Prefrontal Cortex Development in Post-Institutionalized Adolescents

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Introduction

Animal studies have documented neuroanatomical and behavioral effects of early life deprivation. Research with post-institutionalized (PI) children suggests that early deprivation is associated with potential deficits in cognitive and socioemotional development (Gunnar et al., 2000), and changes in the limbic system (Mehta et al., 2009; Tottenham et al., 2010) and prefrontal cortex (Eluvathingal et al., 2006; Behen et al., 2009; Govindan et al., 2010). Although individual variability exists, longer duration of institutional care is predictive of reduced physical catch-up growth (Van IJzendoorn et al., 2007) and poorer cognitive achievement (Johnson, 2002).

Questions

Do post-institutionalized (PI) children show altered development of the prefrontal cortex?
Are changes in brain development more pronounced in later-adopted PI children?

Participants

12-14 year old children either adopted internationally from institutional care or raised in Minnesota with their biological family

Controls

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<thead>
<tr>
<th></th>
<th>Early Adopted (PI-EA)</th>
<th>Late Adopted (PI-LA)</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>38 (18 females)</td>
<td>44 (26 females)</td>
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Not adopted

<table>
<thead>
<tr>
<th></th>
<th>Adopted before 12 months</th>
<th>Adopted between 13-72 months</th>
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<tbody>
<tr>
<td></td>
<td>• No developmental, neurological, or psychiatric disorders</td>
<td>• No FAS or developmental disorders</td>
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<tr>
<td></td>
<td>• At least 50% of pre-adoptive care spent in an institution</td>
<td>• At least 50% of pre-adoptive care spent in an institution</td>
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<td></td>
<td>• Diverse countries of origin</td>
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Methods

Structural MRI Scan: T1-weighted 3D MPRAGE anatomical series acquired on a Siemens 3T Trio Scanner

- TR = 2530 ms, TE = 3.56 ms, FOV = 256 mm, flip angle = 7 degrees
- slice thickness = 1 mm, 240 sagittal slices

MRI Analyses: Freesurfer Image Analysis Suite was used to obtain automated, volumetric segmentation data for subcortical and cortical structures

Cortical thickness analyses adjusted for average hemispheric thickness

Volumetric analyses adjusted for total intracranial volume

All analyses included age and gender as covariates

Discussion

We found evidence for persisting effects of early life deprivation in prefrontal cortex development of PI children, which has been implicated in animal models of early life stress:

• Prefrontal cortex thickness was atypical in both EA and LA children in bilateral caudal anterior cingulate, left medial orbitofrontal cortex, and left frontal pole. Does this represent developmental differences in synaptic pruning?
• Prefrontal cortex volume was reduced in both EA and LA children. Is this region especially vulnerable to early stress?
• Group differences were driven by volume reductions in left lateral orbitofrontal cortex and in bilateral superior and inferior frontal gyri.

We did not find strong evidence for the duration of early life stress impacting prefrontal cortex development, given the largest differences in structural brain development were between PI children and non-adopted controls.

Future studies should investigate the functional implications of atypical prefrontal volume and thickness in PI children.

Conclusion

By early adolescence, PI children show altered development of both prefrontal cortical thickness and prefrontal gray matter volume.