GENDER DIFFERENCES IN NEURAL RESPONSES TO WINS & LOSSES IN RISKY DECISIONS:

CONSIDERATIONS FOR CONTINGENCY MANAGEMENT TREATMENT

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CONTINGENCY MANAGEMENT
(Motivational Incentives)

- Based on principle of behavior modification
- Detect target behavior through objective monitoring
- Tangible reinforcers
- Most effective for initiating drug abstinence **BUT**….
- Long-term goals divided into short-term steps

CONTINGENCY MANAGEMENT
Target Behaviors

- Abstinence from drugs/tobacco/alcohol
  - reduced drug use
- Therapy attendance and retention
- Treatment plans
- Medication adherence
- Improved outcomes:
  - marijuana
  - cigarettes
  - alcohol
  - opioids
  - benzodiazepines
  - polydrug use

CONTINGENCY MANAGEMENT

Types of Incentives/Reinforcers:

- Tangible
  - cash
  - gift certificates/ vouchers/ tokens
  - retail items
  - fishbowl (intermittent reinforcer)
- Social
  - social recognition
  - special privileges

Novel and Innovative Applications:

- Earned salary as contingent benefit

CONTINGENCY MANAGEMENT (Age, Gender, Diagnoses)

Effectiveness of CM:

- Short-term abstinence from cigarette smoking in **adolescents**
- Research on 78 cocaine-abusing **mid-adult** methadone maintenance clients (53 females)
- Research study with large sample size and cohorts of **young, middle, and older cocaine-dependent adults**
  - Benefits: retention and longest duration of abstinence
  - Older adults improved less from CM (62% females)

GENDER DIFFERENCES: What Is Known

- Females myelinate PFC earlier
  (Powell, K., 2006. How does the teenage brain work? Nature 442(24), 865-867.)
- Different PFC recruitment during task (Schweinsburg, A.D., Nagel, B.J., Tapert, S.F., 2005. fMRI reveals alteration of spatial working memory networks across adolescence. J Int Neuropsychol Soc 11, 631-644.)
- Gender: strong predictor for risk tolerance
  - Females: more risk aversion
  - Males: more financial risks

(Figner, B., Weber, E.U., 2011. Who takes risks when and why?: Determinants of risk taking. Curr Direct Psychol Sci 20, 211-216.)

GENDER DIFFERENCES: What Is Known

- Non-invasive transcranial direct current stimulation (tDCS):

(Fecteau, S., Pascual-Leone, A., Zald, D. H., Liguori, P., Théoret, H., Boggio, P. S., Fregni, F., 2007. Activation of prefrontal cortex by transcranial direct current stimulation reduces appetite for risk during ambiguous decision making. J Neurosci 27(23), 6212-6218.)

  - Risk aversion = upregulation of activity in bilateral DLPFC regions

- Low-frequency repetitive transcranial magnetic stimulation (rTMS):

(Knoch, D., Gianotti, L. R., Pascual-Leone, A., Treyer, V., Regard, M., Hohmann, M., Brugger, P., 2006. Disruption of right prefrontal cortex by low-frequency repetitive transcranial magnetic stimulation induces risk-taking behavior. J Neurosci 26, 6469-6472.)

  - Male only study
  - Reduced inhibitory control
  - Increased risk decision-making
  - Suppression of right DLPFC activity

PURPOSE OF STUDY

- Find prefrontal correlates of risk decisions (wins/losses) in adults
- Identify gender differences in neural correlates of wins vs. losses
- Demonstrate feasibility of optical imaging in risk decision research
- Determine appropriate sample size for power in optical imaging research

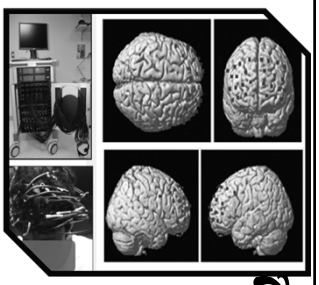
BACKGROUND/SIGNIFICANCE: ADULT RISK DECISIONS

- Increase in white matter = PFC maturity (Giedd, J.N., 2008. The teen brain: Insights from neuroimaging. J Adolesc Health 42, 335-343)
- PFC maturity achieved in early adulthood (Yurgelun-Todd, D., 2007. Emotional and cognitive changes during adolescence. Curr Opin Neurobiol 17, 251-257)
- Adults—Less difficulty with:
  - Decision-making
  - Impulse control
  - Delay of gratification
  - Emotional regulation
  - Attention
  - Long-range planning

(Ellis, L., 2005. A theory explaining biological correlates of criminality. Eur J Criminol 2(3), 287-315)

BACKGROUND/SIGNIFICANCE: OPTICAL IMAGING (FNIRS)

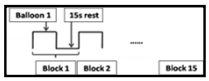
- Functional Near-Infrared Spectroscopy
- Non-invasive
- Laser diodes
- Stimuli-evoked changes in oxygenated and deoxygenated Hgb concentrations
- Targeted cortical and prefrontal regions of interest
- Comparable to BOLD findings in fMRI



Irani, F., Platek, S.M., Bunce, S., Ruocco, A.C., Chute, D., 2007. Functional near infrared spectroscopy (fNIRS): An emerging neuroimaging technology with important applications for the study of brain disorders. Clin Neuropsychol 21, 9-37.

METHODS

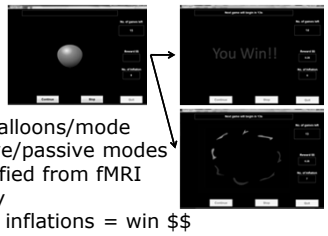
- Correlational blocked design



- Examined oxygenated Hgb (HbO) changes in PFC of 40 right-handed healthy adults
  - 25 to 44 years of age (mean 28.8 yrs)
  - 23 males; 17 females
  - 70% college degree: 63% engineers
  - Normal or corrected-to-normal vision
  - BP measurement (mean 119/67)

METHODS

- Risk Task Paradigm:
  - **Balloon Analogue Risk Task**



- 15 balloons/mode
- Active/passive modes
- Modified from fMRI study
- Stop inflations = win $$
- Balloon explodes = lose accrued $$

(Rao, H., Korczykowski, M., Pluta, J., Hoang, A., Detre, J. A., 2008. Neural correlates of voluntary and involuntary risk taking in the human brain: An fMRI study of the Balloon Analog Risk Task (BART). NeuroImage 42, 902-910)

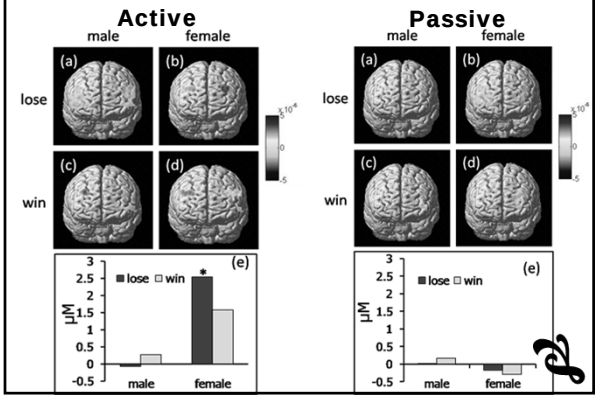
[a]One-Way Analysis of Variance (ANOVA)
[b]Independent Samples Mann-Whitney U Test

RESULTS:
BEHAVIORAL BART DATA

Behavioral Data	Total Group (n=40) Mean (SD) Range	Males (n-23) Mean (SD) Range	Females (n=17) Mean (SD) Range	Gender Differences
Total # of "win" balloons--Active	7.0 (2.7) 1-12	6.3 (2.6) 1-10	7.9 (2.7) 3-12	F (1,38) = 3.5; p = 0.07[a]
Total # of "lose" balloons—Active	8.0 (2.7) 3-14	8.7 (2.6) 5-14	7.1 (2.7) 3-12	F = (1,38) = 3.5; p = 0.07[a]
Average adjusted inflations/"win" balloon—Active	6.0 (1.2) 3-10	6.1 (1.4) 3-10	5.8 (0.94) 4.5-7.4	F (1,38) =.88; p = 0.35[a]
Average adjusted inflations/"lose" balloon--Active	6.0 (1.5) 1.5-9.6	6.5 (1.2) 4.4-9.6	5.2 (1.6) 1.5-8.4	U = 103.5; z = -2.52; p = 0.01[b]

[a]One-Way Analysis of Variance (ANOVA)
[b]Independent Samples Mann-Whitney U Test

RESULTS: HEMODYNAMIC DATA



RESULTS:
POWER ANALYSIS & PSYCHOMETRICS

- Post hoc power analysis:
  - 0.9 (based on differences of HbO means between active and passive modes)
  - 0.6 (based on differences of male/female HbO means during active losses)
  - Need 30 males and 30 females to achieve power to interpret gender differences
- Internal Consistency Reliability
  - α = 0.74

CONCLUSIONS

- **Adult males:**
  - Decided to risk earnings
  - Suffered more losses
  - Reduced inhibitory control
- **Adult females:**
  - Demonstrated risk aversion
  - Losses associated with bilateral dorsolateral PFC activation

FUTURE IMPLICATIONS

Contingency Management

- Role of gender and age in effectiveness of Contingency Management
  - Reinforcers as "wins"
  - Role of risk aversion
- No qualitative research has been done on gender-specific client perceptions of CM
- Extend optical imaging to lifespan risk decision research of "normal" and "clinical" populations

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