Introduction

Children reared in orphanages experience experience deprivation as a result of inadequate physical care, and/or lack of cognitive and socio-emotional stimulation. Some domains improve following adoption; however, cognitive and emotional problems often persist. Previous studies have suggested altered structure and connectivity in this population. Few studies have addressed functional development of prefrontal regulatory systems. The current study examined behavioral and neuroimaging measures of prefrontal function in post-institutionalized (PI) youth, emphasizing the effects of duration of deprivation. Forty PI youth (12-14 yrs.) and 24 non-adopted (NA) controls performed a cognitive conflict task involving motor relearning during fMRI scanning. PI youth were either early-adopted (EA; N=24) or late-adopted (LA; N=24).

Participants

<table>
<thead>
<tr>
<th>Group (F/M)</th>
<th>Age Test [SD]</th>
<th>Age Adopt [SD,range]</th>
<th>Time In Inst. [SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Adopted (16/8)</td>
<td>13.4m [6.4m]</td>
<td>8.0m [2.3m; 4-12m]</td>
<td>7.3m [2.1m]</td>
</tr>
<tr>
<td>Early-Adopted (13/11)</td>
<td>13.2m [7.2m]</td>
<td>24.4m [10.5m; 13-51m]</td>
<td>21.0m [8.4m]</td>
</tr>
</tbody>
</table>

• PI youth were adopted from non-US orphanages into MN families (16 S.E. Asia; 28 Europe; 4 S. America)
• PI youth were institutionalized at 0 to 22 months of age for a minimum of 4 months and at least 50% of their pre-adaptive life (M=2.1m; SD=4.7m)
• Normal or corrected-to-normal vision
• No evidence of FAS or neurological disease

Behavioral Task

- 4 blocks per instruction set
- 20 stimuli/120 sec
- 1.5 sec ISI
- 9 per block

Behavioral Performance

- PI youth were less accurate and slower to respond than typically-developing controls, suggesting the task was more effortful for PI youth. All participants had accuracy greater than 70% for Congruent trials.
- Accuracy: Responses to Incongruent mappings were less accurate than responses to Congruent mappings (F(1,69)=107.1, p<.001), and accuracy was lower as a function of duration of institutionalization (F(2,69)=3.7, p<.05). Accuracy for Incongruent trials was significantly lower for Late-adopted PI youth than for Controls (Tukey, p<.05).
- Reaction time: Congruent mappings produced faster reaction times than Incongruent mappings (F(1,69)=43.4, p<.001). No significant differences in reaction time were observed between groups for Congruent or Incongruent response mappings (all p>.05).
- Z-score normalized reaction time produced equivalent findings.

Neuroimaging Methods

- Magnet: Siemens 3T Tim Trio with 12-channel phased-array head coil Structural: MP-RAGE, 1.0 mm isovoxel, 50% gap
- Fieldmap and Functional: EPI, 34 interleaved axial slices, 3.125 x 3.125 x 3.0 mm voxels, 33% gap
- Data processing (FSL)
  - B0 unwarping
  - Motion and slice-time correction
  - High-pass filtering and spatial smoothing (8mm FWHM)
  - Co-registration with structural volume
  - Transformation into 2 mm MN space
  - Block design with fixation as baseline
  - Focused on group differences in Incongruent > Congruent

Areas of significant activation were identified using a whole-brain voxel-wise analysis at p<.005 with a minimum contiguous volume criterion of 390 mm³ (equivalent to 10 functional voxels, including the gap).

Conclusions

- Behavioral and functional imaging results support the hypothesis that early deprivation is associated with long-term alterations in the development of prefrontal circuitry, and that developmental outcomes vary with individual differences in early experience.
- PI children showed increased activity in DLPPC compared to non-adopted controls, suggesting that factors associated with even brief periods of early deprivation may have long-term impacts on prefrontal function.
- Prefrontal cortex and other regions showed additional effects of duration of deprivation. Recruitment of additional regions in EA youth may reflect compensatory activity, given this group’s normative task performance. The function of additional activity in LA youth is unclear.
- Future work will investigate whether activity in these regions predicts behavioral performance for the different groups.