

Neural Correlates of Deception

著者	Abe N., Suzuki M., Tsukiura T., Mori E., Yamaguchi K., Itoh M., Fujii T.
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Abe N. *, Suzuki M. **, Tsukiura T. ***, Mori E. *, Yamaguchi K. **, Itoh M. **, and Fujii T. *

**Department of Behavioral Neurology and Cognitive Neuroscience,
Tohoku University Graduate School of Medicine*

***Division of Cyclotron Nuclear Medicine, Cyclotron and Radioisotope Center,
Tohoku University*

****Cognitive and Behavioral Sciences Group, Neuroscience Research Institute, National Institute of Advanced
Industrial Science and Technology (AIST)*

So far, several neuroimaging studies using functional magnetic resonance imaging (fMRI) on deception have reported the involvement of the prefrontal cortex (PFC)¹⁻⁶, which has an indispensable role for executive function. Activation of the anterior cingulate cortex (ACC), which has been regarded as a substantial area for conflict monitoring, has also often been reported^{4,6}. Although these previous studies indicate crucial roles of the PFC and ACC in human deception, the specific role of each region during deception is still unclear.

In the present PET study, we examined brain activity focusing on two types of deception for past episodes: deception for experienced events (pretending not to know) and deception for un-experienced events (pretending to know). During two deception conditions and two truth conditions, subjects were presented with old photographs related to experienced events in one and new photographs related to un-experienced events in the other. We expected the PFC to be active during the two deception conditions compared to the two truth conditions, because the former necessitate executive functions. In contrast, we anticipated that the ACC would be active only during the deception condition in which subjects were asked to tell lies in response to the old photographs (pretending not to know). The old photographs, compared with the new ones, would elicit stronger conflict for the inhibition of true answers during deception because the memory of experienced events would be vividly recovered by recognition of the old photographs, but not by the new photographs.

Before PET scanning, subjects experienced 20 real-world events. During PET,

they were presented with either old photographs related to experienced events or new photographs related to un-experienced events and were instructed to tell either truths or lies orally in four conditions: (1) a Truth-Old (TO) task, in which they were instructed to tell truths about experienced events, (2) a Lie-Old (LO) task, in which they had to tell lies about experienced events, (3) a Truth-New (TN) task, in which they had to tell truths about un-experienced events, and (4) a Lie-New (LN) task, in which they had to tell lies about un-experienced events.

To identify the neural correlates of deception, the functional imaging data were first analyzed for the main effect of deception [(LO–TO) + (LN–TN)]. This analysis revealed significant activations in the left middle frontal gyrus (BA 10/46; the most anterior part of the dorsolateral PFC), right inferior frontal gyrus (BA 45; ventrolateral PFC), right ACC (BA 24/32), and right medial prefrontal cortex (BA 9; medial PFC). Table 1 summarizes these data for anatomical structures and Brodmann’s area, MNI coordinates, Z-values, and cluster size of peak activations. Second, to examine the influence of the familiarity of stimuli on regional cerebral blood flows (rCBFs) in each activated region and whether or not an interaction occurred, the rCBF values measured at each maximum were analyzed using two-way ANOVA with the response to stimuli (Truth, Lie) and the familiarity of stimuli (Old, New) as factors. The results are illustrated in Fig. 1. Results of the ANOVA for the left dorsolateral PFC showed a significant main effect of the “Lie” [$F(1, 13) = 23.470, p < 0.001$], but showed neither a main effect of the familiarity of stimuli [$F(1, 13) = 0.172, p = 0.685, ns$] nor an interaction between the two factors [$F(1, 13) = 0.173, p = 0.684, ns$]. ANOVA for the right ventrolateral PFC yielded similar results: a significant main effect of the “Lie” [$F(1, 13) = 24.857, p < 0.001$], without a main effect of the familiarity of stimuli [$F(1, 13) = 1.879, p = 0.194, ns$] or an interaction [$F(1, 13) = 1.087, p = 0.316, ns$]. Results for the right ACC showed a significant main effect of the “Lie” [$F(1, 13) = 20.895, p < 0.001$], without a main effect of the familiarity of stimuli [$F(1, 13) = 1.301, p = 0.275, ns$]. In this region, interaction between the two factors was significant [$F(1, 13) = 14.828, p < 0.005$]. Post-hoc test (Scheffe) revealed that in the right ACC the effect of “Lie” was significant between the LO tasks and TO tasks (LO > TO, $p < 0.001$), but was not significant between the LN tasks and TN tasks ($p = 0.756, ns$), and the effect of “Old” was significant between the LO tasks and LN tasks (LO > LN, $p < 0.05$), but not between the TO tasks and TN tasks ($p = 0.631, ns$). Results for the right medial PFC showed a significant main effect of “Lie” [$F(1, 13) = 16.336, p < 0.005$] and a main effect of “Old” [$F(1, 13) = 18.692, p < 0.001$], without an interaction [$F(1, 13) = 0.404, p = 0.536,$

ns].

Our results demonstrate the possibility of dissociable roles of the prefrontal and anterior cingulate cortices in human deception. The prefrontal cortices, including the dorsolateral PFC, ventrolateral PFC, and medial PFC, were associated with giving deceptive responses regardless of the familiarity of the stimuli, although the precise role of each prefrontal cortex needs to be clarified in future studies. The ACC was associated only with giving deceptive responses to old (experienced) stimuli. When individuals have to give deceptive responses to experienced events, the ACC probably detects strong cognitive conflict and may have a specific role in the inhibition of memories about experienced events.

There are limitations of the present study that should be borne in mind for future studies into the brain mechanisms underlying deception. Although we employed real-world event tasks, simulated deception in laboratory experiments cannot be viewed as being the same as deception in real life. In particular, tasks dealing with deception are often not emotional enough to allow one to investigate the effect of emotion during deception. A further refined experimental design is needed to deal with this problem and to enable us to understand the complex biological mechanisms of human social interactions.

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Table 1. Brain regions showing activation in a main effect of deception.

Region (Brodmann's Area)	MNI coordinates			Z value	Cluster size
	x	y	z		
Lt middle frontal gyrus (10/46)	-26	54	14	4.39	51
Rt inferior frontal gyrus (45)	52	18	12	4.07	22
Rt anterior cingulate cortex (24/32)	10	16	32	4.16	34
Rt medial prefrontal cortex (9)	10	56	24	4.04	26

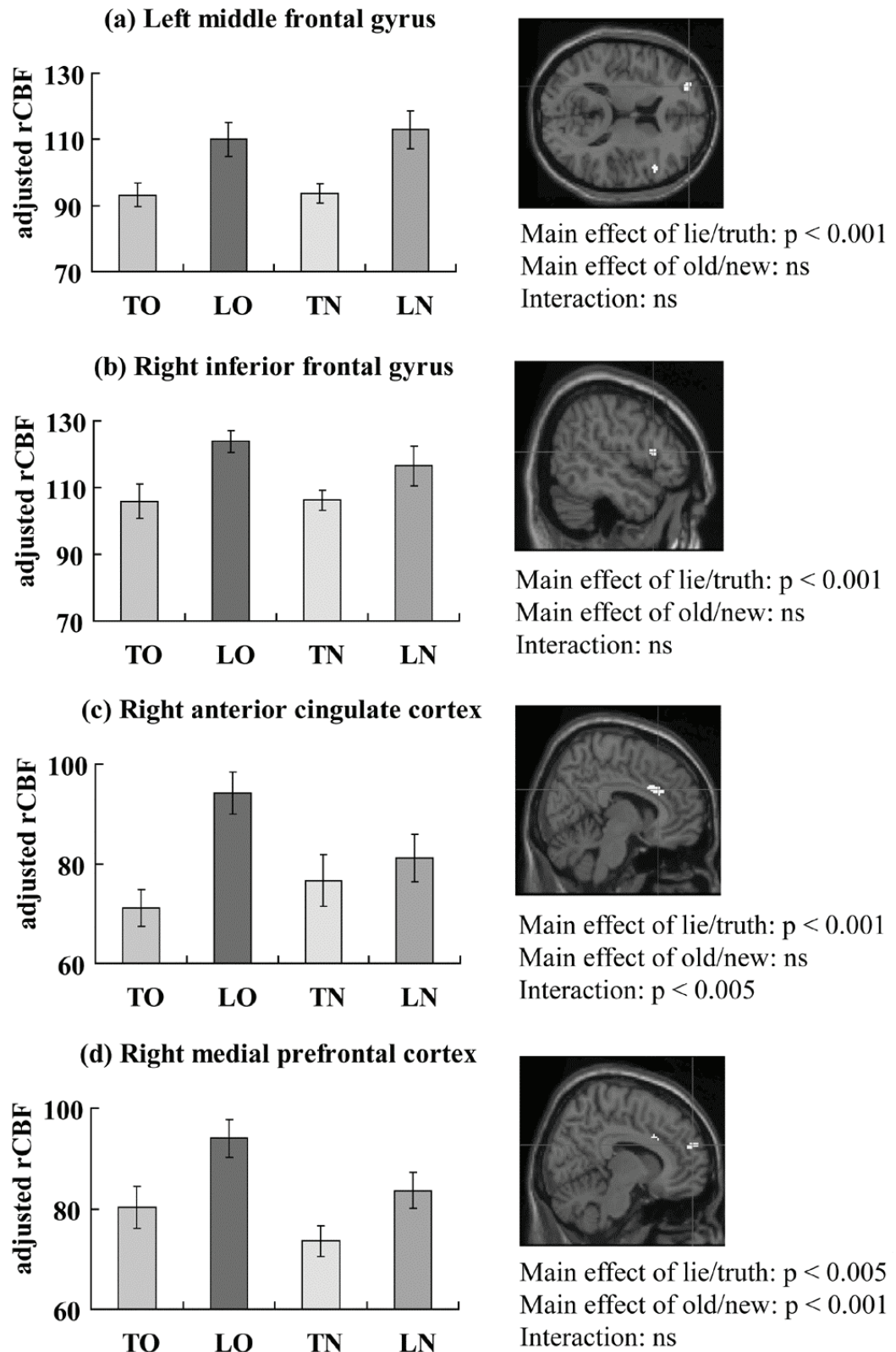


Fig. 1. Four regions showing a significant main effect of deception. The activations are superimposed onto MRIs of Montreal Neurological Institute (MNI) templates.