



# **Cerebral responses to vocal attractiveness and auditory hallucinations in schizophrenia: An fMRI study for understanding social cognitive function**



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# Background

Auditory hallucinations and thought disorders are the main symptoms of schizophrenia, and these symptoms profoundly affect the neural basis of social communications as well as behavior.

Greeting conversations are essential tools for communicating socially with family, friends, and community.

- Attractiveness is one of the favorable behaviors associated with social communication (Kampe et al., 2001; Winston et al., 2007).
- The roles of **the inferior frontal gyrus (IFG) and superior temporal gyrus (STG)** are essential for perceiving auditory attractiveness (Bestelmeyer et al., 2012).
- A recent meta-analysis:  
Schizophrenia patients with auditory hallucinations had significantly **increased activity in IFG-STG areas** involved in speech generation and speech perception (Jardri 2011).

However, to our knowledge, no study has ever investigated the cerebral response to auditory attractiveness in schizophrenia.

# Objective

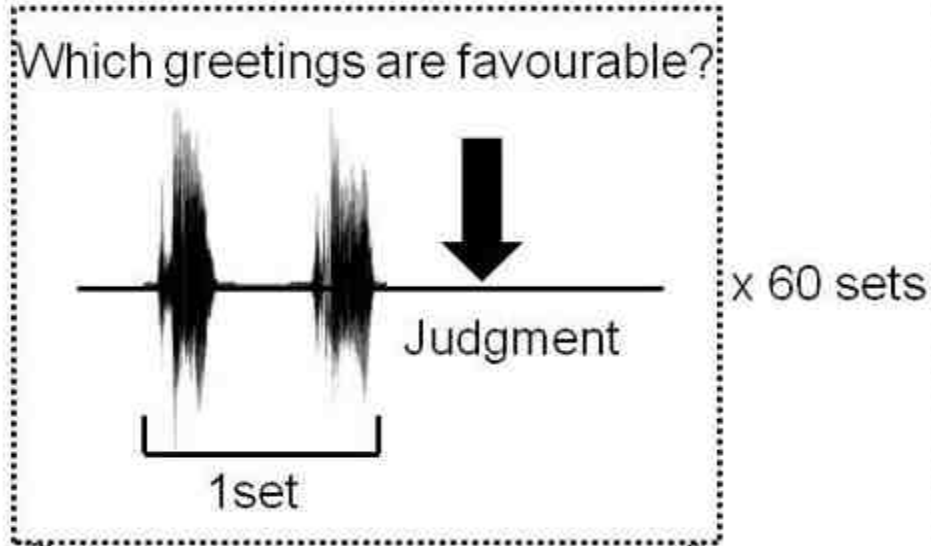
The aim of our research is to clarify the cerebral response to auditory attractiveness when patients with schizophrenia are listening to greetings.

# Methods

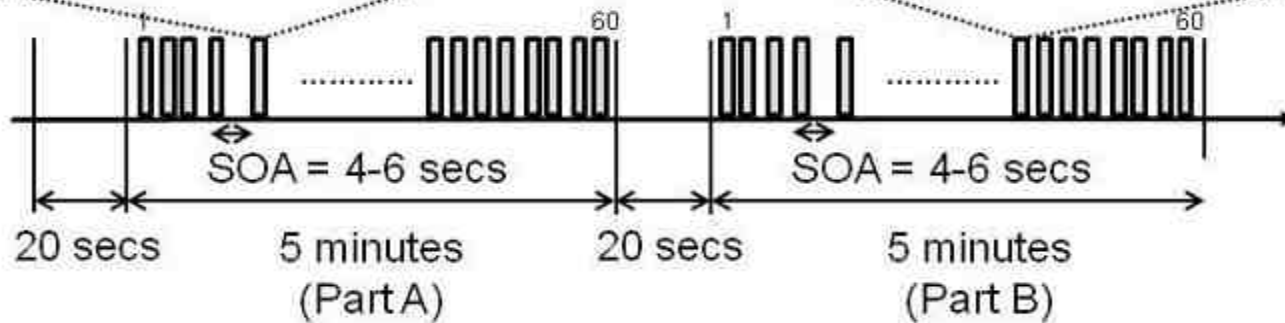
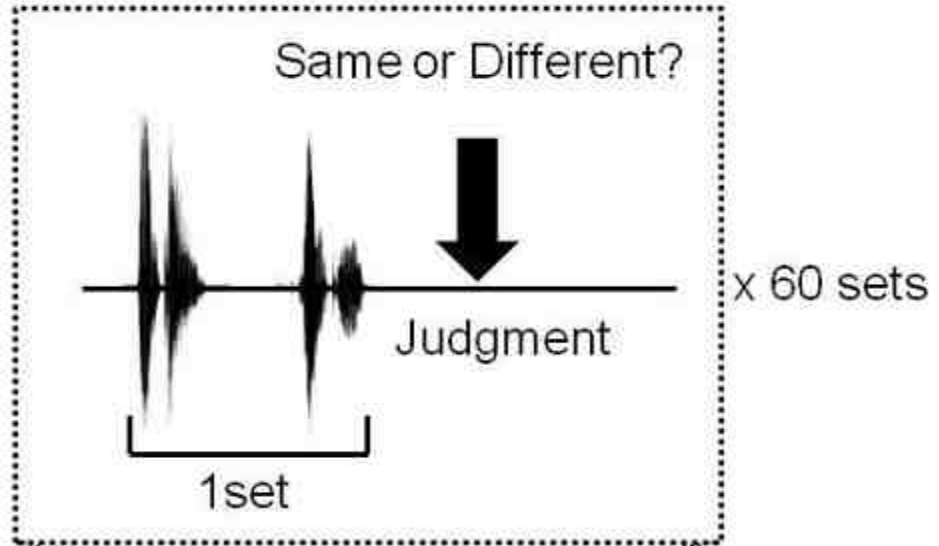
(Mean $\pm$ SD)	Controls	Patients
Subjects	18	18
(M/F)	9/9	8/10
Age	35.5 $\pm$ 8.6 yrs	35.7 $\pm$ 8.4 yrs
Illness duration		12.3 $\pm$ 8.0 yrs
Dose		4.7 $\pm$ 2.2 mg (Risperidone Eq)
Education	13.0 $\pm$ 1.0 yrs	13.3 $\pm$ 1.3 yrs
PANSS		
positive		15.1 $\pm$ 6.4
negative		20.7 $\pm$ 6.2
general psychopathology		32.3 $\pm$ 7.9

# FMRI procedure

## Favorability Judgment Task (FJT)



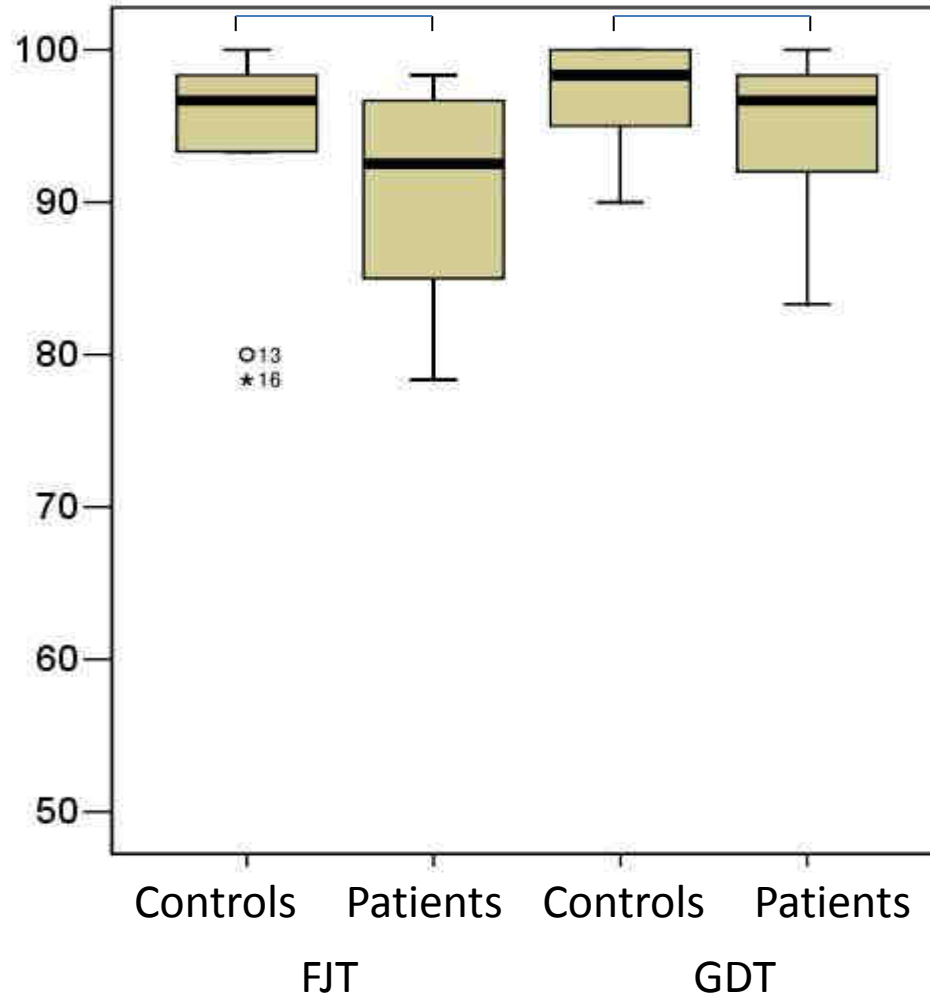
## Gender Discrimination Task (GDT)



MRI acquisition: GE scanner (1.5T), TE/TR 50/2500 msec, 264 EPI sequences, slice thickness 6mm, Matrix: 64 X 64, FOV: 24 x 24  
Data analysis was performed with SPM8. For cerebral activation, ANOVA was calculated using the factors of subjects' group and fMRI task (FJT/GDT).

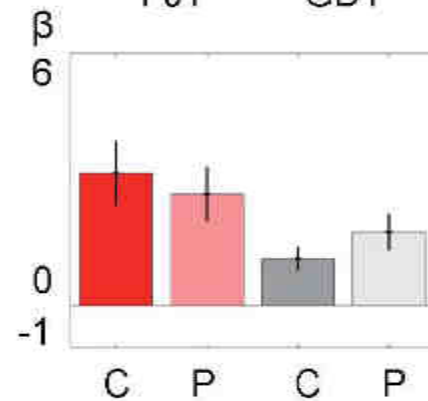
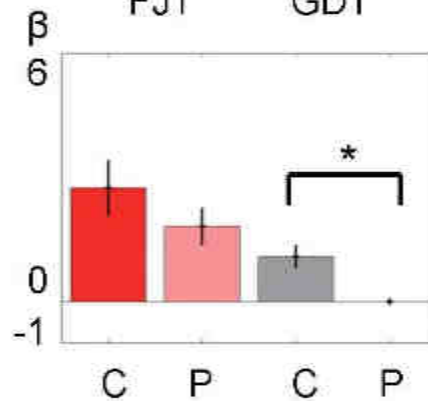
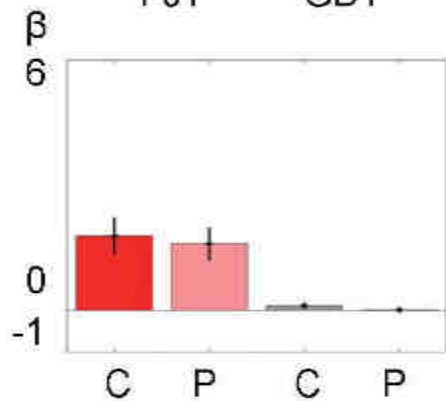
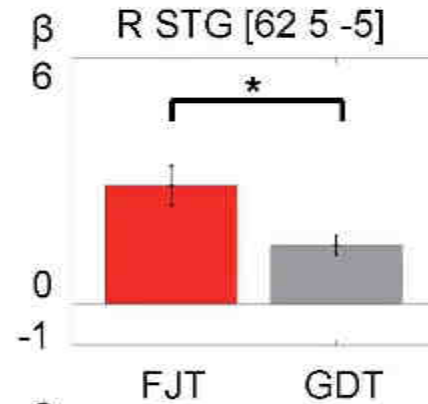
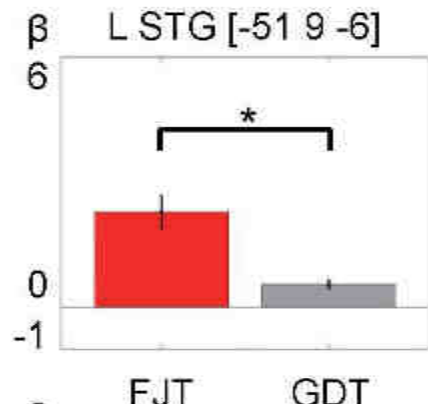
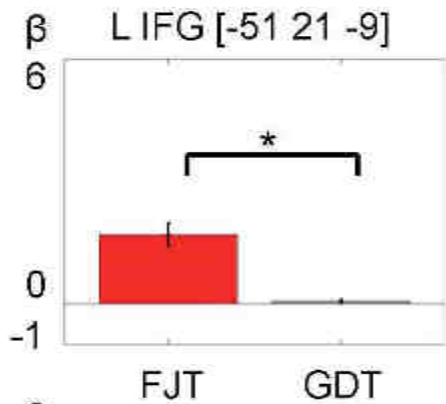
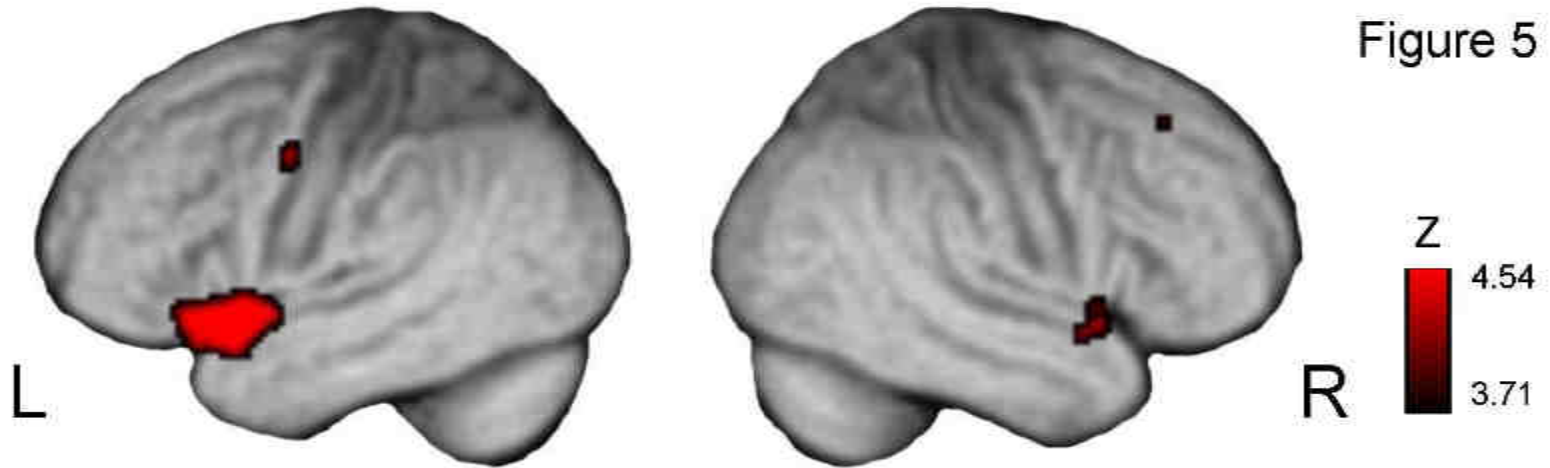
# Results

Accuracy (%)



# Main Effect of Task (FJT/GDT)

Figure 5

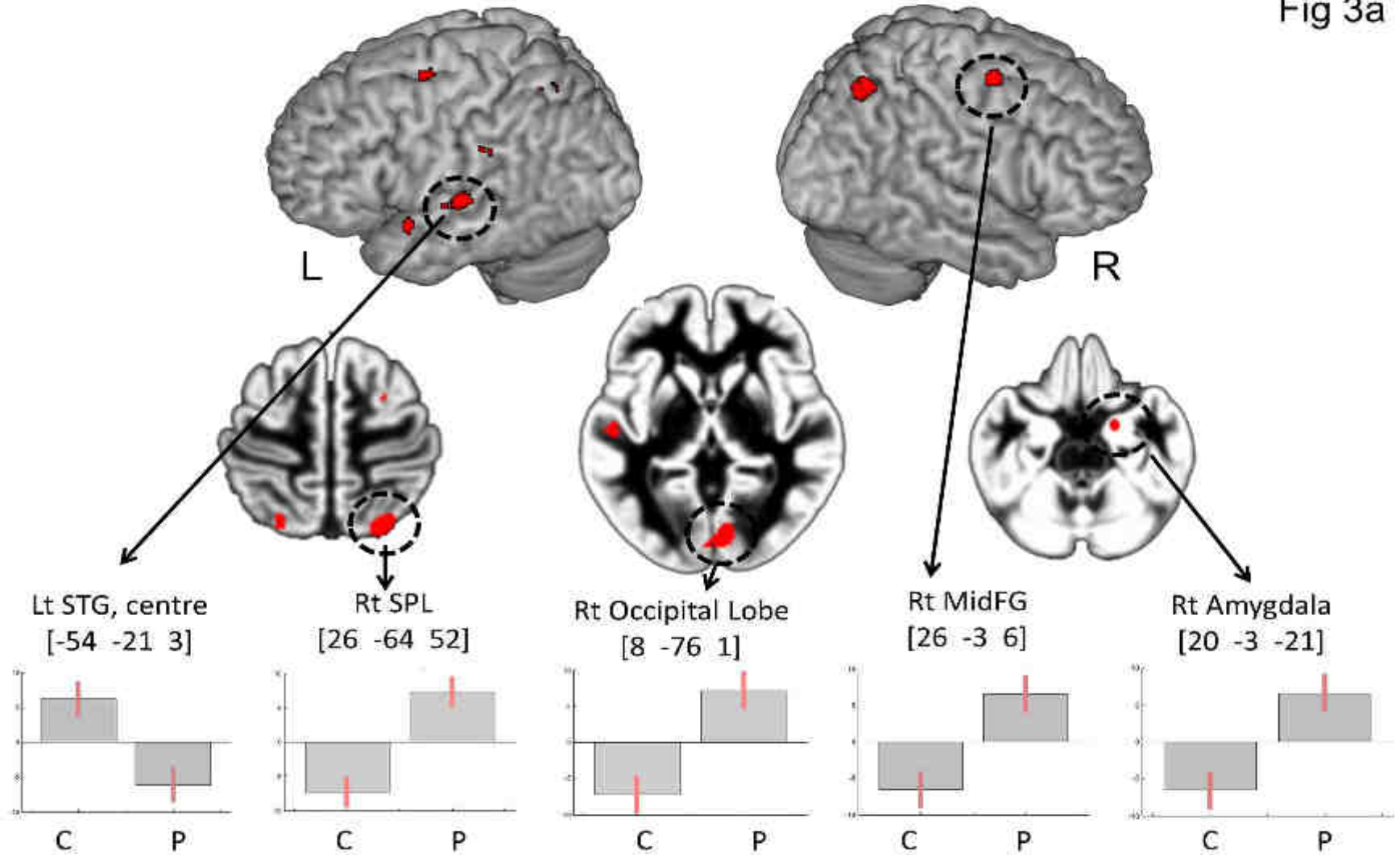


\*  $P < 0.05$



# Main Effect of Group (Controls/Schizophrenia)

Fig 3a

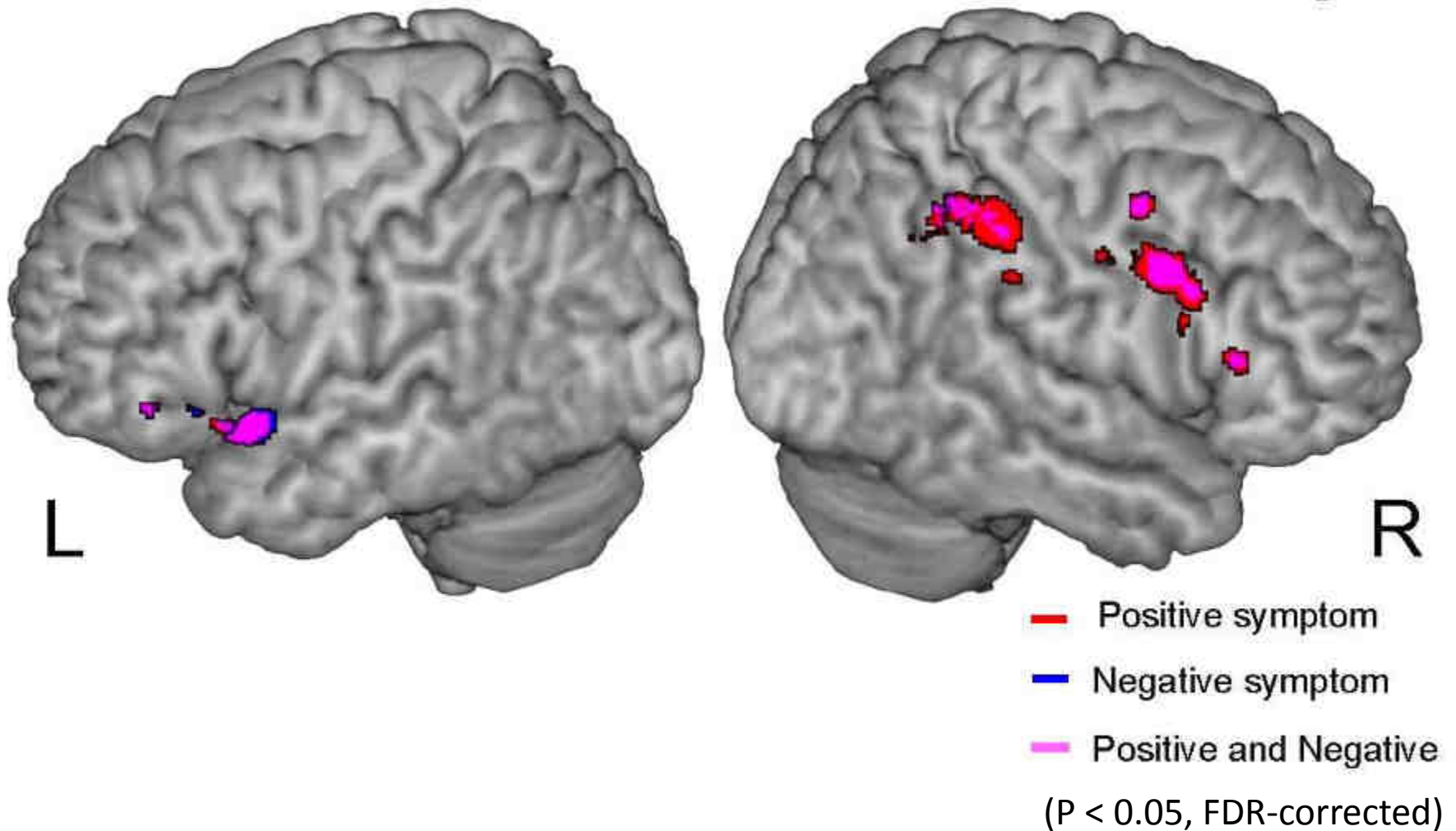


( $P < 0.05$ , FDR-corrected)

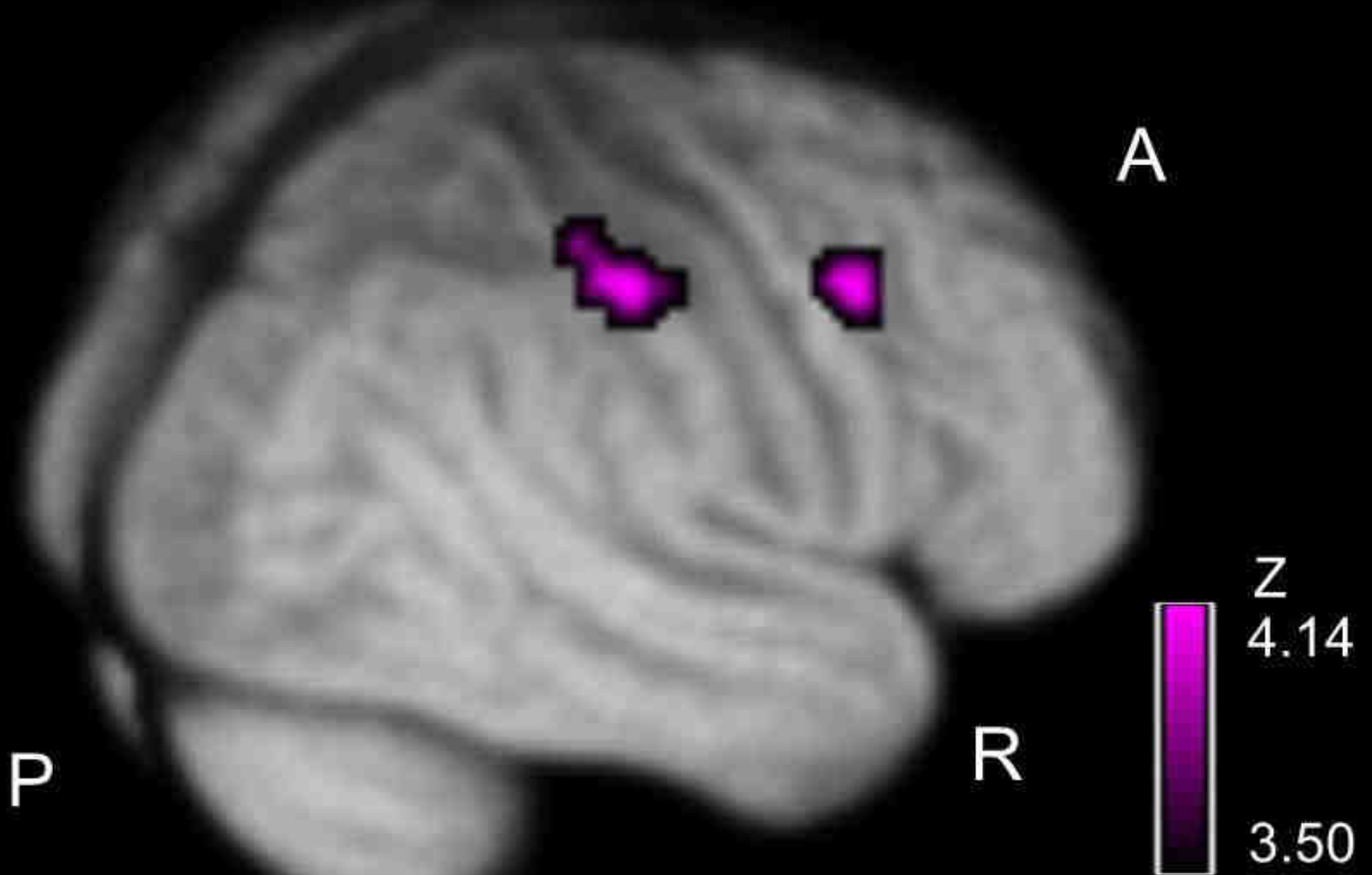
Koeda et al. (2013, *Frontiers in Human Neuroscience*)

# Correlation between cerebral activation under FJT>GDT contrast and psychiatric symptoms

Figure 6

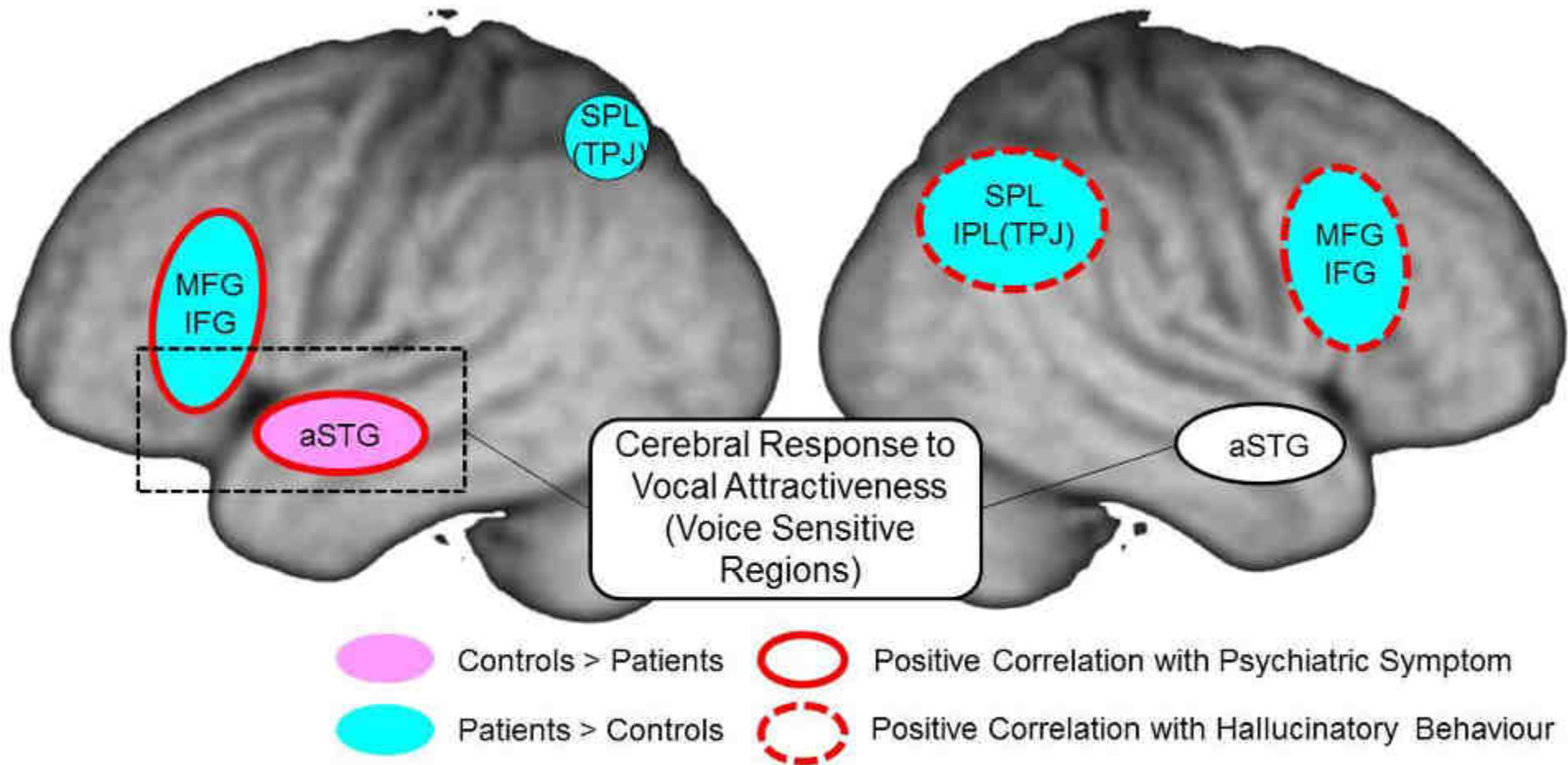


# Correlation between favorable activation and severity of auditory hallucination



Koeda et al. (2013, *Frontiers in Human Neuroscience*)


# Summary of Results



# Discussion

## Left STG-IFG activation by recognition of auditory attractiveness

- Cerebral function of STS is important for grasping auditory social cues (Saarela and Hari, 2008; Scharpf et al., 2010).
- Functional connection between STG and IFG is important in the recognition of auditory attractiveness (Bestelmeyer et al., 2012).



In accord with these findings, our results showed left STG-IFG activation in the recognition of auditory attractiveness including social communications.

In comparison with controls, schizophrenia patients showed **less activation in left STG**, but **greater activation in MFG, amygdala, TPJ, and occipital lobe in the right hemisphere**.

Paradoxical brain activation in schizophrenia patients with auditory hallucination may be caused by both 1) **reduced activation** due to impaired brain function in auditory processing and 2) **increased activation** due to disturbance of attention bias toward internally generated information (Jardri et al., 2011; Kompus et al., 2011).

In accordance with this recent study, **less activation** in schizophrenia could represent impairment of favorability judgment in auditory processing, whereas **greater activation** in schizophrenia may reflect disturbance of attention bias toward internally generated information by the appearance of auditory hallucination.

# Conclusions

- Cerebral function in recognition of auditory attractiveness was revealed in left IFG and left STG.
- In schizophrenia, compared with controls, **less activation** was observed at **left STG**, whereas **greater activation** was confirmed in **the right fronto-parietal region**. Cerebral response in this region was positively **correlated with the severity of auditory hallucinations**.

- These findings suggest that dysfunction in the left fronto-temporal regions is related to the ability to appropriately assess the attractiveness of vocal communications in schizophrenia.
- The right fronto-parietal region could represent cerebral dysfunction to auditory attractiveness including social communications.