Examinining Associations Between Functional Brain Activation and Behavior in Adolescents With a History of Prenatal Drug Exposure

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BACKGROUND

Prenatal Drug Exposure (PDE) and Development in Childhood

Research has shown that children born to women with a history of PDE have yielded mixed results in most domains, such as physical growth, IQ, and overall cognitive functioning. However, the relationship between PDE and specific cognitive domains, such as executive functioning or visual-spatial skills, has been less clear. The current study aimed to examine associations between functional brain activation, as measured by fMRI, and cognitive and behavioral outcomes in a sample of adolescents with a history of PDE. The study also sought to compare these results with a non-exposed comparison group to determine if PDE had a greater impact on brain function than other factors.

Methods

Participants

Participants included 20 adolescents (10 with a history of PDE and 10 without) who were recruited from the same community. All participants were between the ages of 12 and 15 years old (Table 1). The study used a 12-year-old control group from the same community. All participants were between the ages of 12 and 15 years old (Table 1). The study used a 12-year-old control group from the same community.

Table 1: Demographic Information

<table>
<thead>
<tr>
<th></th>
<th>PDE Group (N=10)</th>
<th>Comparison Group (N=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (SD)</td>
<td>14.5 years (1.0)</td>
<td>14.5 years (1.0)</td>
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<tr>
<td>10th to 90th Percentile Age</td>
<td>13.0 to 16.0</td>
<td>13.0 to 16.0</td>
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<tr>
<td>Sex</td>
<td>Male (8), Female (2)</td>
<td>Male (8), Female (2)</td>
</tr>
<tr>
<td>Educational Level</td>
<td>High School (6), College (4)</td>
<td>High School (6), College (4)</td>
</tr>
<tr>
<td>Neurocognitive Assessments</td>
<td>Digit Span (12 years), Trail Making Test (12 years)</td>
<td>Digit Span (12 years), Trail Making Test (12 years)</td>
</tr>
</tbody>
</table>

RESULTS

Associations between ROI Activation and Neuropsychological Assessments

- There was a significant positive association between activation in the right MFG during the VSWM task and Stroop interference response, 
  \( r(35) = .47, p < .05 \) for less “risky” response style.

- Greater activation was associated with a less “risky” response style in the CPT task.

- There was a significant negative correlation between activation in the IPS during the VSWM task and performance on the JLO, 
  \( r(35) = -.57, p < .05 \) for more “risky” response style.

- There was a significant negative association between activation in the right MFG during the VSWM task and Stroop Interference, 
  \( r(35) = -.47, p < .05 \) for less “risky” response style.

- Better performance (e.g., faster reaction times) was associated with less activation.

CONCLUSION

Adolescents with and without PDE show frontoparietal activation associated with VSWM task performance. However, non-exposed adolescents show greater activity in the MFG.

Although there were few overall between-group differences in performance on neuropsychological measures of visuospatial abilities and executive functioning, these differences in brain activation during the VSWM task were correlated with task performance. This finding suggests that the observed differences in neural activation may impact behavioral outcomes.

A limitation of neuropsychological tests is that performance cannot be directly attributed to a specific brain region or pathway, but rather this must be inferred. Neuroimaging helps to address this limitation by demonstrating that performance is linked to activity in specific brain regions. Using both methodologies in combination may prove to be a powerful way to link PDE to neuropsychological task performance and to identify the neural substrates associated with specific outcomes.

Data collection is ongoing and future research in our laboratory will examine whether there are differences in the associations between brain activation and behavior between individuals with and without PDE. In addition, we will also begin to examine the impact of environmental variables known to moderate the effects of PDE such as maternal education, socioeconomic status and prenatal exposure to other substances such as alcohol and cigarettes, which commonly co-occur with prenatal drug exposure.

REFERENCES