Childhood Parental Nurturance Affects Later Brain Morphology in Adolescents

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Introduction Examinations of the effects of early life experience have well demonstrated that early life environmental deprivation or restriction can induce both cognitive and affective impairments, while environmental enrichment or complexity may facilitate the recovery from brain injury (1-2). Studies in animals have documented the lasting effect of early experience in multiple brain regions, particularly hippocampus (3-4). However, the study of the effects of childhood experience on human brain development has so far been limited to the effects of trauma or severe deprivation. Specifically, little is known about whether and how childhood parental nurturance affects the longitudinal development of normal human brain. Taking advantage of prospectively collected information of childhood experience of a relatively large cohort of adolescents (5) as well as unbiased symmetric image registration tool (6), the present study used high-resolution structural MRI to non-invasively investigate the effects of childhood parental nurturance on late brain morphology. We hypothesized that the quality of early childhood parental nurturance would affect the late morphology of hippocampus in adolescents.

Methods Participants were 49 adolescents of low socioeconomic status (25 males, mean age 14.2 years), recruited from a large cohort of prenatally cocaine exposed and non-exposed adolescents who have been followed since their birth (5). Prospectively collected information on childhood experience was obtained for 47 of 49 subjects when the subjects were aged 4 and 8, using the Home Observation for Measurement of the Environment (HOME) Inventory (7). The index of parental nurturance (e.g., physical and verbal affection, parental availability, discipline) was derived for each subject. A Siemens 3.0T Trio scanner was used to acquire the high-resolution anatomic images with a 3D MPRAGE sequence (TR/TI/TE = 1620/950/3ms, flip angle = 15°, 160 contiguous axial slices, Resolution = 1 x 1 x 1 mm^3). The unbiased and reliable image registration and segmentation tool, i.e., the symmetric diffeomorphisms (6), was used to quantify the brain morphology. The relative volume of each individual brain structure was calculated and entered to a voxel-wise GLM analysis in SPM2. Since previous analyses on these subjects have revealed no significant difference between the exposed and non-exposed groups (except for caudate) (8), the data of the two groups was combined in this study. The GLM analysis used the index of parental nurturance as the interested regressor, and age, gender, group as the covariates of non-interest. Areas of significant activation were identified as the uncorrected *P* value smaller than 0.001. Small volume correction (SVC) was applied to the hippocampus as a priori defined region of interest.

Results Consistent with our hypothesis, the GLM analysis revealed that the index of early childhood (age 4) parental nurturance inversely correlated with the morphology of bilateral hippocampus (Fig.1, uncorrected $p<0.001$, SVC corrected $p<0.005$), posterior cingulate and medial orbitofrontal cortex, and positively correlated with the morphology of bilateral precuneus. ROI analyses confirmed the negative correlation in hippocampus (Fig.2, left, R=-0.60, $p<0.001$; right, R=-0.53, $p<0.001$). However, no such correlation was found for the index of late childhood (age 8) parental nurturance (Fig.2). The late parental nurturance inversely correlated with the morphology of lateral orbitofrontal cortex (Fig.1, uncorrected $p<0.001$). The correlations between the bilateral hippocampus morphology and quality of parental nurturance were significantly different between age 4 and 8 (both $p<0.005$). Analyses on the separate groups did not change these results.

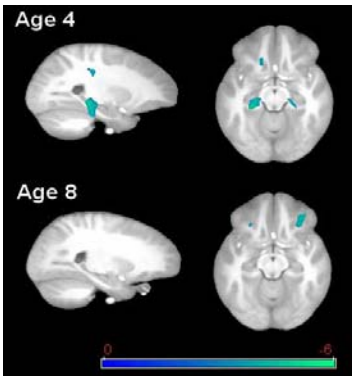

Fig.1. Results from GLM analyses.

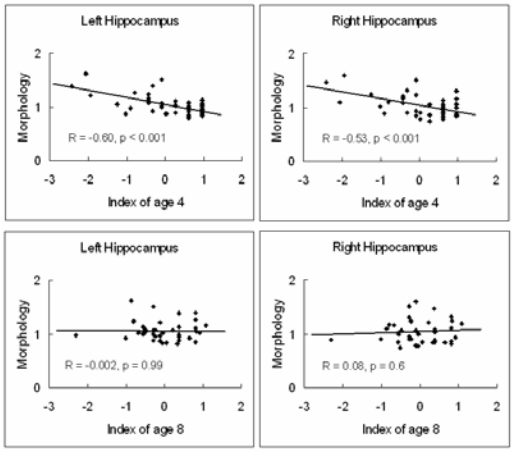

Fig2. Results from ROI analyses on hippocampus.

Conclusions To our knowledge, this is the first study that demonstrated the effects of the quality of childhood parental nurturance on the morphology of hippocampus in adolescents. These findings support the lasting effects of early life experience in later development of human brain. The dissociable effects of early and late childhood parental nurturance suggest that hippocampus and lateral orbitofrontal cortex may have different sensitive periods associated with early life experiences.

References

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