Brain Networks Related to Loneliness in Adolescents

Abi M. Heller¹, David E. Warren², Tony W. Wilson², Vince D. Calhoun³, Julia M. Stephen³, Yu-Ping Wang⁴, & Janelle N. Beadle¹

¹University of Nebraska at Omaha
²University of Nebraska Medical Center
³University of New Mexico-Mind Research Network
⁴Tulane University
“If you want to go fast, go alone. If you want to go far, go together.”

-African Proverb

According to the General Social Survey, Millennials are the loneliest generation yet
Today’s Presentation

• Introduction
  - Loneliness in Adolescence/Brain
• The Current Study
  - Methods/Measures
  - Results
• Discussion/Future Directions
Introduction: Defining Loneliness

• Webster Dictionary:
  1. sadness because one has no friends or company.

• “Perceived Isolation”
  - Being alone is not the same as being lonely
  - Loneliness can become a chronic issue

Weiss, 1973
Lonely Adolescents...

- Psychological Health
  - Personality Disorders
  - Depression (neuroticism)
  - Suicide
- Physiological Health
  - Obesity
  - Sleep Disturbances
  - Immune Function
  - Cardiovascular Health

(Hawkley & Cacioppo, 2010; Heinrich & Gullone, 2006)
Loneliness in the Brain

- Loneliness activates:
  - Amygdala: experiencing emotions

(Bickart et al, 2012; Bolling et al, 2011; Eisneberger et al 2003; Von Der Heide et al, 2014)
Loneliness in the Brain

- Loneliness activates:
  - Cingulate Cortex: emotion formation and processing

(Bickart et al, 2012; Bolling et al, 2011; Eisneberger et al 2003; Von Der Heide et al, 2014)
Loneliness in the Brain

• Loneliness activates:
- Prefrontal Cortex (PFC): Regulating emotions and emotional responses

(Bickart et al, 2012; Bolling et al, 2011; Eisneberger et al 2003; Von Der Heide et al, 2014)
The Current Study: Brain Networks Related to Loneliness in Adolescents

- DevCoG- Developmental Chronnecto-Genomics (56 children from NM and NE)

<table>
<thead>
<tr>
<th>N=56</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs.)</td>
<td>11.6 (1.9)</td>
</tr>
<tr>
<td>Education (yrs.)</td>
<td>8.6 (1.8)</td>
</tr>
<tr>
<td>Handedness</td>
<td>51R, 5L</td>
</tr>
<tr>
<td>Gender</td>
<td>30 M, 26 F</td>
</tr>
<tr>
<td>Race (% Caucasian)</td>
<td>80.7</td>
</tr>
</tbody>
</table>
Measure of Loneliness

- NIH Emotion Toolbox Measures (ages 8-14)
  - Loneliness: “I feel that I have nobody to talk to” “I feel that I don’t have any friends”
  - Friendship: “I have friends to sit with at lunch” “I can find a friend when I need one”
  - Perceived Rejection: “People in my life put me down” “I don’t feel like I fit in”
Resting State Functional Connectivity

- Functional Magnetic Resonance Imaging (fMRI)
  - Blood Flow $\rightarrow$ Neuronal Brain Activity
- Measure of brain activity at rest!
- Advanced Functional Neuroimaging Analysis (AFNI)
Hypothesis

1. In more lonely individuals, greater connectivity between amygdala and socio-emotional brain regions is seen.
2. In more lonely individuals, less connectivity between cingulate cortex and socio-emotional brain regions is seen.
# Results

## Regression Model on Loneliness

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>β</th>
<th>SE</th>
<th>P</th>
<th>95% CI</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejection</td>
<td>.6</td>
<td>.5</td>
<td>.1</td>
<td>&lt; .01</td>
<td>.4, .8</td>
<td>6.6</td>
</tr>
<tr>
<td>Friendship</td>
<td>-.6</td>
<td>-.5</td>
<td>.1</td>
<td>&lt; .01</td>
<td>-.7, -.4</td>
<td>-6.5</td>
</tr>
</tbody>
</table>

M=mean; SD= standard deviation. $R=.876; R^2=.767, (p<.01)$; Adjusted $R^2=.758$; SE= Standard Error; CI= Confidence Interval
Results

R Amygdala Seed

L Cingulate Gyrus  L Superior Temporal Gyrus
Results
R Posterior Cingulate Seed

R Inferior Frontal Gyrus
Discussion

• Increased amygdala rs-FC to the cingulate gyrus and superior temporal is consistent with depression and anxiety literature.
  - Lonely individuals are at a greater risk for depression, anxiety and neuroticism.

• Decreased rs-FC between posterior cingulate and the inferior frontal gyrus reflecting social rejection, difficulty focusing on others’ emotions.

(Cacioppo et al, 2009; Kanai et al, 2012; Roy et al, 2013)
Implications

• Connectivity patterns used as a biomarker to predict future loneliness, depression and anxiety.

Future Directions

• Independent Component Analysis
• Year 2 Measures
  - Personality, Empathy, Loneliness
Questions?

Funding:
• National Science Foundation: Supported by grant #1539067 to VC, YW, TW and JS

Thank you!
• Aging Brain and Emotion Lab- Dr. Janelle Beadle
• Department of Neurology- Dr. David Warren, Dr. Tony Wilson and other lab members who contributed along the way!
References


# Means and Correlations Among Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>M (SD)</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Loneliness</td>
<td>12.7 (5.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Friendship</td>
<td>19.2 (5.0)</td>
<td>-.8*</td>
<td></td>
</tr>
<tr>
<td>3. Rejection</td>
<td>9.6 (4.5)</td>
<td>.8*</td>
<td>-.5*</td>
</tr>
</tbody>
</table>

\[ p < 0.01 \]