INTEGRATING NURSING AND BIOENGINEERING EXPERTISE IN RESEARCH:

USE OF OPTICAL IMAGING TO UNCOVER NEURAL CORRELATES OF ADULT RISK DECISIONS

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PROBLEM

- Gender differences in imaging research rarely reported.

- Limitations of Functional Magnetic Resonance Imaging (fMRI):
  - Expensive
  - Participant confinement
  - Motion artifact
  - Noise
  - Restrictions for eligibility

PURPOSE

- 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: GENDER DIFFERENCES

- Females myelinate PFC earlier

(Powell, K., 2006. How does the teenage brain work? Nature 442(24), 865-867.)

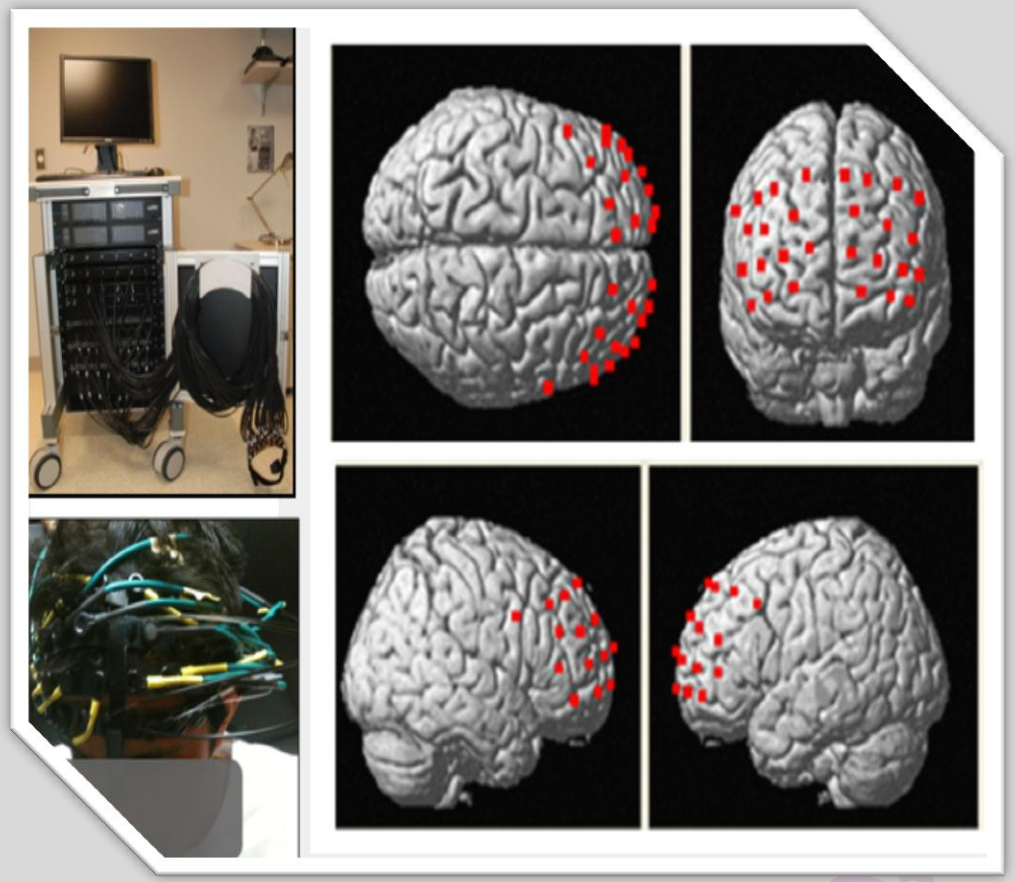
- Different PFC recruitment during task (Schweinsburg, A.D., Nagel, B.J., Tapert, S.F., 2005. fMRI reveals alteration of spatial working memory networks across adolescence. J Int Neuropsychol Soc 11, 631-644.)

- 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 in Psychol Sci 20, 211-216.)

BACKGROUND/SIGNIFICANCE: OPTICAL IMAGING (FNIRS)

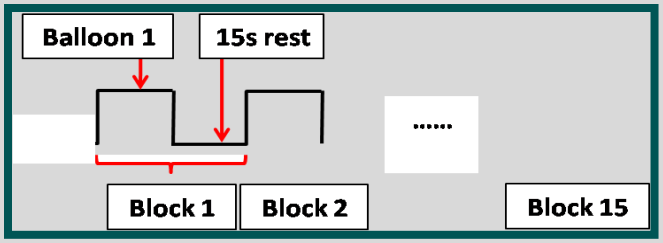
- Functional Near-Infrared Spectroscopy
- Non-invasive
- Laser diodes
- Stimuli-evoked changes in oxygenated and deoxygenated Hgb concentrations
- Targeted cortical and prefrontal regions of interest
- Comparable to BOLD findings in fMRI



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

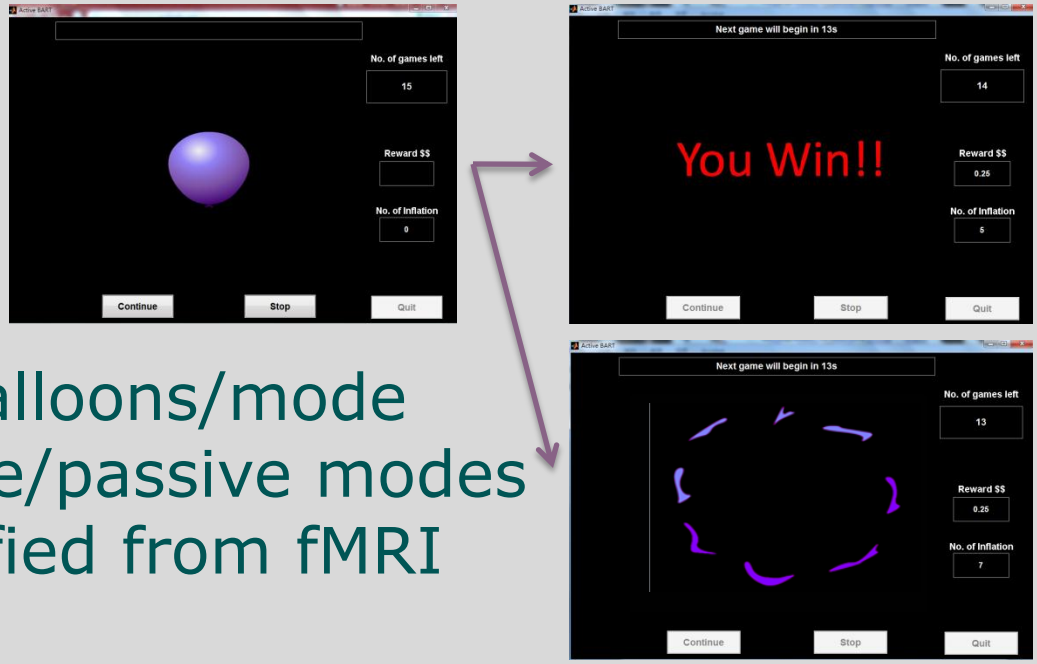
- Correlational blocked design



- 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

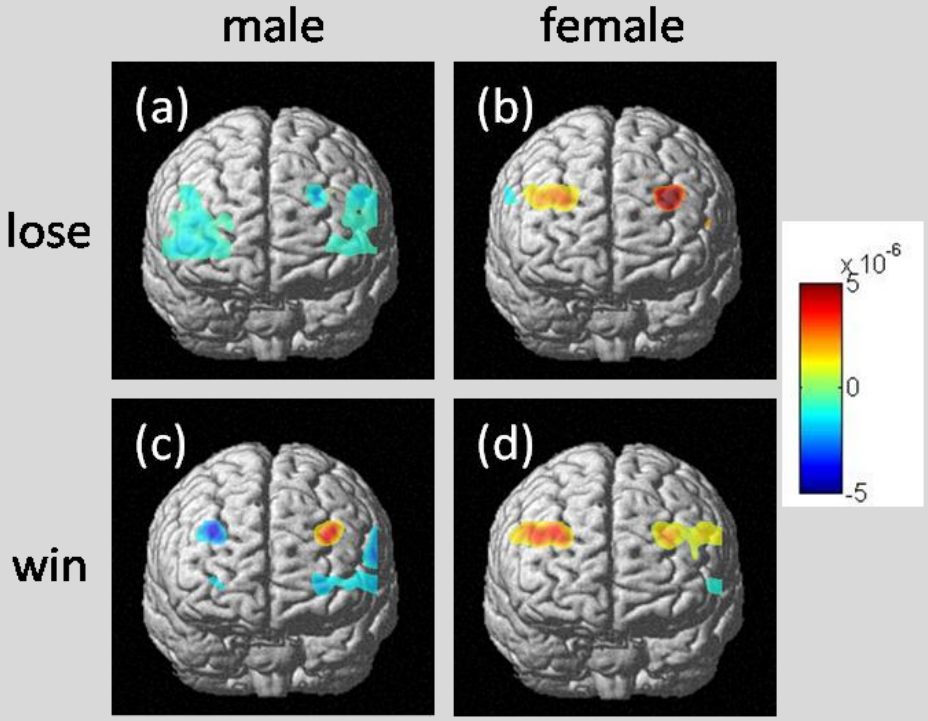
RESULTS:
BEHAVIORAL BART DATA

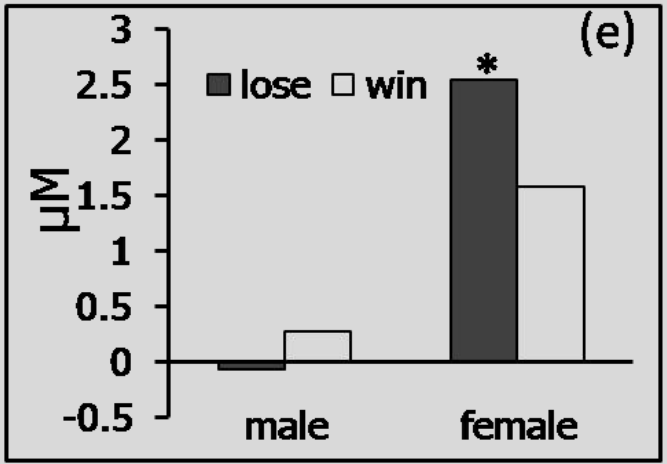
Behavioral Data	Total Group (n=40) Mean (SD) Range	Males (n-23) Mean (SD) Range	Females (n=17) Mean (SD) Range	Gender Differences
Total # of "win" balloons--Active	7.0 (2.7) 1-12	6.3 (2.6) 1-10	7.9 (2.7) 3-12	F (1,38) = 3.5; p = 0.07[a]
Total # of "lose" balloons—Active	8.0 (2.7) 3-14	8.7 (2.6) 5-14	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

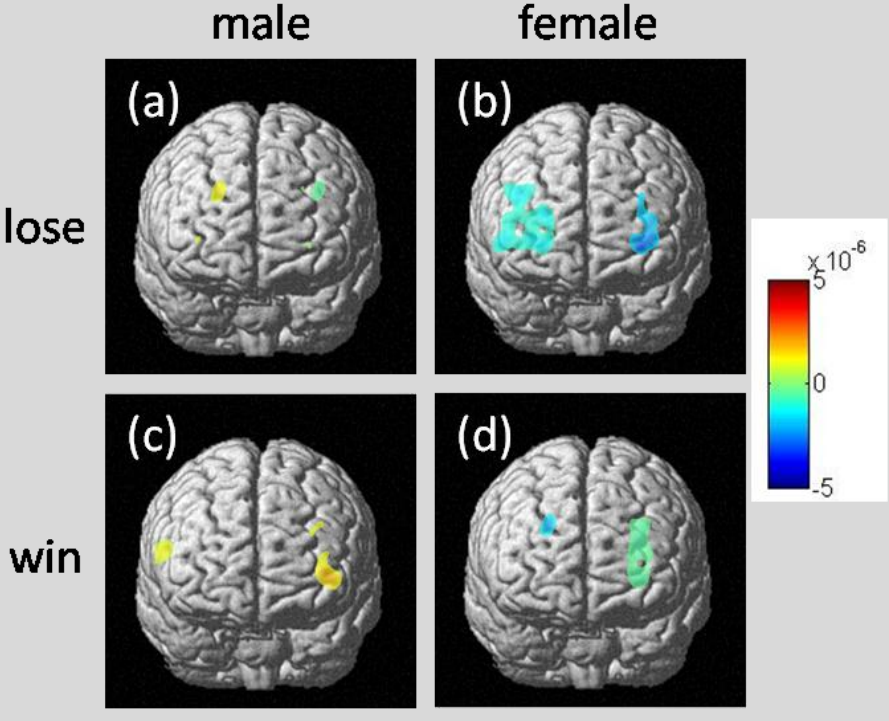
RESULTS: HEMODYNAMIC DATA

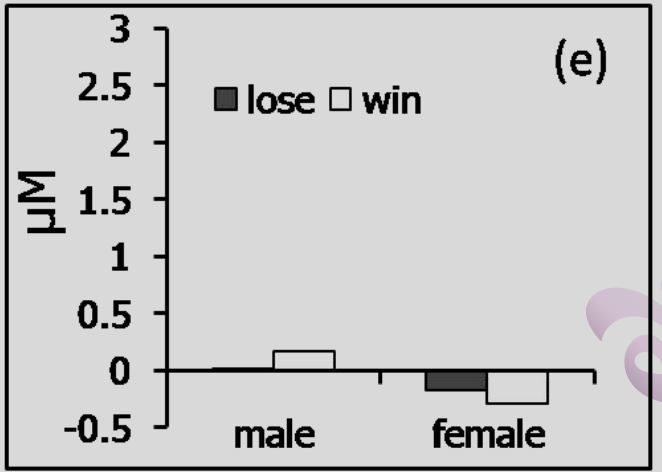
Active





Passive





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
  - $\alpha = 0.74$

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

CONCLUSIONS

- **Collaboration between Nursing and Bioengineering:**
  - Feasibility and convenience of fNIRS technology
  - Inclusion of psychometric and power analyses
  - Strong emphasis on rigor of study design
  - Extend to lifespan risk decision research of “normal” and “clinical” populations.