RISKY DECISION MAKING IN TEENS

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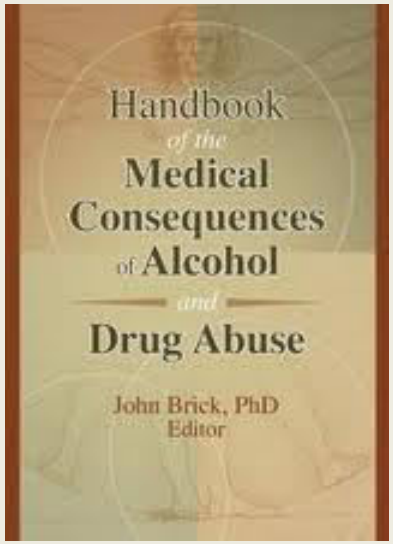
KTGF	X							
Indiana CTSI	X							
SOBP								X

OUTLINE

- Decision Making Under Risk
- Modeling Risky Decision Making in the MRI Scanner
- Results
- Implications
- Future Directions

IMPACT OF SUBSTANCE USE DISORDERS



$193 billion

Estimated cost of drug use to the U.S society in lost productivity, health care and criminal justice costs in 2007

(Source: NDIC)

drugabuse.gov

COULD WE HAVE SEEN THIS COMING?

COSTS OF RISKY DECISIONS

- Risky Driving: $19,342/year/risky driver (Sommers 2011)
- Substance Use Disorders: $110 Billion/year
- Accidents: leading cause of death among adolescents

TREATMENTS FOR RISKY DECISION MAKING

- ZERO
- NADA
- Nothing

MODELING RISKY DECISION MAKING: BALLOON ANALOG RISK TASK (BART)

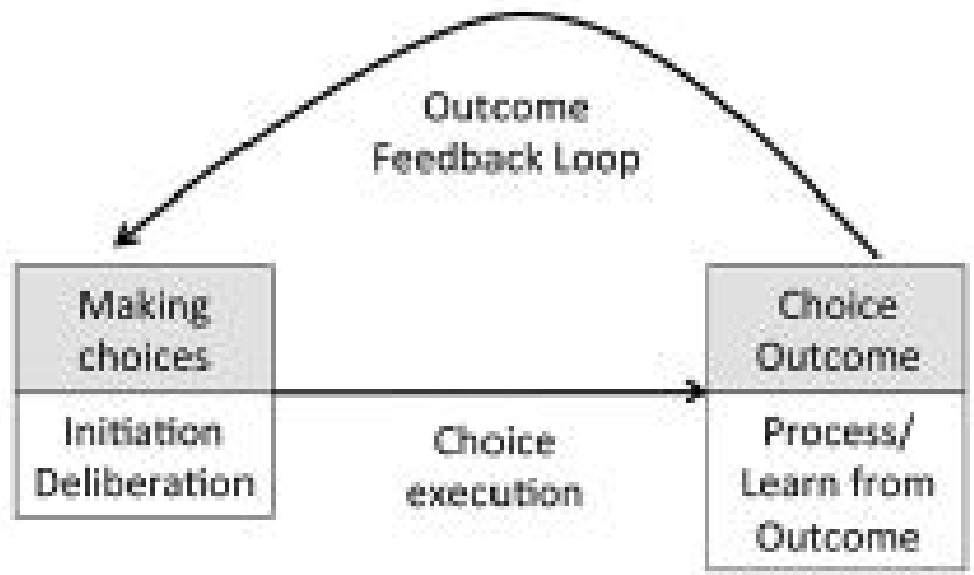


Fig. 1. Stages and associated processes involved with decision-making.

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Neural activation during risky decision-making in youth at high risk for substance use disorders

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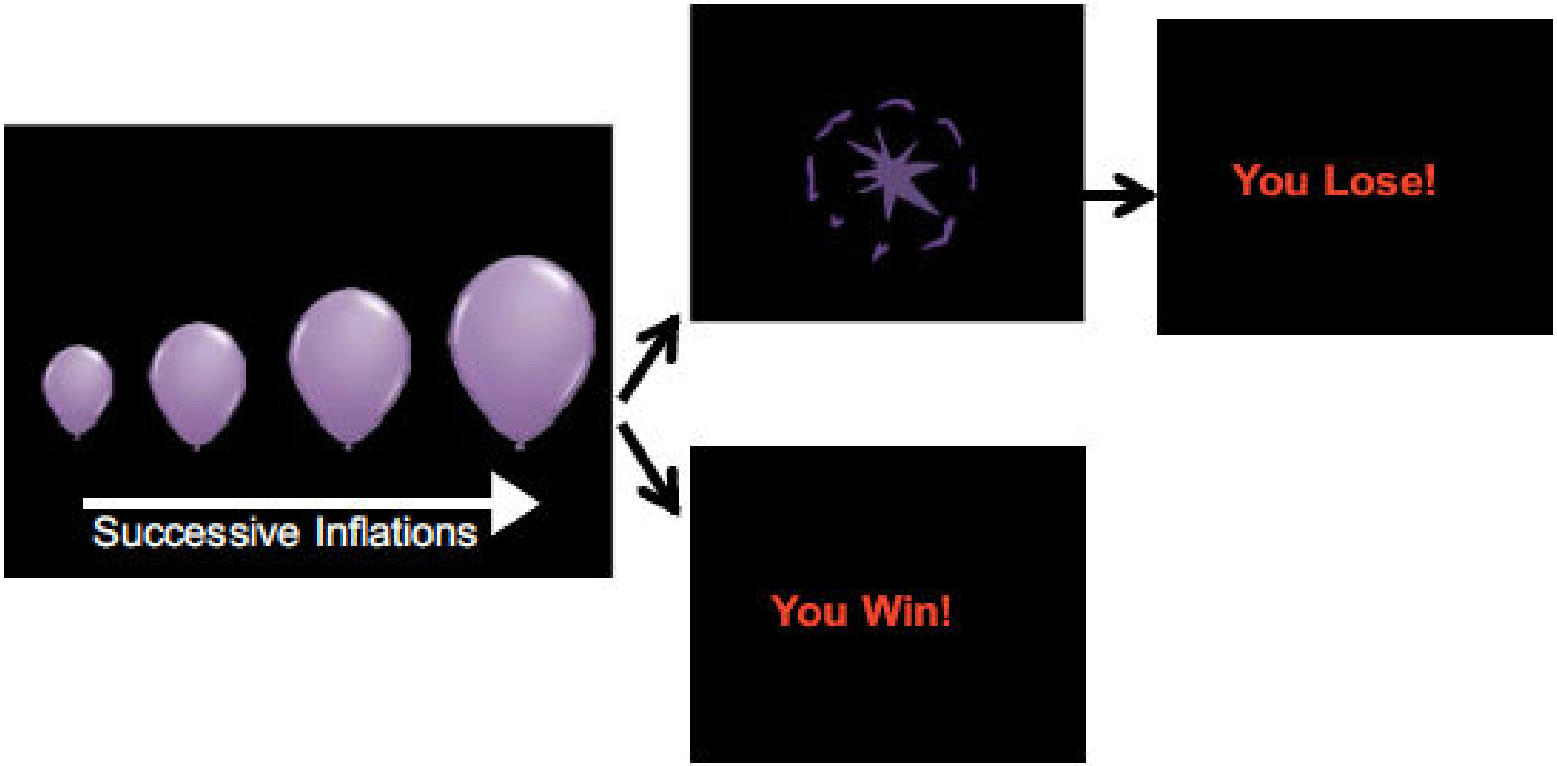
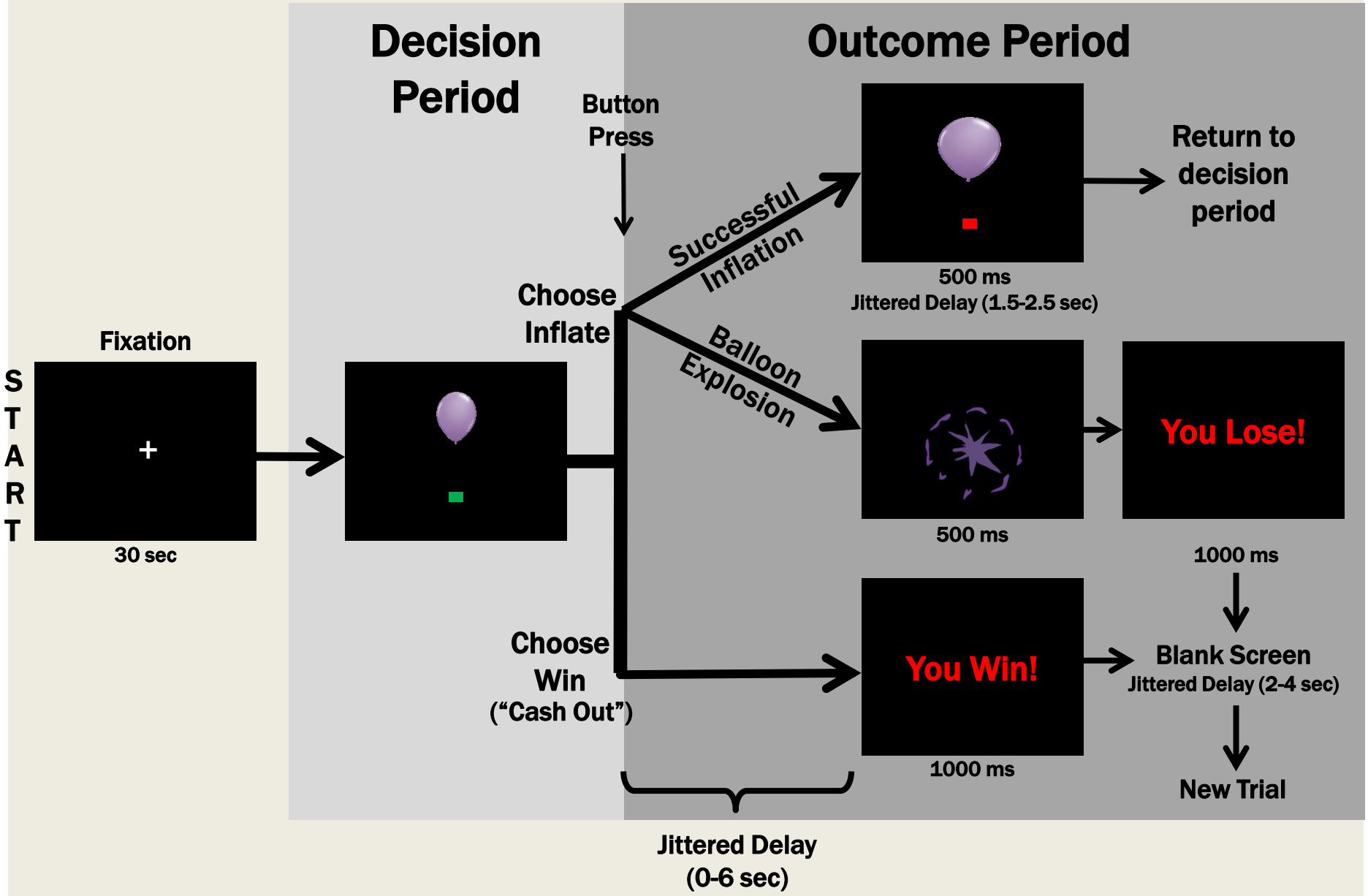
BART



the balloon analog risk task (BART) showing successive balloon inflations (i.e., a D series of Choose Inflates) that either en
Explode ("You Lose!").


Decision Period
Outcome Period
Button Press
START
Fixation
+
30 sec
Choose Inflate
Successful Inflation
500 ms
Jittered Delay (1.5-2.5 sec)
Return to decision period
Balloon Explosion
500 ms
You Lose!
1000 ms
Choose Win
("Cash Out")
You Win!
1000 ms
Blank Screen
Jittered Delay (2-4 sec)
New Trial
Jittered Delay
(0-6 sec)

BART FINDINGS

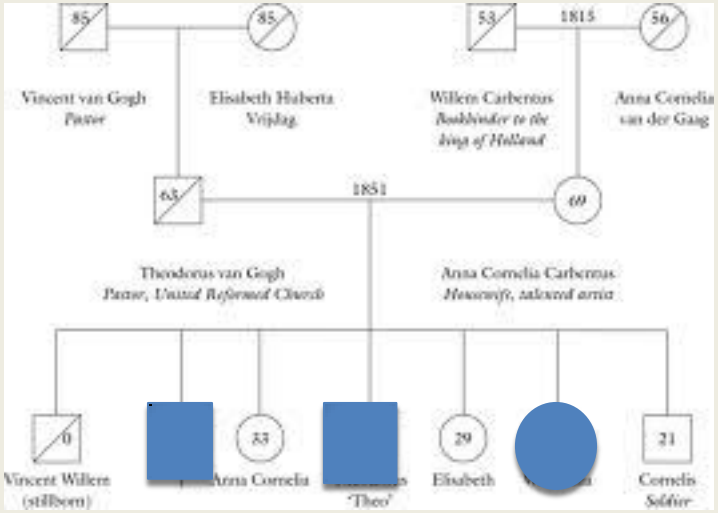
- **Behavioral:**
  - Differentiates smokers and non-smokers (Lejuez, 2003)
  - Performance related to MDMA use (Hopko, 2006)
  - Associated with psychopathology and impulsivity (Hunt, 2005; Bornovalova, 2009)
  - Predicts real world adolescent risk taking (Lejuez, 2003)
  - Acute stress induces sex-differences (Lighthall, 2009)

BART FINDINGS

- **Neuroimaging:**
  - Voluntary (mesolimbic frontal) vs. Involuntary Risk (DLPFC; Rao 2008)
  - vmPFC involved in value calculation; escalating risk taking=increasing potential losses (Schonberg 2012)
  - IFG/ACC = loss aversion at time of choice (Fukunaga 2012)
  - Adolescents with TBI (Chui et al 2012)
  - Predicting risky vs. safe choice (Helfinstein 2013)

ULTRA/FAMILIAL HIGH RISK PARTICIPANTS

- 10-14 yo male and female **biological offspring of men with past or present SUDs** + another 1st or 2nd degree family member with a SUD
- High risk **"neurobehavioral disinhibition" estimated by a** diagnoses of **ADHD + CD/ODD/DBD NOS (KSADS).**
- Used drugs, alcohol or nicotine **NO MORE than five times** in their lifetime



MID-RISK PARTICIPANTS

- 10-14 yo male and female **biological youth from families without SUDs (<2 relatives)**
- High risk **"neurobehavioral disinhibition" estimated by a** diagnoses of **ADHD + CD/ODD/DBD NOS (KSADS).**
- Used drugs, alcohol or nicotine **NO MORE than five times** in their lifetime

LOW-TYPICAL RISK PARTICIPANTS

- In addition to other exclusionary criteria, no ADHD, ODD/CD/DBD NOS
- No current diagnosis or lifetime history of any DSM-5 psychiatric or SUD (exceptions: specific phobias, enuresis, learning disorders)
- Exclude participants with a first degree relative with a history or current diagnosis of a SUD
- Attempt to match controls on age, sex, IQ and socioeconomic status.

EXCLUSION CRITERIA

- Lifetime history of bipolar disorder, psychotic symptoms, pervasive developmental disorders or SUDs
- Current major depressive disorder
- Current psychopharmacologic treatment (none within 4 weeks) other than psychostimulants (held the days of assessment and scanning)
- History of neurological problems (e.g., epilepsy, traumatic brain injury, brain tumors, cerebrovascular disease)
- Estimated Full Scale IQ below 80
- Active or debilitating medical conditions
- Active maternal substance use disorder during pregnancy
- Left handedness

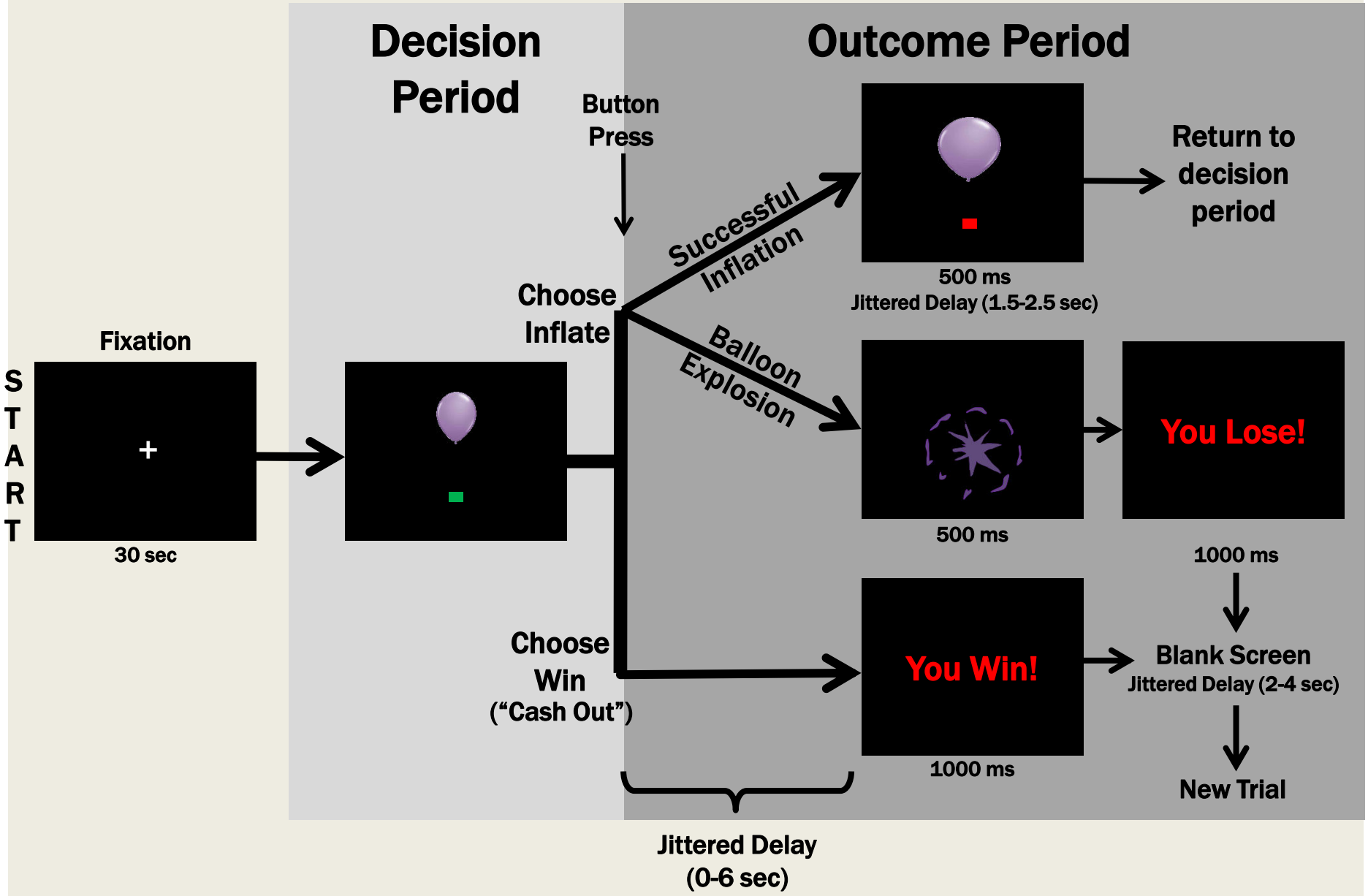
MRI ANALYSES

- Mock scanner training
- Seimens 3T; 32-channel head coil
- AFNI
- Event Related Design
- Parametric Modulation
- Choose Win vs Choose Inflate
- Outcome Explode vs Outcome Inflate
- $P<0.01$ at voxel level; cluster size correction $k=216$ voxels $p<0.05$
- IQ/SES with and without covariates

RESULTS: BART BEHAVIORAL FINDINGS

	Low Risk		High Risk	
Total Winnings	$10.35 (± 0.48)		$11.51 (± 0.53)	
Reaction Times >5000 ms	0.70 (± 0.99)		0.04 (± 0.21)	
Reaction Times of Inflate Trials (ms)	835.91 (± 53.47)		710.09 (± 43.99)	
Total Balloons Completed	20.40 (± 0.48)		20.39 (± 0.72)	
	Won	Lost (Exploded)	Won	Lost (Exploded)
Balloon Outcomes	15.37 (± 0.75)	4.81 (± 0.34)	15.26 (± 0.94)	5.13 (± 0.38)
Inflations per Balloon	5.35 (± 0.15)	4.59 (± 0.15)	5.57 (± 0.17)	4.85 (± 0.21)
Standard Deviation of Inflations	1.03 (± 0.08)	1.40 (± 0.12)	1.17 (± 0.10)	1.42 (± 0.11)
Minimum Number of Inflations	3.44 (± 0.23)	2.96 (± 0.20)	3.39 (± 0.27)	3.22 (± 0.20)
Maximum Number of Inflations	6.89 (± 0.20)	6.26 (± 0.27)	7.43 (± 0.22)	6.61 (± 0.31)
Reaction Times (ms)	770.69 (±66.23)*	727.85 (± 61.35)	554.82 (±38.31)*	634.68 (± 69.69)

RESULTS: BART NEUROIMAGING FINDINGS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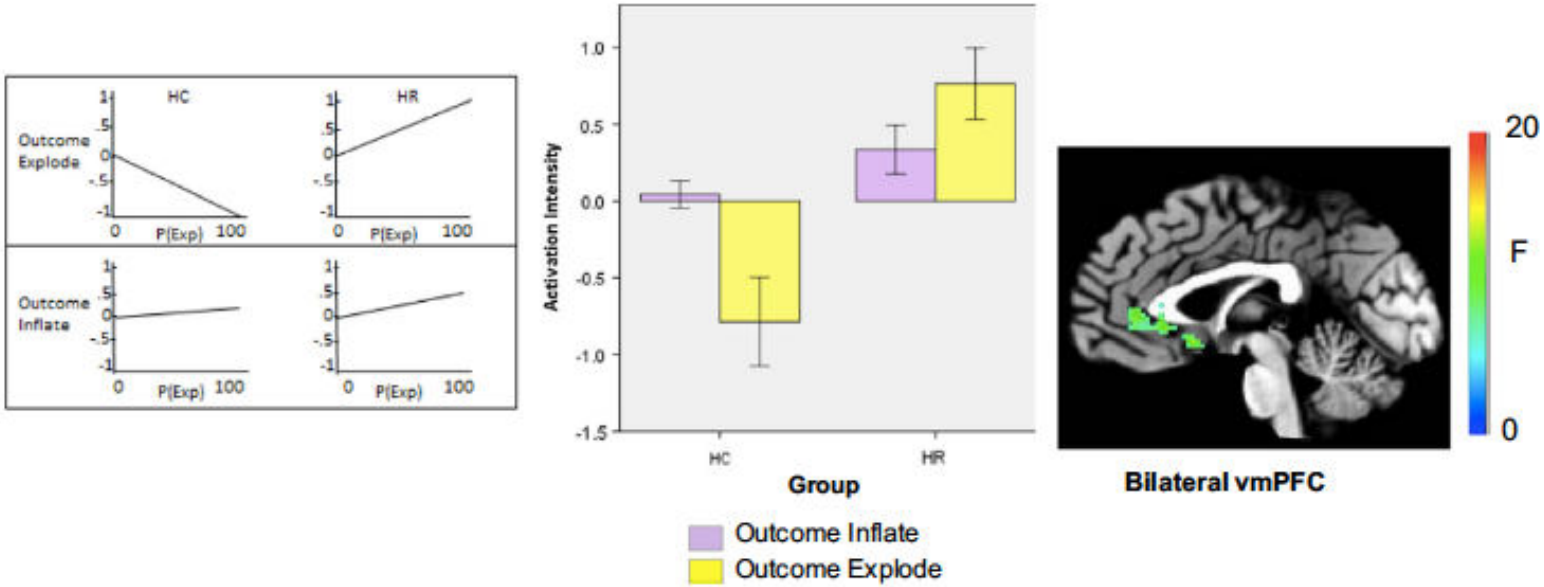
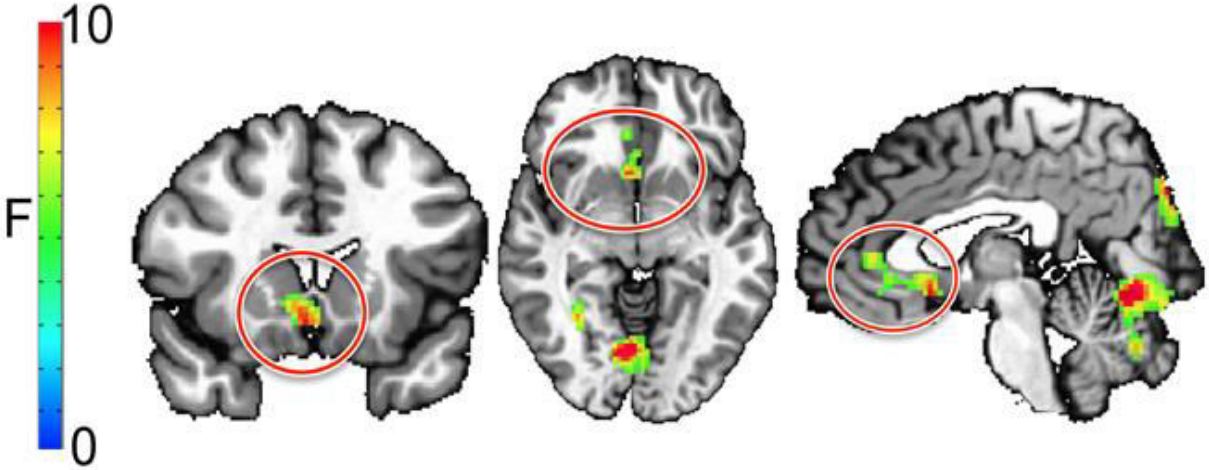
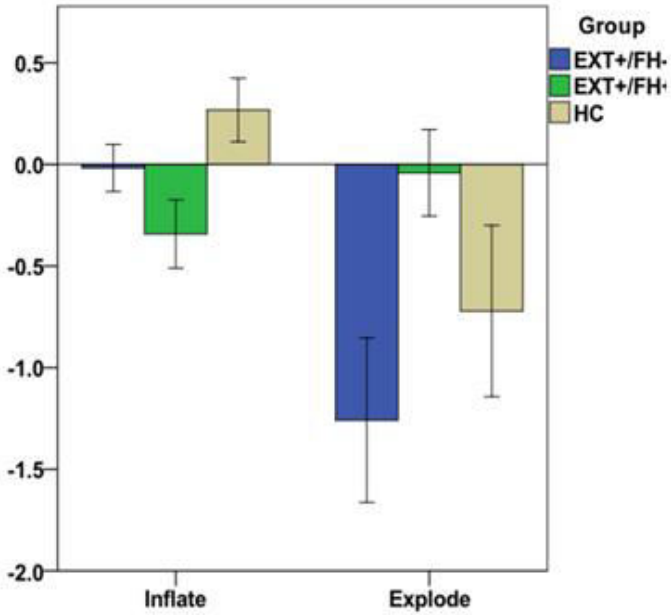


Fig. 2. Group differences (healthy comparisons (HC) vs. high risk (HR)) on the parametrically modulated outcome contrast. Group differences, driven by increasing activation intensities as explosion probability increases in the HR group, were found in a bilateral cluster in the ventromedial prefrontal cortex (vmPFC; Table 5). Bar graphs plot activation intensities (*y*-axis) from the cluster according to condition (Outcome Inflate or Outcome Explode) and group (HC or HR). Line graphs illustrate the relationship between probabilities of balloon explosion (*x*-axis) vs. activation intensities of the blood oxygen level dependent (BOLD) signal in the cluster (*y*-axis).

FAMILY HISTORY + VS -: VENTROMEDIAL PFC





DECISION MAKING

- **vmPFC:** Decision making during uncertainty; deficits seen during tasks where individuals “fail to learn from their mistakes”

- **Ventral striatum:** Uncertain outcomes; forming expectancies for future

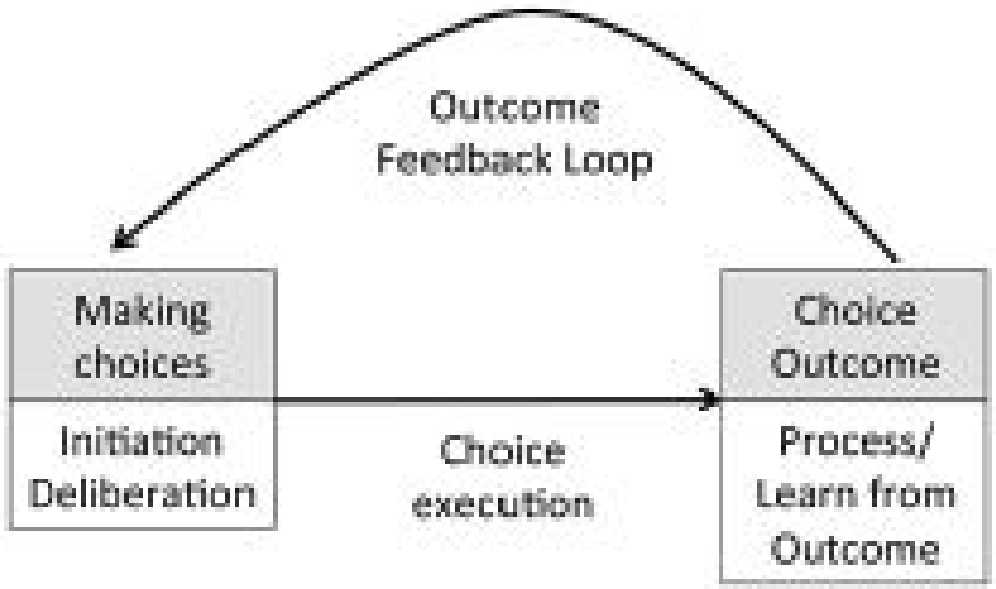


Fig. 1. Stages and associated processes involved with decision-making.

IMPLICATIONS

- In this age group, impulsive, disruptive behavior disordered youth show different activation patterns, as risk changes, than comparisons, but only on the OUTCOME of decision making

- Proposed mechanism: Failure to close the “feedback loop” related to learning from high risk experiences?

- Regions implicated are particularly relevant to highly uncertain scenarios and formation of expectations for future decisions

CURRENT STUDY

- R01: 222 kids, followed over 5 years
- Adding study of sexual risk behaviors
- Understanding cognitive mechanisms underlying these deficits (working memory? Executive control?)
- Comparing with other types of decision making tasks
- ULTIMATE GOAL: TRANSLATE TO NEW TREATMENT INTERVENTION FOR HIGH RISK KIDS

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- Violet Davies, BA
- NIDA
- Kids and their families!!
- Many students/interns

CURRENTLY RECRUITING 11-12 YEAR OLD KIDS!!!

Compensation:

Free mental health evaluation

Participants can make up to $430

317-278-7795 or

email iubrain@iupui.edu