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Authors(English)	hiroyuki akama
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Neural representations of language switching in early bilinguals: An fMRI study

Miaomei Lei, Hiroyuki Akama, *Brian Murphy
Graduate School of DST, Tokyo Institute of Technology *Carnegie Mellon University

Introduction

bilingualism

- How do bilinguals organize and switch two distinct languages in one brain?
- May Different languages shape different brain organizations for their processing?
- A vital controversy in bilingualism is whether spatially overlapped or segregated neural substrates subserve two reciprocal language switching tasks.

Experiment

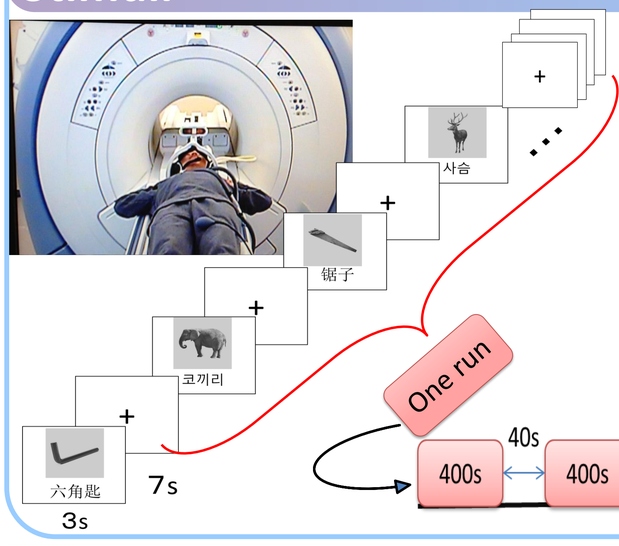
Objective

To investigate neural activity with respect to language switching.

Participants

5 Korean-Chinese early bilinguals, belonging to the Chinese Korean minority from Yanbian Korean Autonomous Prefecture.

Stimuli



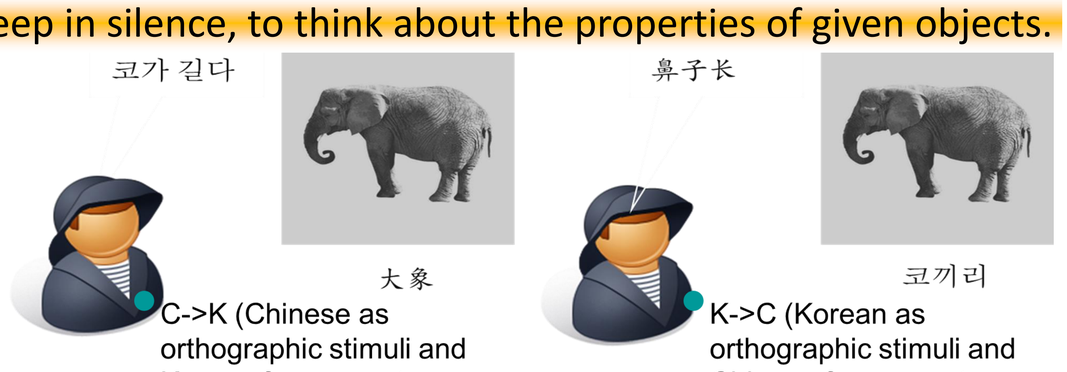
40 images with captions written in Chinese or Korean.

Shown randomly on the screen in fMRI device.

6 repeated runs

Bilingual language switching task

keep in silence, to think about the properties of given objects.



⚠ When the stimuli were shown in Chinese, participants were asked to do the covert association production task in Korean (C>K), and vice versa (K>C).

Results

Data analysis

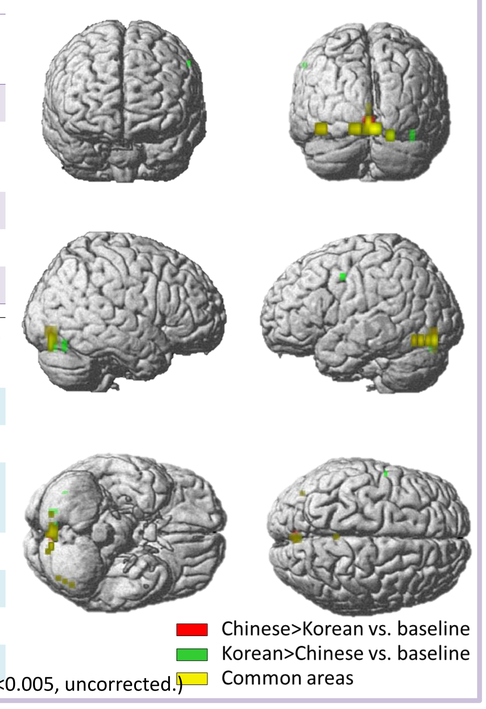
- The fMRI data were preprocessed and analyzed using Statistical Parametric Mapping software (SPM8, Wellcome Department of Cognitive Neurology, London, UK).
- GLM (Friston et al., 1995) was performed on fixed effect analysis basis combining the data of 5 participants.

Brain activations contrast 1

Regions of brain activation of Chinese > Korean vs. baseline	Talairarch Coordinates	Z value
Occipital		
Left inferior occipital gyrus	-42,-68,-8 -45,-61,-8	5.77 4.91
Left fusiform gyrus	-39,-74,-8	4.60
Other areas: Vermis	0 ,-41,5	5.14
Cerebellum: Right cerebellum	17,-80,-12	3.54

Regions of brain activation of Korean > Chinese vs. baseline	Talairarch Coordinates	Z value
Frontal : Left precentral gyrus	-56,1,42	4.58
Occipital		
Left inferior occipital gyrus	-42,-68,-8 -45,-61,-8	5.39 4.14
Right fusiform gyrus	39,-68,-13	3.13
Left fusiform gyrus	-39,-74,-8	4.17
Other areas : Vermis	0 ,-41,5	4.97
Cerebellum : Right cerebellum	21,-80,-12	5.23

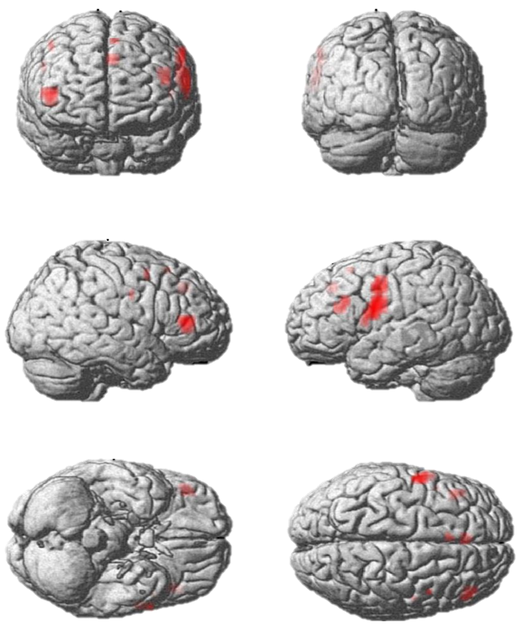
(P<0.005, uncorrected.)



Brain activations contrast 2

Regions of brain activation of Korean > Chinese vs. Chinese >Korean	Talairarch Coordinates	Z value
Frontal		
Right inferior frontal gyrus	48,37,7	5.43
Right middle frontal gyrus	45,7,48	3.13
Right precentral gyrus	50,-5,32	3.09
Left precentral gyrus	-56,0,20 -56,1,37	4.96 3.46
Left inferior frontal gyrus	-42,26,24	3.44
Left medial frontal gyrus	-3,36,35	3.45
Left superior frontal gyrus	-3,22,52	3.45

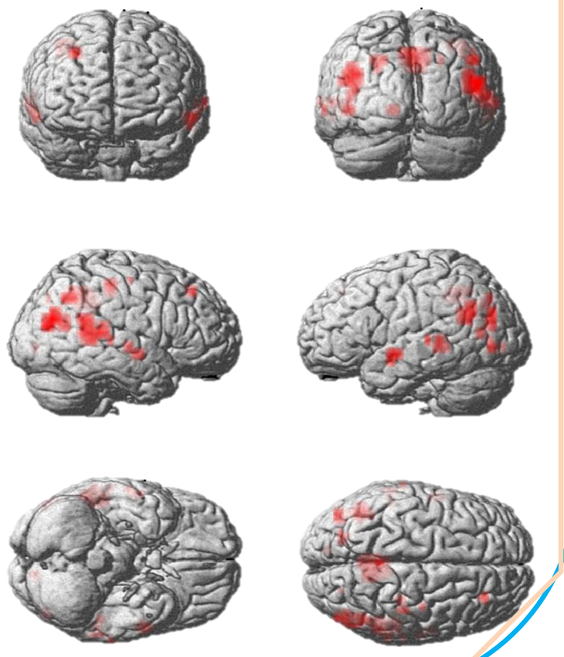
(P<0.005, uncorrected.)



Brain activations contrast 3

Regions of brain activation of Chinese > Korean vs. Korean >Chinese	Talairarch Coordinates	Z value
Temporal		
Right middle temporal gyrus	50,-70,24	4.33
Right superior temporal gyrus	53,-44,22	4.53
	53,-32,11	4.23
Parietal		
Left superior parietal gyrus	-21,-51,45	3.07
Left angular gyrus	-42,-55,29	4.69
Occipital		
Left middle occipital gyrus	-39,-75,30	3.78
Left superior occipital gyrus	-21,-72,40	3.75
Right precuneus	6,-46,39	5.09

(P<0.005, uncorrected.)



Conclusion

- The patterns of brain activity evoked by language switching task in Korean-Chinese bilingual participants are overlapped, similar neural substrates subserve two languages.
- The increased activation in the left precentral by switching L1 to L2, suggested that the processing in L2 requiring an additional motor control associated with phonological retrieval .
- These contrasting activation patterns might support the hypothesis that the neural representations in language switching tasks hinge on the linguistic typology and the cognitive motor control.