Neural correlates of socio-cognitive processes in deception: Meta-Analysis of Functional Neuroimaging Studies of Lying

En-Syuan Huang [1] , Ying-Chen Liu [2] , Chih-Mao Huang [2,3,4]

1.Institute of Neuroscience, National Yang-Ming University, Taiwan
2. Department of Biological Science and Technology, National Chiao-Tung University, Taiwan
3.Center for Intelligent Drug Systems and Smart Bio-devices (IDS 2 B), National Chiao Tung University, Taiwan
4.Cognitive Neuroscience Laboratory, Institute of Linguistics, Academia Sinica, Taiwan;

INTRODUCTION

1. Deception usually refers to the behavior to falsify others by conveying the wrong information or concealing the truth and is commonly observed in the real world.
2. Previous functional neuroimaging studies suggest that information processing involved in deception relies on neural substrates of socio-cognitive systems for executive function, decision-making, theory of mind, and social cognition.
3. A large number of studies have explored neural mechanisms of executive function involved in deception. On the other hand, more and more studies investigating deception have sought for the other mechanisms in socio-cognitive systems.

In the present study, we investigate the common and distinct neural correlates of deception, honest actions, social lying and nonsocial lying conditions by performing a quantitative meta-analysis of functional magnetic resonance (fMRI) studies using activation likelihood estimation (ALE) approach. The fMRI data that have been analyzed in this study were acquired from PubMed and were filtered for keywords such as, deception, lie and honest.

METHODS AND MATERIALS1

Literature search

The functional neuroimaging studies from 44 published works which were collected from PubMed were used. The coordinate of the activated regions in response to the deception condition or the honest condition were reported in those studies.

Data categorization

After collecting the required coordinate data, the coordinates were transferred into the consistent one (Montreal Neurological Institute coordinate, MNI). And then, we divided the data into two conditions: lying condition and honest condition.

Subsequently, the lying condition would be divided into two subtypes according to the paradigm they utilized in those investigations: 1) Social interactive lying, for example, the participants could give a spontaneous lie when allocating the financial gain to the counterpart in order to get more monetary reward (Sun et al., 2017). 2) Non-social interactive lying, such as the study used Yes/No questions that the participants were instructed to lie or to be honest (Ofen et al., 2016). A total of 4 conditions were performed in the study: lying, honest, social lying and non-social lying conditions.

Meta-analysis

ALE approach was performed to conduct a group-level meta-analysis and analyze the coordinate data across different experimental conditions. The False Discovery Rate, pN (FDR pN) p< 0.01 was used for our significant threshold with the minimum cluster size 200 mm^3.

RESULTS

Table 1 The significant cluster of Honest condition, FDR pN p< 0.01, minimum cluster size 200 mm^3.

	Volume (mm^3)	Weighted Center (x,y,z)			Left/ Right	BA	Region
Honest	616	42.77	-4.09	3.62	R	13	insula

Table 2 The significant clusters of Lie condition , FDR pN p< 0.01, minimum cluster size 200 mm^3.

	Volume (mm^3)	Weighted Center (x,y,z)			Left/ Right	BA	Region
Lie	10472	-1.26	24.43	48.81	L/ R	6, 8	Superior Frontal Gyrus/ Medial Frontal Gyrus
	4168	-38.3	14.19	41.87	L	9	Precentral Gyrus
	840	-23.66	59.27	9.46	L	10	Middle Frontal Gyrus
	520	10.67	55.76	-4.31	R	10	Middle Frontal Gyrus
	7464	-40.38	20.95	-3.26	L	45, 47	Inferior Frontal Gyrus
	6584	43.97	20.02	-3.14	R	45,47	Insula/ Inferior Frontal Gyrus
	4144	-48.62	-50.64	39.22	L	40	Supramarginal Gyrus
	1528	52.44	-46.41	37.81	R	40	Inferior Parietal Lobule
	1160	14.96	-6.75	18.66	R		Caudate Body

Table 3 The significant clusters of Social condition , FDR pN p< 0.01, minimum cluster size 200 mm^3.

	Volume (mm^3)	Weighted Center (x,y,z)			Left/ Right	BA	Region
Social	632	-39.63	19.62	-4.24	L		insula
	392	45.09	-4.88	4.46	R	13	insula
	496	38.65	21.47	-15.94	R	47	Inferior Frontal Gyrus
	352	6.86	5.01	42.37	R	24	Cingulate Gyrus
	344	-51.22	-52.36	49.17	L	40	Inferior Parietal Lobule
	312	51.4	-46.41	39.73	R	40	Inferior Parietal Lobule
	264	-12.65	-46.46	59.34	L	7	Precuneus

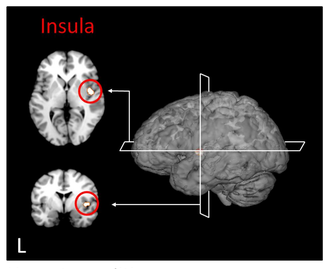
Table 4 The significant clusters of Nonsocial condition , FDR pN p< 0.01, minimum cluster size 200 mm^3.

	Volume (mm^3)	Weighted Center (x,y,z)			Left/ Right	BA	Region
Nonsocial	11520	-0.69	24.66	49.09	L/ R	6	Superior Frontal Gyrus
	3688	-40.6	11.08	37.78	L	9, 6	Precentral Gyrus/ Inferior Frontal Gyrus
	1168	47.31	21.74	34.01	R	9	Precentral Gyrus/ Middle Frontal Gyrus
	336	-38.85	51.48	1.36	L	10	Middle Frontal Gyrus
	288	9.98	54.74	-4.38	R	10	Middle Frontal Gyrus
	7576	-41.63	20.7	-2.32	L	13, 45,47	Insula/ Frontal Gyrus
	4000	39.69	22.31	-3.06	R	45,47	Insula/ Inferior Frontal Gyrus
	232	-33.72	-5.8	22.61	L	13	insula
	4928	-47.6	-50.29	38.96	L	40	Supramarginal Gyrus
	448	39.31	-51.84	46.35	R	40	Inferior Parietal Lobule
	208	-31.38	-68.69	29.62	L	39	Middle Temporal Gyrus

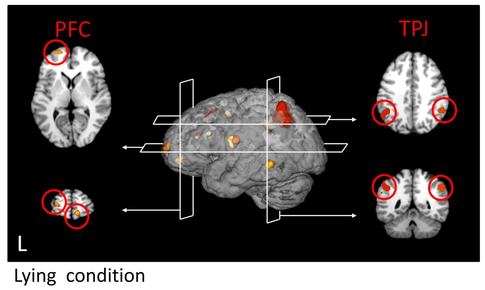
RESULTS

Honest & Lie

The meta-analytic results showed greater activation in insula for honest actions whereas greater activation in premotor cortex, dorsolateral prefrontal cortex (DLPFC), inferior prefrontal cortex, and inferior parietal lobule for processing deception, probably reflecting cognitive efforts for reading intentions of others, conflict monitoring and resolution, and language comprehension.



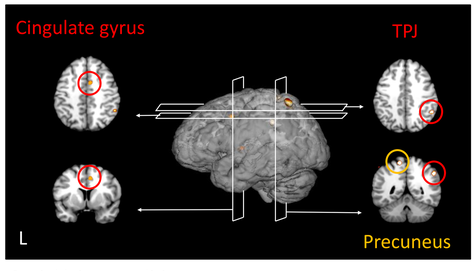
Honest condition



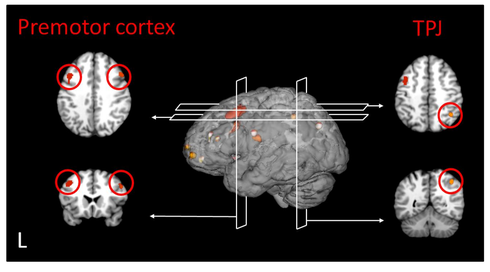
Lying condition

Social lie & Non-social lie

When deception studies were divided into social and non-social conditions, increased activation in precuneus and posterior cingulate cortex was found to be greater in social than non-social deception, suggesting the integrative nature of socio-cognitive information processing in the social setting.



Social lying condition



Non-Social lying condition

DISCUSSION

Some previous studies mentioned that the deceiving behavior would activate the right temporoparietal junction (rTPJ) which is involved in social cognitive process. However, when the lying studies were divided into social and non-social conditions, the TPJ (BA40) was activated in both conditions, which was not consistent with the previous study (Lisofsky et al., 2014). This might be due to the diversity of the functions of the TPJ, such as one's own perspective shifting (Corradi-Dell'Acqua et al., 2008), judgment of others' intention, and inferring others' belief (Firth and Firth, 2006). And the activation of TPJ might be based on the task the studies used, but not only "the interaction with others" itself.

CONCLUSION

Our findings are congruent with the notion that the process of deception is supported by distributed fronto-parietal networks for integrating socio-cognitive information processing and may be influenced by social interaction.

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