

Effects of Prenatal Cocaine Exposure on Human Brain Structures

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Introduction

Brain structural outcomes in individuals exposed prenatally to cocaine have been reported previously [1]. However, findings from previous studies are limited and need to be replicated [1]. In the present study, an automated method was used to segment the entire brain into various cortical and sub-cortical regions of interest (ROIs). Effects of prenatal cocaine exposure (PCE) on the brain were examined as the volumetric differences between PCE and control participants in these ROIs. Thus, more detailed information about PCE effects on brain structures could be observed. In addition, possible gender difference in PCE effect on brain volume was also investigated. Such gender effect has not been reported in human samples.

Methods

Two participant groups (control: 11 males and 16 females, PCE: 23 males and 13 females) participated in this study. Participants in both groups were recruited after birth from the same hospital and are similar in demographic variables (e.g., race, age, education, and head circumference). For each participant, T₁-weighted images were obtained on a 3.0 Tesla Siemens Magnetom TRIO scanner with an MPRAGE sequence (TR = 2300 ms, TE = 3.02 ms, TI = 1100 ms, Flip Angle = 8°, voxel size = 1×1×1 mm³). FreeSurfer was used to automatically segment cortical and sub-cortical ROIs. Volumes of these ROIs were also calculated with FreeSurfer [2]. PASW Statistics (SPSS) 18 was used for statistical analysis.

Results

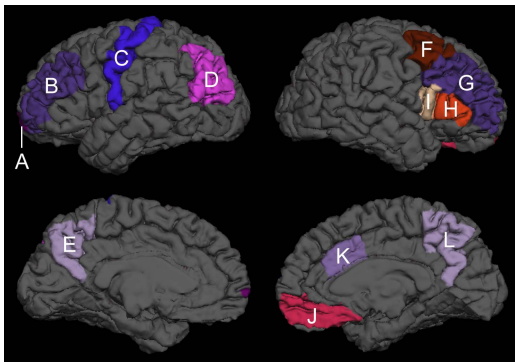


Figure 1. Cortical regions exhibiting reduced volume by PCE. See text for the details.

A 2 × 2 (group: control, PCE; gender: male, female) ANOVA showed that volumes of sub-cortical grey matter regions, including the caudate, putamen, pallidum, thalamus, amygdala, hippocampus and accumbens area in both hemispheres, were not significantly affected by PCE (no significant effect of group factor). In contrast, gross volumes of the left and right cerebral cortices were significantly reduced by PCE. The same ANOVA of the segmented cortical ROIs indicated that PCE exerted an adverse effect (volume reduction) on a few cortical regions. These regions are shown in Figure 1 (In the left hemisphere, A: Frontal Pole, B: Rostral Middle Frontal Gyrus, C: Precentral Gyrus, D: Inferior Parietal Lobule, E: Precuneus Cortex. In the right hemisphere, F: Caudal Middle Frontal Gyrus, G: Rostral Middle Frontal Gyrus, H: Pars Triangularis, I: Pars Opercularis, J: Medial Orbital Frontal Cortex, K: Caudal Anterior Cingulate Cortex, L: Precuneus Cortex).

In addition, a few cortical ROIs exhibited a significant group × gender interaction effect, indicating a gender difference in PCE effect on brain volume. These regions are shown in Figure 2 (In the left hemisphere, A: Supramarginal Gyrus, B: Inferior Parietal Lobule, C: Banks of Superior Temporal Sulcus. In the right hemisphere, D: Inferior Parietal Lobule, E: Superior Frontal Gyrus, F: Precuneus Cortex, G: Temporal Pole). A t-test between the control and PCE groups for each gender showed that all these regions were significantly affected by PCE in the female, but not in the male participants, except for the left supramarginal gyrus which demonstrated no significant PCE effect in both the female and male participants.

Discussion and Conclusion

Although the PCE and control groups were not generally different in head circumference and cognitive outcomes, the present study suggests that the left and right cerebral cortices are altered by prenatal cocaine exposure. More interestingly, the gender difference in PCE effect suggests that female may be more vulnerable to PCE than male. Thus, the gender factor should be considered in future studies of PCE effects on human brain structures and functions.

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References

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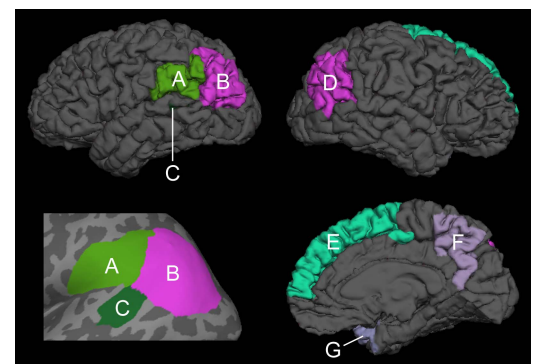


Figure 2. Cortical regions exhibiting a gender difference in PCE effect on brain volume. See text for the details. The same ROIs in the left hemisphere (upper left) are also shown on the cortical surface (lower left).