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  

- PFC maturity achieved in early adulthood  

- Adults—Less difficulty with:
  - Decision-making
  - Impulse control
  - Delay of gratification
  - Emotional regulation
  - Attention
  - Long-range planning

BACKGROUND/SIGNIFICANCE: GENDER DIFFERENCES

- Females myelinate PFC earlier  

- Different PFC recruitment during task  

- Gender: strong predictor for risk tolerance
  - Females: more risk aversion
  - Males: more financial risks
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

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 $$
- Balloon explodes = lose accrued $$

RESULTS: BEHAVIORAL BART DATA

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

*a One-Way Analysis of Variance (ANOVA)  
*b Independent Samples Mann-Whitney U Test
RESULTS: HEMODYNAMIC DATA

Active
- male
- female

Passive
- male
- female

(e)
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.