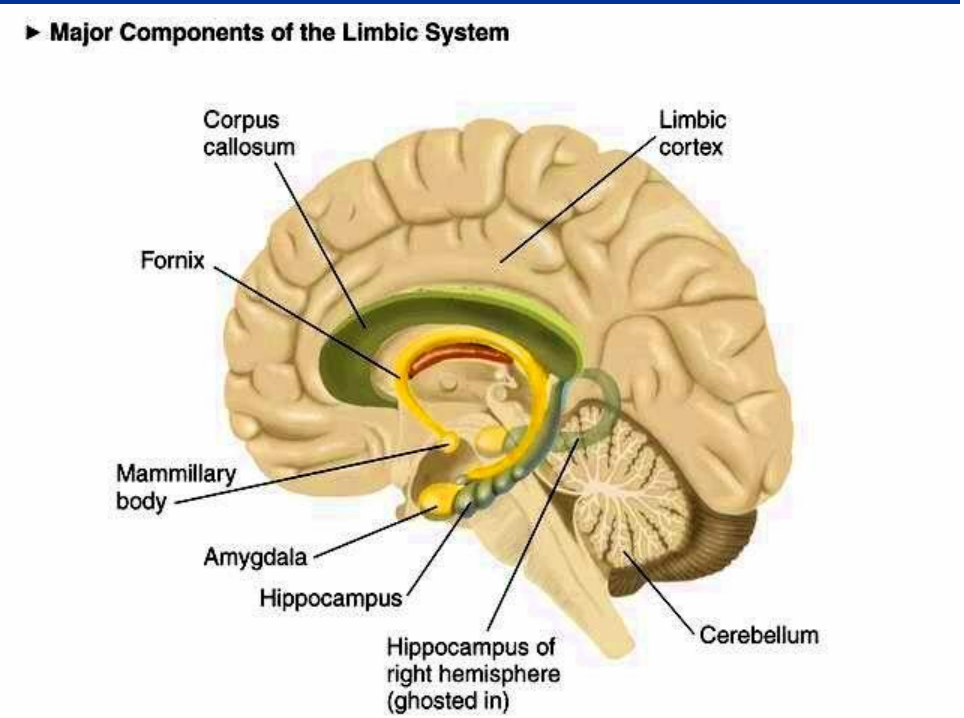
Frontal lobes

- Memory, planning, problem solving
- Gray matter volume peaks ~ age 12
- Change with experience = *plasticity*

Emotional Regulation

Prefrontal cortex modulates lower functions of ACC and limbic system

- Motivation and emotion
- Assigns feeling to incoming stimuli
- Emotional drives
- Stress responses
- Provides for rewarding and addictive properties of drugs and novelty seeking



Breakdown in Brain's Regulatory System may Heighten Risk

Regulatory neural circuitry b/t prefrontal cortex and limbic system vulnerable to:

- genetic defects
- developmental delays
- injury
- metabolic errors
- ***stress and adversity***
- drug and alcohol use

The Adolescent Brain

Prefrontal cortex not fully developed or connected until early adulthood

- Unique stage of change in metabolism, pruning, and increased efficiency in prefrontal function

Emotional centers (limbic) without checks and balances

- Greater sensitivity to rewards, less inhibition
- Seek altered states of consciousness

Effects of social inputs are longstanding

Fundamental Imbalance in Puberty

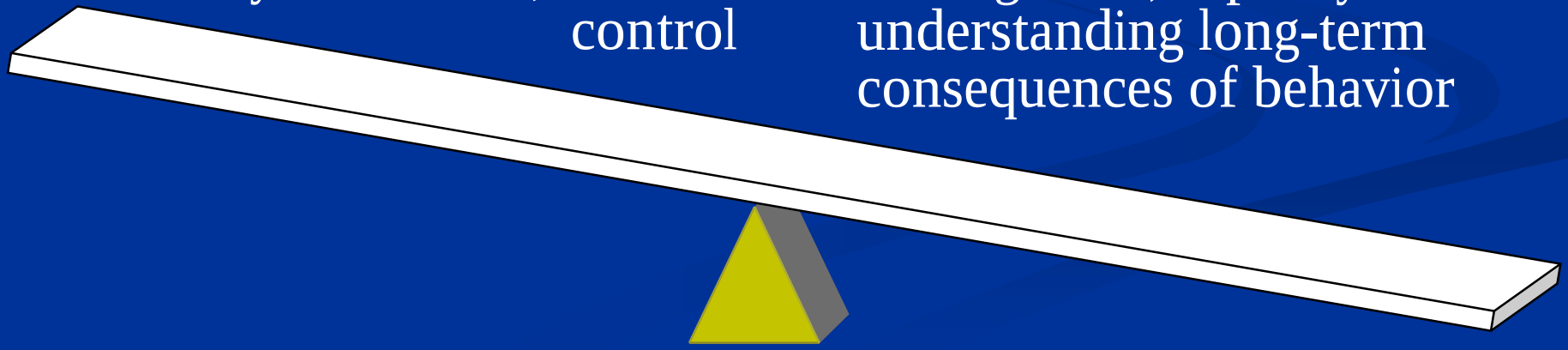
- Rapid physical, endocrine, and social changes that create *early* affective motivations and challenges
- Gradual, *later* development of affect regulation and maturation of cognitive/self-control skills

Emotional Capacity

Pubertal drives and emotions; sensation seeking; risk taking; sensitivity to rewards, low self control

Cognitive Capacity

Planning; logic; reasoning, inhibitory control; problem-solving skills; capacity for understanding long-term consequences of behavior

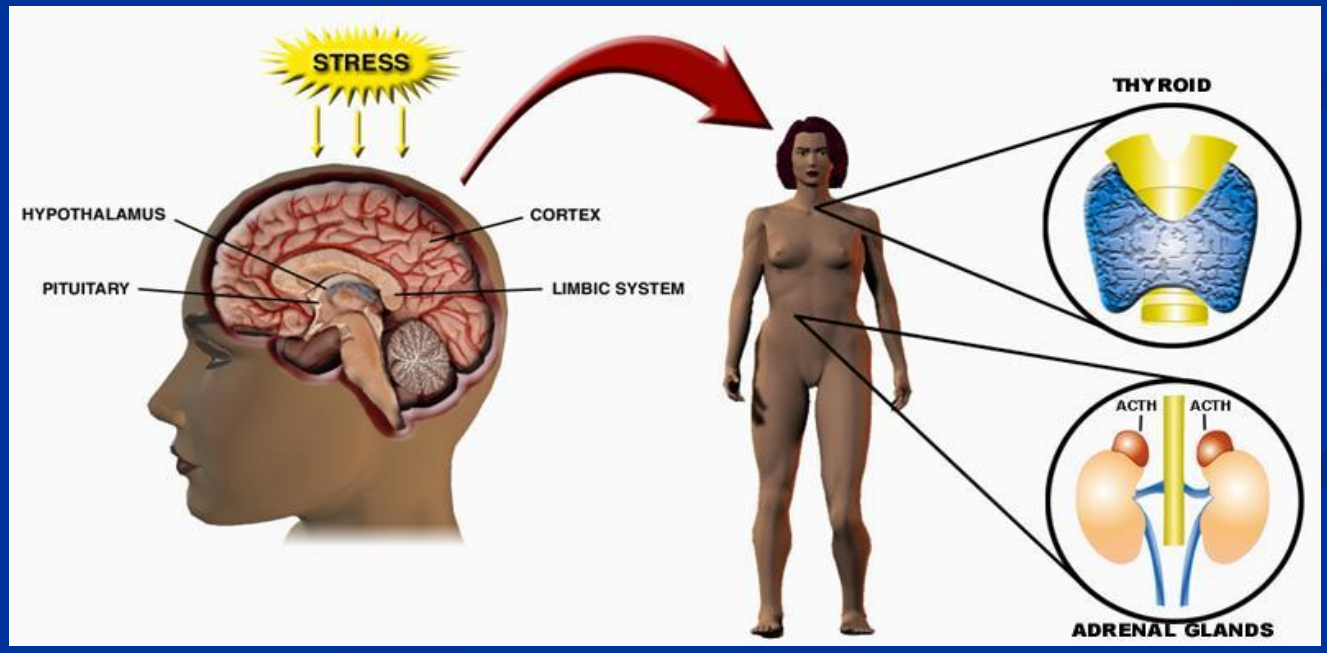


The Adolescent Brain is Plastic for Better or for Worse

- **For Worse**: Particularly vulnerable to external inputs
  - Environmental exposures
  - Psychosocial stressors
  - Drug and alcohol use
  - Protective factors
- **For Better**: Creates unique opportunities for emotional-motivational learning
  - Sculpts connections *between* cognitive control and emotional systems to create lasting changes
  - Scaffolding/social support
- **Relevance to prevention, early intervention and policy**

Chronic stress primes the brain for novelty seeking and drug use

- Alters brain function, disengages coping mechanisms, and compromises ability to execute rational choices
- Increases the likelihood of psychopathology
- Genetic vulnerabilities affect behavioral outcomes
- Positive attributes of person or environment = protection

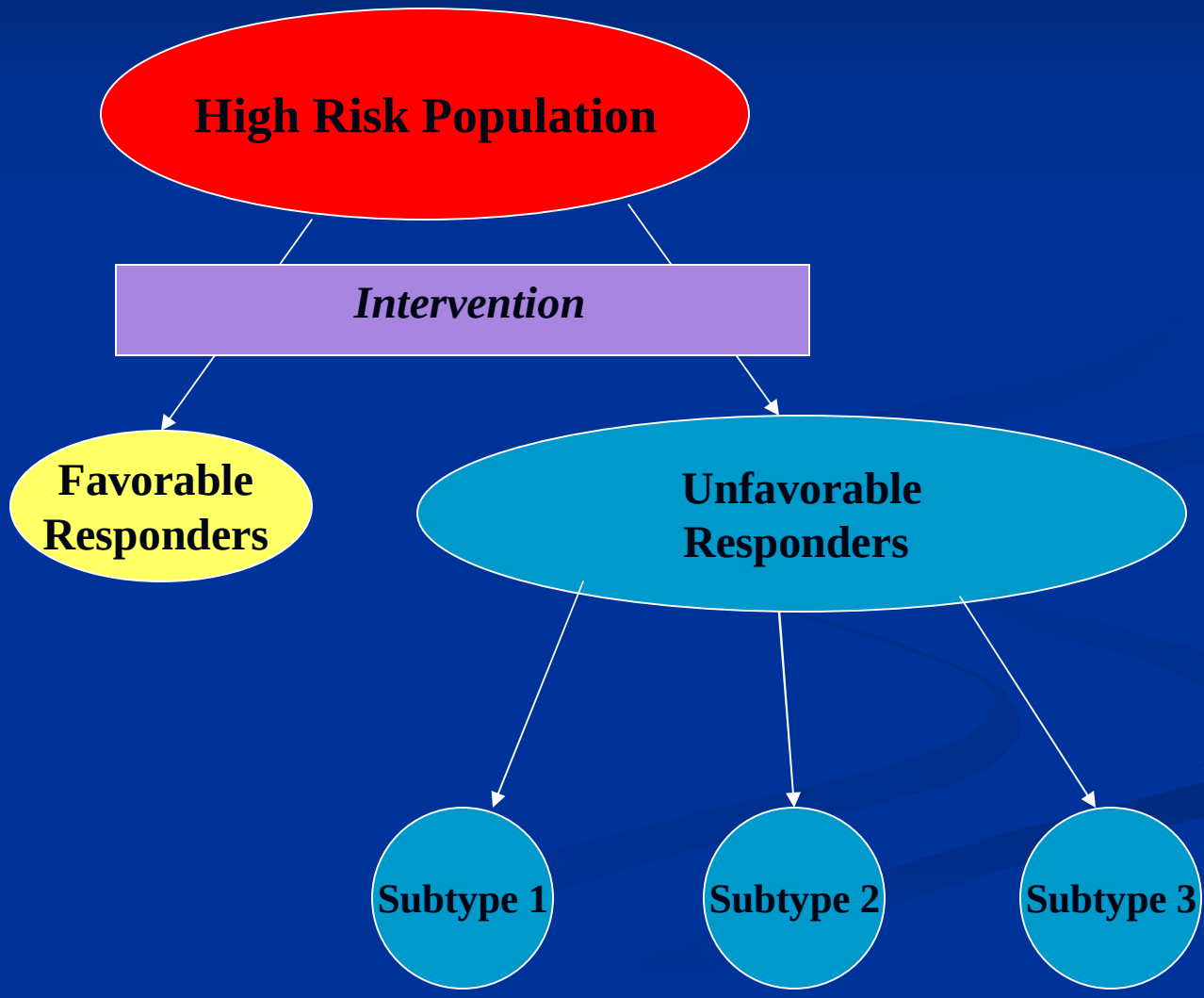


Translational Research

- Basic understanding of the underlying pathophysiology of mental and behavioral disorders.
- Extends basic or clinical research findings to yield a knowledge base for the development of novel, efficacious prevention or treatment interventions:
  - Why do some respond well to conventional treatments?
  - Characterize heterogeneous subgroup that does not respond.
  - Does “effective” treatment actually change brain function?

Implications for Translational Work in the Prevention Sciences

Differential Responses to Prevention Programming



Prerequisites to Favorable Intervention Response

Processing materials requires participants to:

- ü Be cognizant of and responsive to potential negative consequences of behavior
- ü Inhibit inappropriate behavioral responses
- ü Understand and act on the benefits of deliberate and cautious decision-making

Deficits in these basic skills (i.e., dimensions of ECF) may compromise benefit from programs that do not first target these underlying deficits.

Recent Prevention Study

To assess the extent to which ECF and emotional perception moderate response to a model preventive intervention curriculum (PACT).

SUBJECTS

- Subgroup (120 males) recruited from larger longitudinal study by JHU PIRC who are registered in the Baltimore City Public Schools.
- Ten years of longitudinal data from child, parent, teachers, and peers
- Selection Criteria:
  - Control group: no previous or current diagnosis of Conduct Disorder or other high risk behavior
  - Conduct Disorder (CD) group: previous and current diagnosis of Conduct Disorder and other high risk behavior

Design and Methods

Baseline Protocol:

- Estimated IQ (WISC-III: Block Design and Vocabulary)
- Three Neurocognitive Tasks
  - Rogers Risky Decision Making (adapted for children)
  - Logan Stop Signal (impulsivity)
  - Sonuga-Burke Choice Delay (delay of gratification)
- Simultaneous Physiological Monitoring
- Ekman Facial Recognition Task (emotional perception)
- Three Virtual Realty Vignettes assessing emotional composure and communication
- Questionnaire of scenarios to assess beliefs supporting aggression, aggressive conflict resolution and hostility
- Interviewer ratings

Design and Methods

Experimental Design (6 to 8 wks after Baseline)

- Intervention: Random assignment to facilitated PACT video that presents role modeling curriculum to teach negotiation and conflict resolution
- Posttest Measures:
  - Three different virtual reality vignettes
  - Questionnaire scenarios
  - Debriefing and interviewer ratings

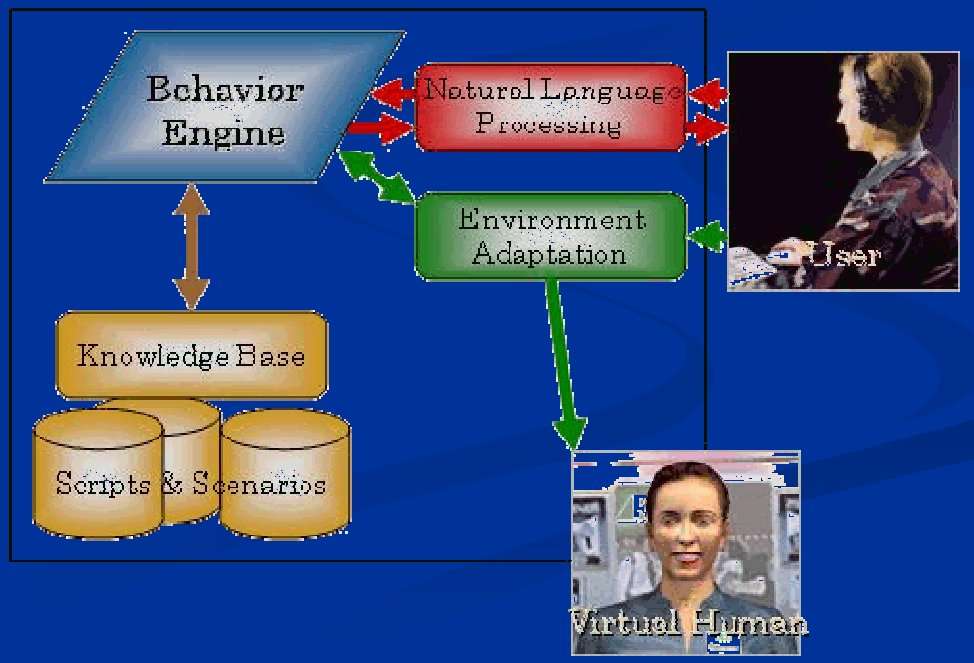
Measurement of Social Context

Social situations during adolescence challenge:

- Emotional and impulse control.
- Conflict resolution through negotiation, seeking information, expressing preferences.
- Advantageous decision making.
- Adverse consequences of low skill levels include drug abuse, violence, school suspension, criminal activity.

Advantage of Virtual Reality

The real-world social context provided by virtual reality technology may enhance our capability to predict intervention response and chart behavioral change.



Virtual Reality Character

Scenarios:

1) Stolen Goods

2) Drinking or Drug Use and Girls

3) Provocation to Fight

Design - VR Measures

- Engagement with vignettes.
- Body language.
- Verbalizations & number of conversational turns.
- Response time
- Outcome:
  - Positive outcome is to decline or back away.
  - Negative outcome is to agree or escalate confrontation.

Observation

- Scoring procedures used during pre/post test with vignettes identify:
  - Level of emotional control.
  - Interpersonal communication skills.
  - Analysis against established measures provides some support for construct and criterion validity.

Results - Self-reports

- Nearly all participants stated their virtual decision mirrored what would be their real-life decision.
- Note: acceptability / usability not different among groups.

Results - Implications

- Simulation effective in differentiating:
  - Adolescents with Conduct Disorder.
  - Adolescents who used drugs the following year.
  - Adolescents who had participated in live training sessions on key skills.
  - Adolescents with high and low responsivity to training

Summary of Results

Neurocognitive and Emotional Deficits Predicted Lack of Behavioral Change in Response to Acute Prevention:

- Misattribution of emotion in facial expressions.
- Risky choices associated with negative consequences
- Greater impulsivity
- Inattention

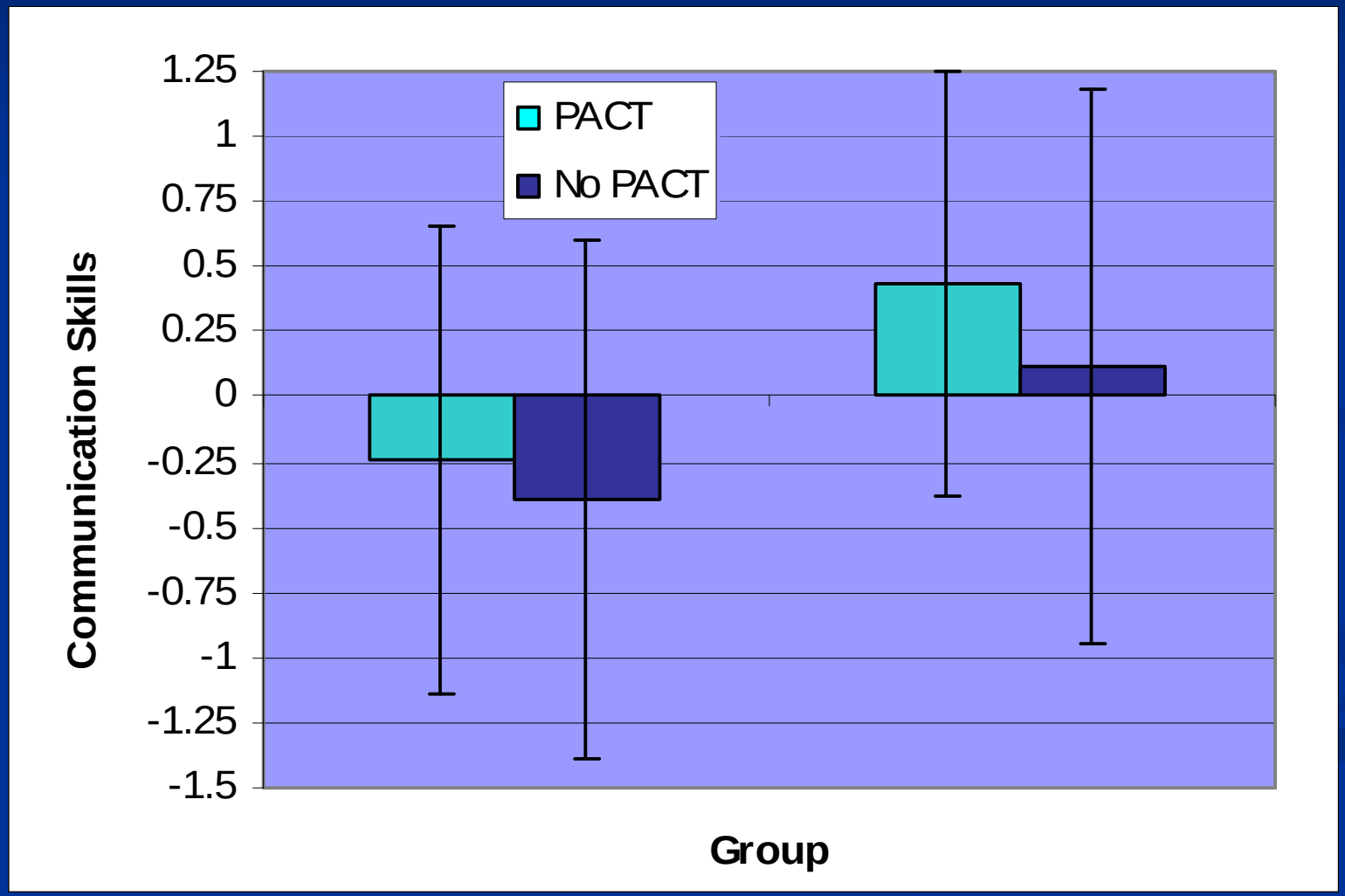
Relationship between intervention, CD, and outcome:

- Adolescents with CD respond less favorably to an acute administration of the PACT intervention as measured by Vignettes

Mediators of Effect:

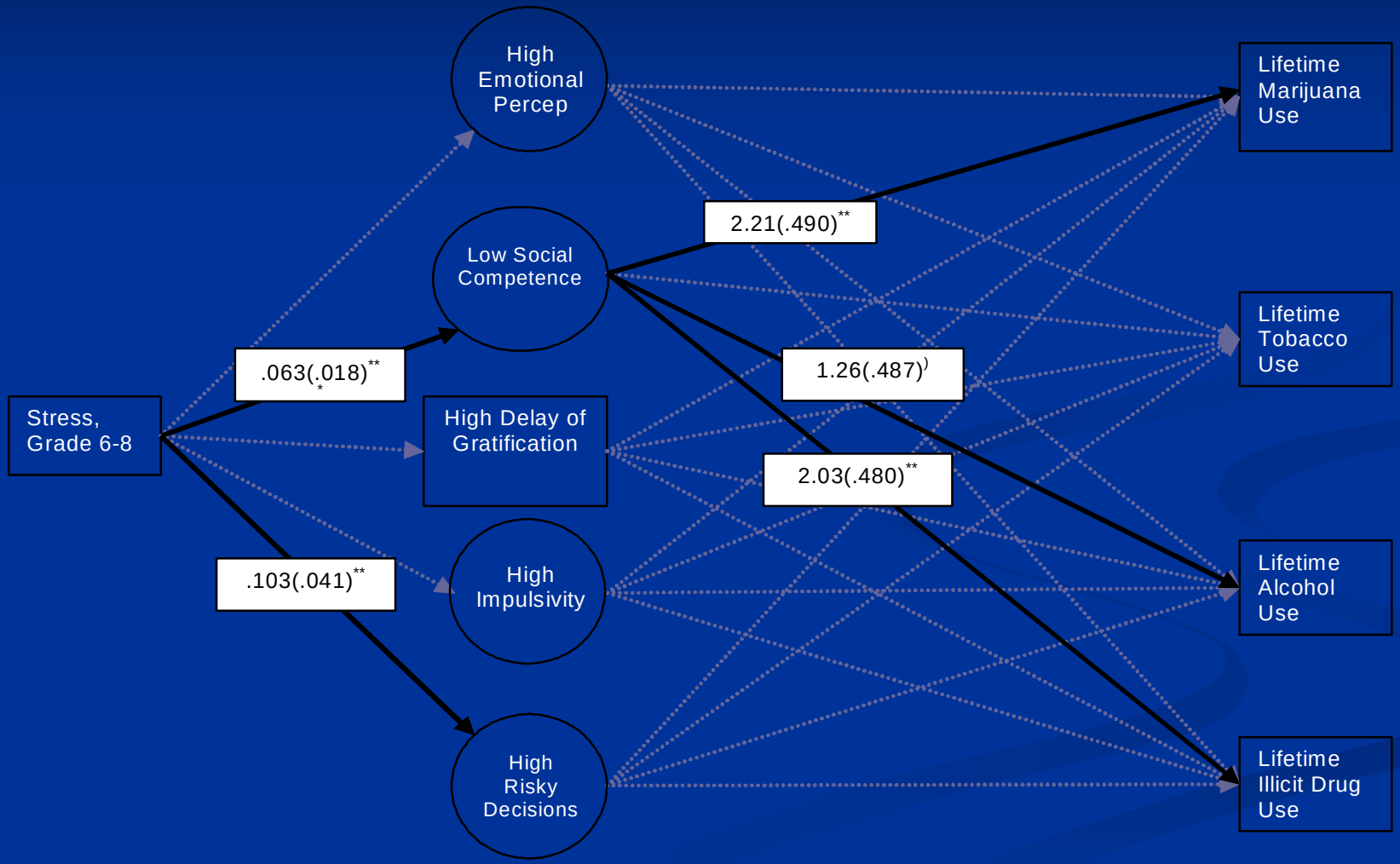
- Relations b/t childhood stressors and drug use mediated by risky decision making and social competency

PACT and CD Group Effects on Communication Skills



(F = 5.5, p = 0.02)

Social Competency Mediates Relationship between Stress and Substance Use



Leverage points for early intervention strategies?

Understanding underpinnings (gene x ***social context*** x development interactions) of affect regulation and cognitive control will inform:

- Type and timing of optimal intervention
- Universal vs targeted
- Developmental phase
- Social contexts as impact, facilitator and manipulation

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