Relation of Subcortical Structure Segmentation and Social Integration

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Background

- The amygdala has been identified as a central structure for neural networks that support social cognition.[2]
- Bickart et al. have identified three different networks all stemming from the amygdala, the aversion network, the affiliation network, and the perception network, which help signal who is untrustworthy or to be avoided, facilitate prosocial behavior and understanding the meanings of social signals and cues respectively.[2]
- The volume of the amygdala has been shown to predict the size and complexity of one's social network,[3] following the idea that increased volume in a subcortical structure is correlated with more advanced computational ability.[1]
- In the social perception network, the ventrolateral amygdala is functionally connected to the orbitofrontal cortex.[2] In humans with social anxiety, there has been evidence of reduced resting-state functional connectivity between the left amygdala and the orbitofrontal cortex.[4]
- Measures of social integration, consisting of social network size and complexity, perceived social support from those closest to the participants, and a non-diagnostic measure of social anxiety, were regressed with the volumetric measures of different subcortical structures, with the hypothesis that those with a larger and more complex social network would show lower social anxiety scores and a larger amygdala volume.

Methods

- 9 participants (0 males), ages 19-22, *(M* = 20.75, *SD* = 1.09*)* self-reported measures of social network size and complexity (SNI), social support (NSSQ), and social anxiety (SAQ-A30).
- T1-weighted anatomic images of participants were collected using a Siemen's 3T MRI scanner.
- FreeSurfer subcortical anatomical segmentation was performed on the obtained images to estimate the volumes of different sub-cortical structures.
- Sub-cortical structures that were reported for the left and right hemispheres were combined if they were not significantly different at a $p < 0.050$.

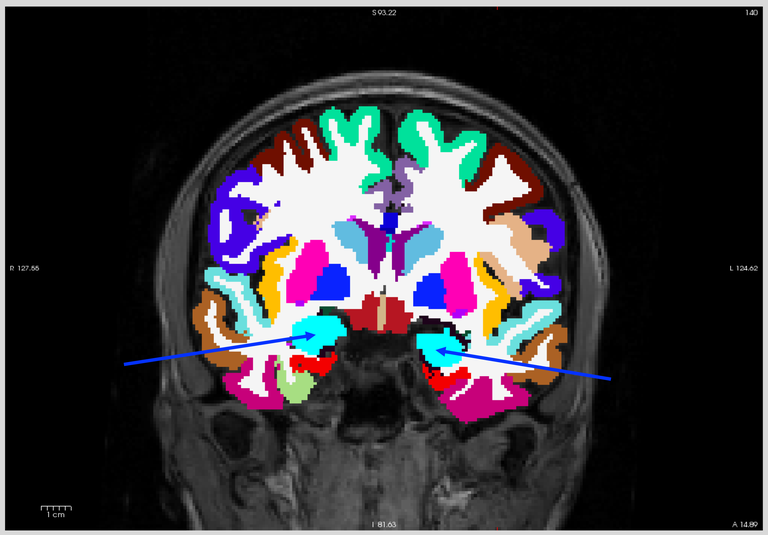

Figure 1. An example of the output of a FreeSurfer segmentation overlaid onto a T1 MRI image for spatial context. The blue arrows point to the left and right amygdala.

References

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Results

Social Anxiety

- Participants who scored past threshold for social anxiety showed slightly significantly larger volumetric size of the left amygdala ($t = 2.429$, $df = 7.000$, $p = 0.046$, $d = -1.622$), but not the right amygdala ($t = 0.566$, $df = 7.000$, $p = 0.589$, $d = -0.380$).

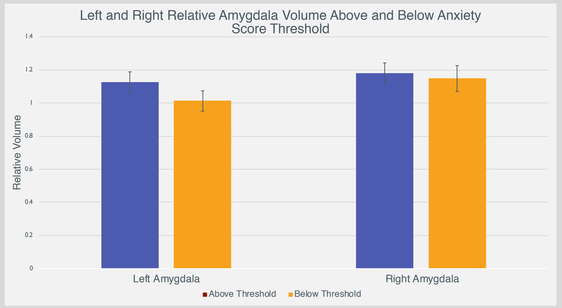

Figure 2. Relative volume, measured by the calculated amygdala volume divided by the individual's estimated total intracranial volume, for the left amygdala is lower in participants that passed the threshold for social anxiety but is not different in the right amygdala.

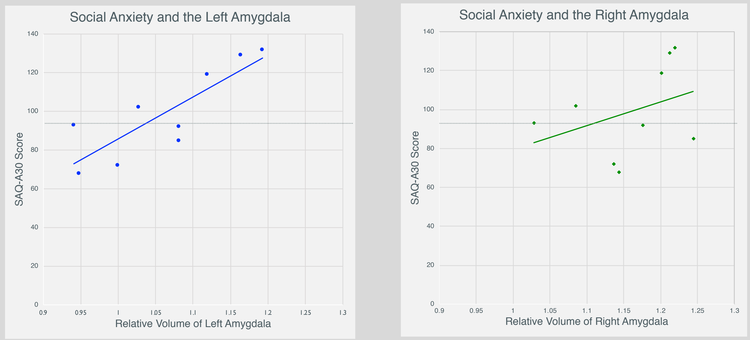

Figure 3. Scatter plots of the volumes of the left (Pearson's $r = 0.822$, $p = 0.007$) and right (Pearson's $r = 0.305$, $p = 0.424$) amygdalae, divided by the estimated total intracranial volumes, as a function of the scores of the Social Anxiety Questionnaire. The dotted lines represent the threshold score at 98 for females.

- No other statistically reliable differences were found for participants who crossed the social anxiety threshold and those who did not.
- Participants who scored for social anxiety were the same on measures of the number of significant persons in their life that they listed, their relative perceived emotional and tangible support, their network diversity, their social network size, and their overall social network index score.

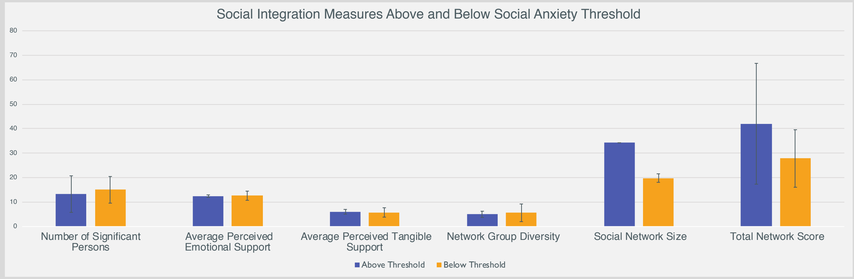

Figure 4. Mean scores of various measures from the NSSQ Social Support Questionnaire and the Social Network Index evaluation for those over and under the social anxiety threshold.

Social Network and the Amygdala

- Previous findings of a correlation between social network size and volume of the amygdala was not supported by the present data.

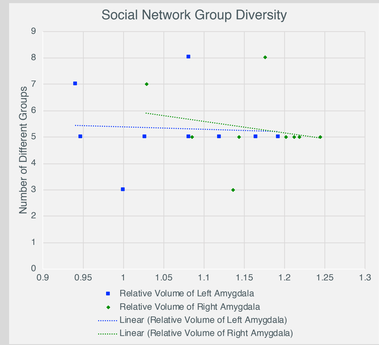

Figure 4. Scatter plot showing the relative volumes of the left and right amygdala as compared to the size of the individual's social network.

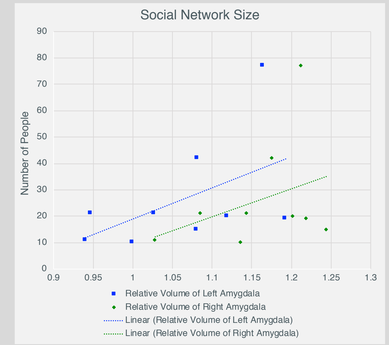

Figure 5. Scatter plot showing the relative volumes of the left and right amygdala as compared to the individual's network diversity.

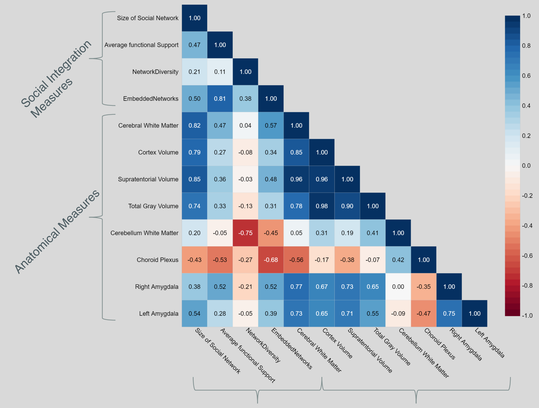

Figure 6. Correlation Matrix of different social integration measures and subcortical structures. Both the left and right Amygdala do not show a correlation with any of the social integration measures. The sub-cortical structures shown had at least one significant correlation with the social integration measures.

Discussion

- The finding that a larger relative left amygdala volume was associated with social anxiety threshold, but not with the relative right amygdala volume, suggests possible left-hemisphere lateralization of the underlying neural structure of social anxiety
- Using the perception network of social cognition and the observations of decreased resting-state functional connectivity of the left amygdala as a framework, the increased volume of the left amygdala may suggest that there are potential differences in the connectivity of the left amygdala to the prefrontal cortex in those with social anxiety, causing them to misunderstand social cues in a way that manifests as anxiety. This interpretation is supported by the lack of a statistically reliable difference in the social integration measures between those who passed the social anxiety threshold and those who did not.
- Previous research that has shown there is a correlation between the relative volume of the amygdala and a person's social network size was not supported.
- Although some neural structures showed correlations with the measures of social network size and complexity, and perceived social support, none of these structures are in either of the three neural networks of social cognition as outlined by Bickart et al.[3] However, these structures are largely measures of cortex, which follows from research that volume of areas of the prefrontal cortex determines social cognitive ability, which in turn helps determine social network size.[6]
- Measures of resting-state functional MRI and diffusion-weighted images were also taken of the participants, and future analysis of this data will help provide further understanding.

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