Two Faces, Two Languages: How Facial Cues Modulate Bilingual Language Activation

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ABSTRACT

It is widely accepted that proficient bilingual speakers non-selectively activate the mental lexicon from both languages in parallel during comprehension or production. Given this non-selective activation of multiple languages, how can bilinguals, while speaking in one language, effectively avoid interference from the other un-intended language? What internal and external cues do bilinguals use to achieve this language control? In this study we presented participants with faces that prompt the linguistic identity of the listener (Asian vs. Caucasian faces) and asked the participants to perform a picture-naming task inside the scanner. Participants were 15 Chinese-English bilinguals. They saw a fixation cross, a face with a picture frame (red or blue, as a language cue), and named the picture in either their first language (L1: Chinese) or second language (L2: English). Behavioral results indicate that naming was facilitated when the naming language and the linguistic identity of the faces were consistent. fMRI results show significant main effects of language and face. A set of structures implicated in conflict monitoring and cognitive control are activated as a result of facial cues. These findings suggest that facial cues play an important role in modulating bilingual activation.

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INTRODUCTION

Previous studies of lexical processing in bilinguals indicate that bilinguals activate both languages in parallel while speaking or listening to only one language (e.g. Dijkstra & van Heuven, 1998; Marian & Spivey, 2003). Brain imaging studies show the neural correlates associated with language control as a result of the parallel activation (Price et al. 1999; Crinon et al., 2006; van Heuven et al. 2008). Bilinguals must use cues from the external linguistic environment or from the internal structure of the linguistic material to help them avoid significant interference from the un-intended language. Just what cues are used effectively by bilinguals is a topic of active investigation.

In this study, we investigate the role of facial cues in modulating the activation of the bilingual's two languages. Facial cues provide the interlocutors' linguistic identity, though not always reliably, in the bilingual language environment. We manipulate the variables of language (L1 vs. L2) and face identify (Asian vs. Caucasian).

METHOD

Participants:
Fifteen Chinese-English bilinguals (eight females; mean age of 24.44 ± 3.43 years) from the Pennsylvania State University participated in the experiment and received payment for their participation. All bilinguals were Chinese native speakers. A language proficiency questionnaire (Li, Sepanski and Zhao, 2008) was administered to assess self-reported English learning history and proficiency in the bilingual's two languages. The average age of acquisition is 11 ± 2.6 years. The self-reported proficiency scores in the L2 (English) were 5.14 ± 0.86, 4.64 ± 0.63, 4.5 ± 0.94, and 4.86 ± 0.86, for reading, writing, speaking and listening, respectively, on a scale of 1 (poor) to 7 (very fluent).

Task:
In the experimental conditions, participants were asked to name the picture in the frame. The picture frame was held by a male or female person with Asian or Caucasian facial features. The picture frame was either in red or blue, as cue to naming in either L1 (Chinese) or L2 (English). A baseline task involved the participants' looking at a crosshair. Pictures were selected from Bates et al. (2003) and Liu et al. (2011) and were controlled for frequency, naming consistency, age of acquisition, and familiarity.

fMRI Protocol:
Block Design; 3T Siemens Trio scanner
TR/TE/Flip Angel = 2000 ms/ 30 ms/ 90°
Matrix size = 64 x 64; Slices = 34; Slice Thickness = 4 mm

RESULTS

Behavioral Data: A two-way ANOVA showed that response times (RT) were faster for congruent conditions than for incongruent conditions. There was no significant difference between naming in the L1 (Chinese) vs. naming in the L2 in terms of RT, but L1 was named more accurately than L2. No other effects were significant.

Imaging Data: Fig. 2 presents peak activations as a function of language (L1 vs. L2) and face (Asian vs. Caucasian). The language effects were mainly due to the difference between L1 and L2, in that a set of bilateral frontal, temporal and parietal areas (e.g., BAs 10, 11, 39) were activated more strongly in L1 than in L2. The face effects were due to the temporal and occipital areas (e.g., BAs 17, 18, 39) during face processing. Paired-samples t-test showed that significant activations are in the right medial frontal and parietal regions for Asian faces, while significant activations are in the inferior frontal gyrus, cingulate gyrus, and the insula for Caucasian faces.

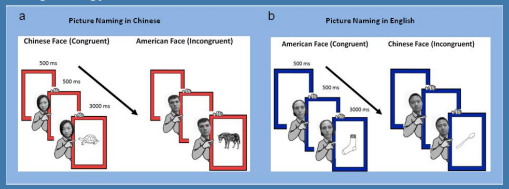

Figure 1 Congruent and incongruent conditions in L1 (a) and L2 (b) picture naming task

	L/R	BA	Region	Cluster	Coordinate	T		L/R	BA	Region	Cluster	Coordinate	T
Language effect			**Chinese (L1) > English (L2)**							**English (L2) > Chinese (L1)**			
Frontal	L	11	medial frontal gyrus	458	-6 44 -22	4.31				NA			
	R	11	medial frontal gyrus	249	2 34 -18	4.41							
	R	10	medial frontal gyrus	44	8 60 8	2.92							
Temporal	R	21	middle temporal gyrus	40	66 -62 0	3.19							
	L	39	middle temporal gyrus	219	-44 -60 20	3.92							
Parietal	R	40	inferior parietal lobe	913	62 -54 22	4.08							
	R	7	precuneus	375	16 -46 40	3.51							
	L	39	angular gyrus	73	-50 -68 32	2.99							
Face effect			**Face > No face**							**No face > face**			
Temporal	R	39	middle temporal gyrus	398	56 -70 2	4.28				NA			
Occipital	R	18	lingual gyrus	474	16 -68 -4	5.64							
	R	17	cuneus	474	10 -86 6	4.86							
Chinese (L1)			**Asian face > Caucasian face**							**Caucasian face > Asian face**			
Frontal	R	8	medial frontal gyrus	43	8 34 46	3.64				NA			
English (L2)			**Asian face > Caucasian face**							**Caucasian face > Asian face**			
			NA							NA			
Asian face			**Chinese (L1) > English (L2)**							**English (L2) > Chinese (L1)**			
Frontal	R	10	medial frontal gyrus	37	18 54 16	3.12				NA			
Parietal	R	40	inferior parietal lobe	167	62 -56 24	4.12							
	R	40	supramarginal gyrus	167	50 -48 32	2.93							
Caucasian face			**Chinese (L1) > English (L2)**							**English (L2) > Chinese (L1)**			
Frontal			NA					L	47	inferior frontal gyrus	154	-30 20 -12	3.22
								R	47	inferior frontal gyrus	206	32 18 -10	3.66
								R	32	cingulate gyrus	167	8 32 34	3.45
								R		insula	102	28 24 2	3.3

Table 1 Peak fMRI activations under different naming conditions

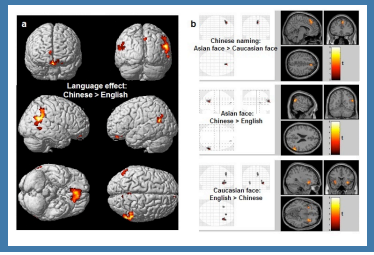

Figure 2. Peak activations during picture naming in Chinese (L1) and English (L2) The main effect of language is shown on the left, and the comparisons of L1 vs. L2 and Asian face vs. Caucasian face shown on the right.

DISCUSSION

Our study indicates that facial features of the listener help to modulate bilingual language activation in terms of congruency between the naming language (L1 or L2) and the linguistic identity of the face (Asian or Caucasian). When language and face are consistent for naming, increased activations are seen in bilateral media frontal and parietal regions in L1; consistent facial information aids in monitoring conflict, as the medial prefrontal cortex is shown in previous research to play an important role in performance monitoring (Ridderinkhof et al., 2004). In the case of L2, structures implicated in cognitive control (bilateral IFG and cingulate cortex) become more strongly activated, indicating that with consistent facial information the bilingual is better able to produce words in their weaker language L2, although perhaps through effortful processing (as shown in strong right insula activation). Future studies will compare these findings with data from ER designs to further investigate effects of language control in switching conditions. Connectivity analyses will also help to determine the interaction between face processing and bilingual language processing.

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