Nucleus Accumbens ROI based Functional Connectivity of the Methamphetamine Users

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Introduction

The reward system involving the nucleus accumbens (NAcc) is one of the main regions related to drug addiction (Baler and Volkow, 2006). In this study, therefore, we investigated whether there is a difference of functional connectivity started from NAcc between drug users and normal subjects.

Subjects and Methods

To investigate the differences of the RSN between drug-addicted and normal subjects, 26 methamphetamine abuser (MA) (4 females; age =39.3±8.6) and 26 health comparison subjects (7 females; age=39.5 ±9.5) were recruited. All participants were requested to be eye-closed and resting state during 6 minutes scanning. For the preprocessing and connectivity analysis, we use the statistical parametric mapping toolbox (SPM5). To take into account the magnetization equilibrium, the first 10 images were excluded. The remaining 155 EPI images were used for the spatial preprocessing . We applied the following processes; realigning, coregistering, normalizing and smoothing. In addition, time series of all voxels within the gray matter after smoothing were quadratic detrended and band-pass filtered (0.01-0.08 Hz).
Then, we analyzed the functional connectivity based on the NAcc-ROIs by calculating Pearson's correlation coefficients of the time series. Finally, the differences of functional connectivity were investigated by performing the two sample *t*-test between the patient group and the normal controls.

Results

Figure 1 (A) shows negative functional connectivity from the NAcc in health controls. Both left and right NAcc have anti-correlated connectivity in the left hippocampus (amygdala) and left inferior frontal lobe. This functional connectivity from the NAcc was not significantly found in the drug abusers. The two-sample *t*-test (uncorr. p<0.001, cluster>50) showed that MA have significantly increased correlation between NAcc and left inferior frontal lobe.

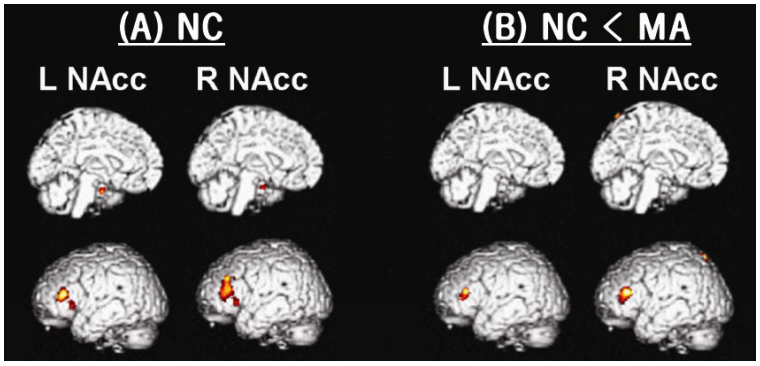

Figure 1. The functional connectivity maps: (A) negative functional connectivity from the NAcc in health controls; (B) two-sample *t*-test showing that MAs have significantly increased correlation between NAcc and left inferior frontal lobe .

Table I. Connectivities from the seed-ROIs by comparing between normal control (NC) and methamphetamine abuser (MA) using two-sample *t*-tests (* : uncorr. p<0.005, ** : uncorr. p<0.001). Where, the positive *t*-values indicate NC>MA, while negative *t*-values indicate NC<MA.

		NC - MA						
		Talairach [mm]						
Seed-ROI	Anatomy regions	BA	*x*	*y*	*z*	t	z	Cluster
Lt. NAcc	Lt. Inferior Frontal Gyrus**	46	-51	30	17	-4.09	-3.78	120
Rt. NAcc	Lt. Middle Frontal Gyrus**	46	-48	32	15	-4.49	-4.09	275
PCC	Rt. Lingual Gyrus*	17	10	-93	0	4.02	3.73	317
Lt. Amyg	Lt. Superior Frontal Gyrus**	-	-22	56	-13	4.65	4.21	74
	Lt. Middle Occipital Gyrus**	18	-32	-91	3	4.07	3.77	132
Rt. Amyg	Rt. Caudate**	-	12	1	20	4.07	3.77	94

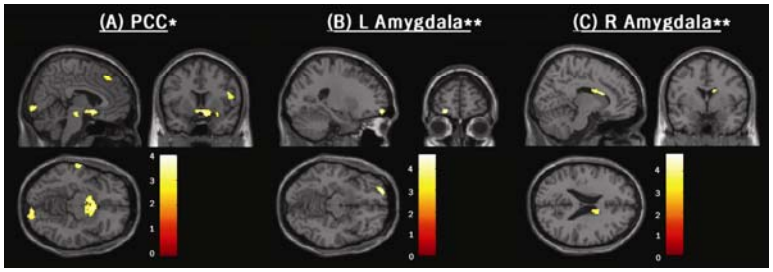

Figure 2. Two-sample *t*-test (* : uncorr. p<0.005, ** : uncorr. p<0.001) projected into the single subject T_1 template. These maps show connectivity differences between NC and MA based on the seed-ROI correlation analysis started from (A) PCC, (B) left amygdala, and (C) right amygdala. Where, the color bars represent *t*-values.

For the MAs, we found that the functional connectivity started from posterior cingulate cortex (PCC) have decreased compared with the control groups. In addition, connectivity between left (right) amygdala and left superior frontal gyrus (right caudate) have significantly decreased in MAs (Figure 2).

Conclusion and Discussion

We found the significant alteration of the functional connectivity in the methamphetamine abusers (MAs) who had been abstinent for an average of nearly 2 years and for a minimum of 7 months. The results of the connectivity analysis based on seed-ROIs can advance our understandings in the reward circuits of drug abusers.

References

[1] Baler, R.D.,Volkow, N.D., 2006. Drug addiction : the neurobiology of disrupted self-control. Trends Mol. Med. 12, 559-566.