Associations between social responsiveness and brain structure in children

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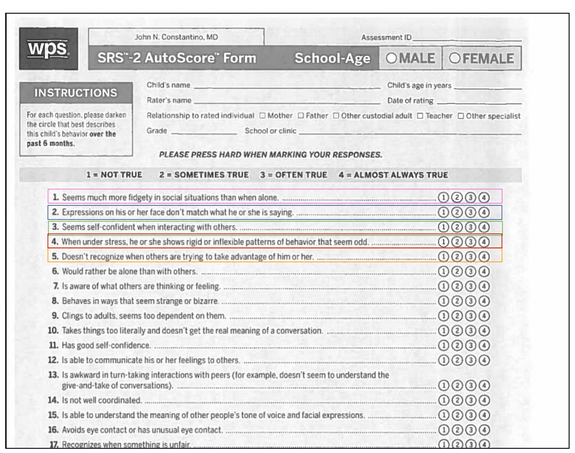
Introduction

- Social Responsiveness: How an individual responds to social needs and societal expectations; critical for successful social interactions
- Variations in social responsiveness have been linked to variations in brain structure in adults and individuals with autism (a neurodevelopmental disorder characterized by altered social interactions and is more prevalent in males)
  - Studies in typically-developed adults show relations between the perception of social cues and amygdala volume[1]
  - Studies also show individuals with autism have larger amygdala and hippocampus volumes[2], along with reduced cortical thickness in caudal middle frontal (CMF) cortex[3]
  - Social responsiveness is thought to be a key indicator of risk and is related to alterations in these structures[4]
- It is currently unknown if Social Responsiveness relates to brain volumes or cortical thickness in typically-developing children
- Our goal was to explore relations between amygdala and hippocampus volume, cortical thickness, and social responsiveness in typically-developing children

Methodology

- A total of 200 4- to 8-year-old children (females = 100, males = 100) were recruited to participate in a study involving Neuroimaging (MRI) data and parent-reported Social Responsiveness Scale (SRS) scores
- Freesurfer (version 5.1.0): standard automatic segmentation program used to determine amygdala and hippocampus volumes, and caudal middle frontal cortical thickness
- Left, right, and bilateral volumes were measured for each ROI
- Computed SRS total and subscales: social awareness, social cognition, social communication, social motivation, and repetitive behaviors and interests
- Statistical analyses (i.e., correlations & regressions) conducted using R to determine relation between ROIs and SRS scores
- Regression analyses were conducted for all participants and then for males and females separately (ICV and sex were covariates)



wps — John N. Constantino, MD — Assessment ID

SRS™-2 AutoScore™ Form — School-Age — ○MALE ○FEMALE

INSTRUCTIONS

For each question, please darken the circle that best describes this child's behavior **over the past 6 months.**

Child's name ____ Child's age in years ____

Rater's name ____ Date of rating ____

Relationship to rated individual ☐ Mother ☐ Father ☐ Other custodial adult ☐ Teacher ☐ Other specialist

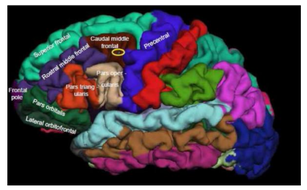
Grade ____ School or clinic ____

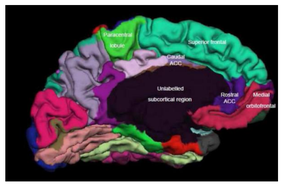
PLEASE PRESS HARD WHEN MARKING YOUR RESPONSES.

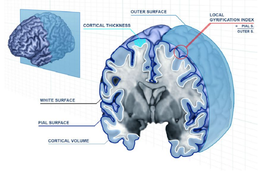
	1 = NOT TRUE	2 = SOMETIMES TRUE	3 = OFTEN TRUE	4 = ALMOST ALWAYS TRUE
1.	Seems much more fidgety in social situations than when alone.	①	②	③	④
2.	Expressions on his or her face don't match what he or she is saying.	①	②	③	④
3.	Seems self-confident when interacting with others.	①	②	③	④
4.	When under stress, he or she shows rigid or inflexible patterns of behavior that seem odd.	①	②	③	④
5.	Doesn't recognize when others are trying to take advantage of him or her.	①	②	③	④
6.	Would rather be alone than with others.	①	②	③	④
7.	Is aware of what others are thinking or feeling.	①	②	③	④
8.	Behaves in ways that seem strange or bizarre.	①	②	③	④
9.	Clings to adults, seems too dependent on them.	①	②	③	④
10.	Takes things too literally and doesn't get the real meaning of a conversation.	①	②	③	④
11.	Has good self-confidence.	①	②	③	④
12.	Is able to communicate his or her feelings to others.	①	②	③	④
13.	Is awkward in turn-taking interactions with peers (for example, doesn't seem to understand the give-and-take of conversations).	①	②	③	④
14.	Is not well coordinated.	①	②	③	④
15.	Is able to understand the meaning of other people's tone of voice and facial expressions.	①	②	③	④
16.	Avoids eye contact or has unusual eye contact.	①	②	③	④
17.	Recognizes when something is unfair.	①	②	③	④

Figure 1. Social Responsiveness subscales and sample questions

Results







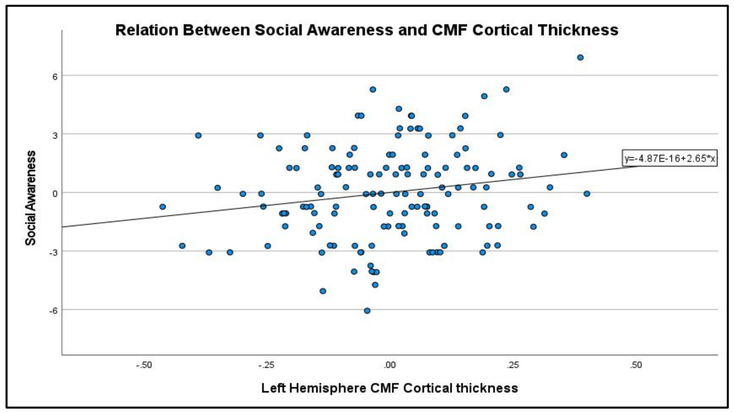
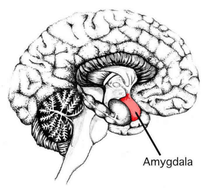


Figure 2. Across all participants, there was a marginal positive correlation between left hemisphere caudal middle frontal thickness and social awareness, controlling for ICV and sex ($F(3, 137) = 2.54$, $p = 0.059$, adjust $R^2 = 0.032$).



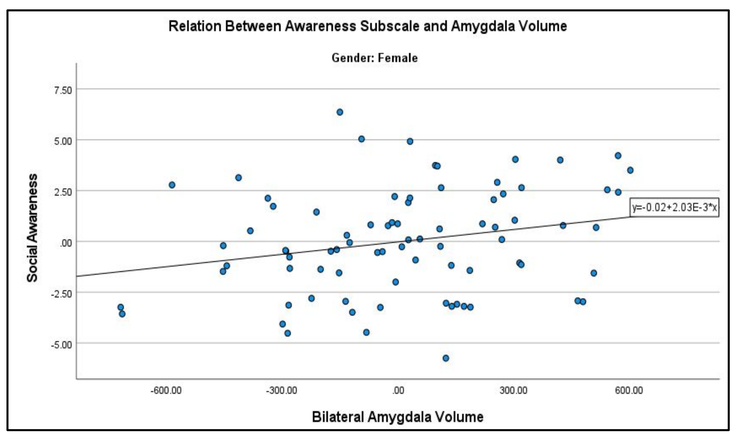
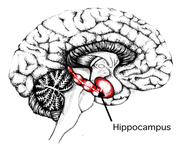


Figure 3. In females there was marginal positive correlation between bilateral amygdala volume and social awareness, controlling for ICV ($F(2,77) = 2.994$, $p = 0.059$, adjusted $R^2 = 0.047$). There was no association in males.

Conclusion/Discussion

- **Caudal Middle Frontal Cortical Thickness**
  - Across all participants, left hemisphere caudal middle frontal thickness, sex, and ICV explain 3.2% of the variance in Social Awareness scores (Figure 2)
  - The awareness subscale focuses on the ability to pick up social cues
  - Caudal middle frontal cortex is associated with executive processing (i.e., attention and internal representation of external stimuli)
  - This suggests children who have greater cortical thickness may have increased social awareness driven by executive processes
- **Amygdala**
  - In females, bilateral amygdala volume and ICV was found to explain ~5% of the variance in Social Awareness subscale scores (Figure 3).
  - Similar to the caudal middle frontal cortex, this suggest that amygdala volume may play a role in the ability to pick up on social cues
  - There was no association between bilateral amygdala volume and the remaining subscales for either males or females
- **Hippocampus**
  - No findings were significant suggesting that social responsiveness may have a weaker correlation with hippocampus volumes at earlier ages in child development
  - This may also be due to limited sample size and lack of variability in our sample



Future Work

- Use fMRI to examine activity in different parts of the brain and if that correlates with social responsiveness
- Explore further why sex may have a role in amygdala volume and social awareness and if that changes in different age populations

Acknowledgements

We would like to thank all of our families for participating in this study and members of the Neurocognitive Development Lab for assistance with this project. This research was supported by NIH (HD079518).

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Additional Resources:
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