The Study of Deception and Truth Using Functional Magnetic Resonance Imaging (fMRI)

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Introduction

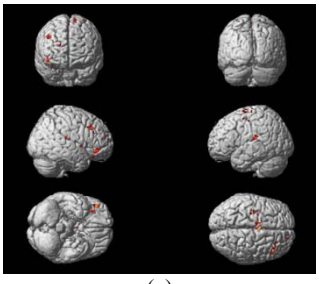
The functional magnetic resonance imaging (fMRI) based on blood oxygen level dependent (BOLD) has been used to measure neuronal activities and to map human brain functions [1]. Published fMRI articles demonstrated increased prefrontal activity in lie telling compared to truth telling [2, 3]. Currently, polygraph is a principal physiological method for lie detection. However, its wide-range accuracy is approximately 50-99% range, whereas, the accuracy of deceptive detection by direct measurement of brain activity employing fMRI is approximately 90% [4]. The brain-imaging-based deceptive detection could be an additional scientific evidence for fact determining in a judicial proceeding [4]. Set of questions also affects the accuracy of deceptive detection [4]. The Peak of Tension Test (POT) along with polygraphy has been used to investigate the information associated with an incident and to evaluate the individual's pattern of responses to the incident involvement [5]. POT is able to specifically provoke deceptions about criminal details and provides reproducible results [5]. To date, no study has applied POT along with fMRI for deceptive detection. The purposes of this research study were to develop a new method to identify deceptions using the POT in fMRI, and to compare the differences in brain activities between deception and truth telling in different types of questions.

Materials and Methods

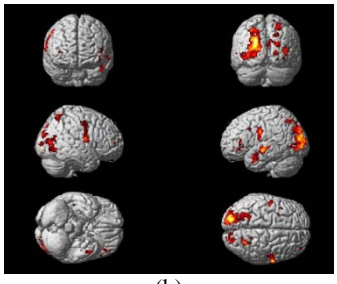
Blood oxygenation level-dependent (BOLD) fMRI were conducted on 20 healthy volunteers (age = 24.30 ± 3.08 years) using a 1.5-Tesla (Achieva, Philips, Netherland) MRI scanner. The study procedures were approved by institutional review board and informed consent forms were read and signed by the volunteers. Before the fMRI scanning, participants were told to pick two of seven valuable objects, and then to deny the incident during MRI scanning. The fMRI protocol was a block design with 5 tasks (randomly presented 6 times per task): deception with "no" answer (Deceptive No), truth telling with "no" answer (Truthful No), deception with "yes" answer (Deceptive Yes), truth telling with "yes" answer (Truthful Yes), and motor only. To answer "yes", the participants needed to respond with no movement, while to answer "no", they needed to tap their right index fingers. Each task block took 21 seconds for resting and 21 seconds for the task. The total scan time was 21 minutes. Gradient-recalled echo-planar imaging sequence was used (TE=50ms, TR=3s, FOV=240mm, in-plane matrix=128×128, 27 different slice locations, slice thickness=4mm). Statistical Parametric Mapping (SPM2) software package was utilized to analyze the image data. At the first level statistical analysis, individual participant's data were analyzed in order to compare functional BOLD responses of types of question (POT > Relevant questions (R) and R > POT) and deceptive-truthful responses (truth > deception and deception > truth). Then, at the second level statistical group analyses (random effect analyses), one-sample t-test module in SPM2 was used to analyze the contrast results from the first level analyses. A statistical threshold at uncorrected $p < 0.01$ (4 voxels extent) was applied to get all results.

Results

In POT > R group analysis, at $p<0.01$, there were increased BOLD responses in right inferior, middle and superior frontal gyri (Figure 1 (a)). However, in R > POT group analysis, at $p<0.01$, there were increased BOLD responses in left inferior frontal gyrus, middle temporal gyrus, and bilateral occipital lobules (Figure 1 (b)). Figure 2 (a) and (b) show differences in brain activations of deception > truth and truth > deception responses respectively. According to deception compared with truth telling, there were BOLD responses at left inferior and middle frontal gyri, and left middle temporal gyrus.

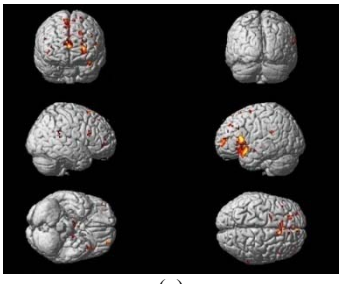


(a)

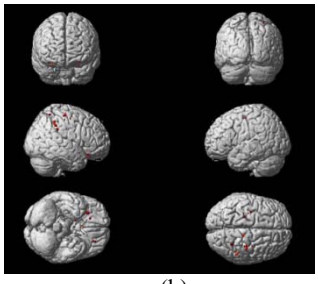


(b)

Figure 1 (a) and **(b).** Maps of brain activations of **(a)** peak of tension test > relevant questions (POT > R) and **(b)** relevant questions > peak of tension test (R > POT) responses ($p<0.01$, N=20).



(a)



(b)

Figure 2 (a) and **(b).** Maps of brain activations of **(a)** deception > truth and **(b)** truth > deception responses ($p<0.01$, N=20).

Discussion and Conclusion

In the POT > R study, there was brain activations on right inferior frontal gyrus, a part of VLPFC. In contrast to the POT > R study, in the R > POT study, there was prominent activation on left inferior frontal gyrus. The activations on inferior and middle frontal gyri could differentiate deceptive from truthful responses (deception > truth) using this study's paradigm. The knowledge and techniques used in polygraph were applied in our deceptive detection fMRI study, using POT and relevant questions. The procedure could successfully identify and separate brain activations according to various deceptive and truthful responses. The strength of this procedure is that the data analysis can be conducted objectively and systematically, reducing the chances of biasness. However, it is a great challenge to apply this new technology to be a real world tool to detect deceptions in the near future.

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