Prenatal cocaine exposure alters the attention regulation between emotion and working memory processing: an fMRI study

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Introduction Prenatal cocaine exposure (PCE) is associated with arousal dysregulation and inefficiencies in working memory [1]. We embedded emotional distracters in a working memory task to compare emotion and memory interactions between the PCE and control subjects. While the behavioral performances were similar between groups, differences in reciprocal interaction between the left dorsal lateral prefrontal cortex (DLPFC) and the amygdala was observed. The present data suggests that PCE could alter attentional resource allocations between emotion and memory processing networks.

Methods Six PCE (age 17±0.5, 5M1F) and six control (age 17±0.8, 1M5F, economic status & education level matched) subjects were scanned (3T Siemens, 2 EPI-BOLD fMRI scans with 120 volume measurements in each, matrix=64×64, 30 axial slices, thickness/gap=3mm/0mm, TR/TE/FA/FOV=3000ms/30ms/90°/192cm). Participants were asked to perform a working memory task by pressing a button either when "RR" was displayed (0-back condition) or when the displaying letter pair matched with the previous one (1-back condition). Emotionally neutral or negative pictures were placed between the memory stimuli list thus producing 4 different task blocks (neutral 0-back, NEU0; neutral 1-back, NEU1; negative 0-back, NEG0; negative 1-back, NEG1). Fig.1 shows the examples of stimuli presented in the experiment.

Fig.1. Examples of the task stimuli. Durations of each display are shown. Letter-fixation-picture-fixation constitutes one displaying cycle. The pictures were all "neutral" or "negative" within block (here we just showed the negative case).

AFNI (http://afni.nimh.nih.gov) was used for fMRI data analysis. Boxcar stimulus functions were convolved with an impulse response function [2] to generate the expected hemodynamic responses for regression analysis. Multiple regression coefficients (β-weights) for each of the 4 conditions were calculated. The β-weights of two regions of interests, the left DLPFC (BA9-46, only voxels with significant memory effect) and the amygdala (only voxels with significant emotion effect), were submitted to a 2 (PCE vs. control) × 2 (0-back vs. 1-back) × 2 (NEU vs. NEG) ANOVA.

Results The performance (accuracy & reaction time) of the PCE subjects did not significantly differ from that of the controls in the EMOTION (E), MEMORY (M) or E × M interaction effects (Fig.2). Significant E (negative pictures elicited higher BOLD signal) and M (1-back elicited higher BOLD signal) effects were observed respectively in the amygdala and left DLPFC in both groups. However, the E × M interaction pattern in the two GROUPs (G) were generally reversed. In the amygdala, higher memory load tend to lead to higher activation in the controls but lower activation in the PCE group. In the left DLPFC, the negative pictures decreased activation in the 0-back condition for the controls but increased 0-back activation in the PCE subjects. In addition, negative pictures did not affect the activation in the 1-back condition for the controls but decreased 1-back activation in the PCE group. The graphical comparison and statistics are shown in the Fig.3.

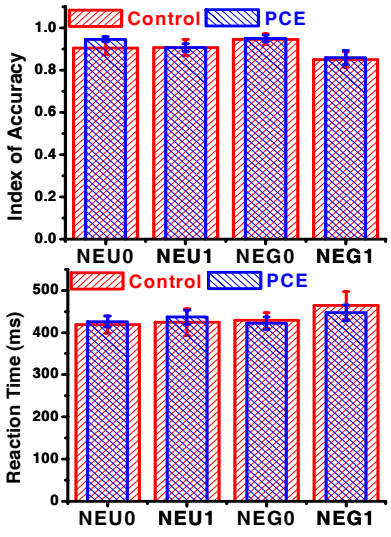

Fig.2. The accuracy (top) and reaction time (bottom) comparison between conditions and groups.

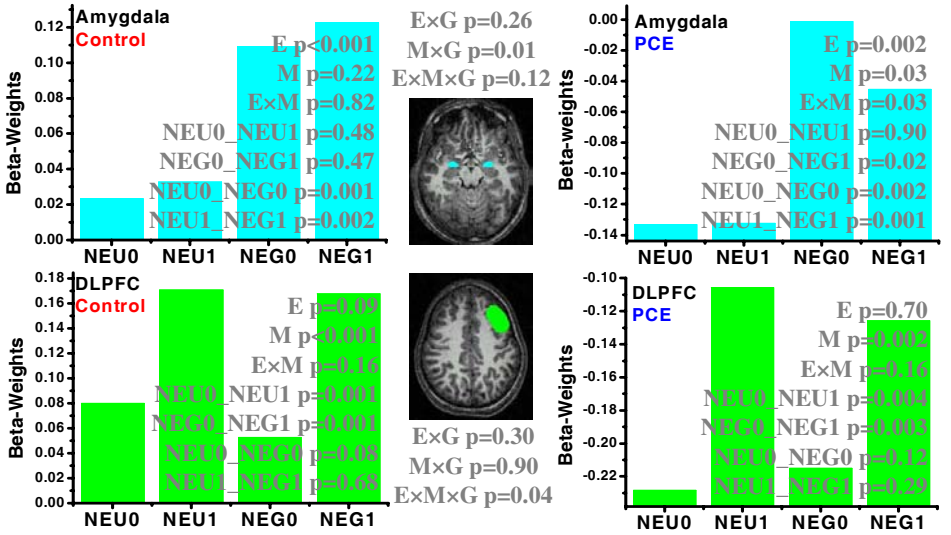

Fig.3. The β-weights comparison between conditions in the amygdala (cyan) and the left DLPFC (green). The statistical significance of the main effects, interactions, and the pair-wise comparison are shown as the gray numbers.

Conclusion The data reflect a counterbalance between the memory and emotion system [3] and that the attentional regulation may be impaired by the PCE. The emotion processing should be given more attention resource for negative pictures, but it was not in the PCE group when challenged by a concurrent memory task; the memory processing should be given more attentional resource for 1-back condition, but it was not also in the PCE group, due to the emotion distraction.

References [1] Mayes, L. 2002. Neurotoxicol Teratol. 24:385. [2] Cohen MS. 1997. Neuroimage. 6:93. [3] Drevets, WC. et al. 1998. Cogn Emot. 12:353.

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