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fMRI evidence for the interaction between orthography and phonology in reading Chinese compound words

Jiayu Zhan [1,2], Hongbo Yu [1,2] and Xiaolin Zhou [1,2,3,4,5]*

[1] Department of Psychology, Peking University, Beijing, China
[2] Center for Brain and Cognitive Sciences, Peking University, Beijing, China
[3] Key Laboratory of Machine Perception (Ministry of Education), Peking University, Beijing, China
[4] Key Laboratory of Computational Linguistics (Ministry of Education), Peking University, Beijing, China
[5] PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing, China

Edited by:
Gui Xue, Beijing Normal University, China

Reviewed by:
Suiping Wang, South China Normal University, China
Leilei Mei, University of California Irvine, USA

*Correspondence:
Xiaolin Zhou, Department of Psychology, Peking University, 5 Yiheyuan Road, Beijing 100871, China
e-mail: xz104@pku.edu.cn

Compound words make up a major part of modern Chinese vocabulary. Behavioral studies have demonstrated that access to lexical semantics of compound words is driven by the interaction between orthographic and phonological information. However, little is known about the neural underpinnings of compound word processing. In this functional magnetic resonance imaging study, we asked participants to perform lexical decisions to pseudohomophones, which were constructed by replacing one or both constituents of two-character compound words with orthographically dissimilar homophonic characters. Mixed pseudohomophones, which shared the “rst constituent with the base words, were more dif“cult to reject than non-pseudohomophone non-words. This effect was accompanied by the increased activation of bilateral inferior frontal gyrus (IFG), left inferior parietal lobule (IPL), and left angular gyrus. The pure pseudohomophones, which shared no constituent with their base words, were rejected as quickly as non-word controls and did not elicit any signi“cant neural activation. The effective connectivity of a phonological pathway from left IPL to left IFG was enhanced for the mixed pseudohomophones but not for pure pseudohomophones. These “ndings demonstrated [(pseudohse)-329(“ndings)-329 up7 ...

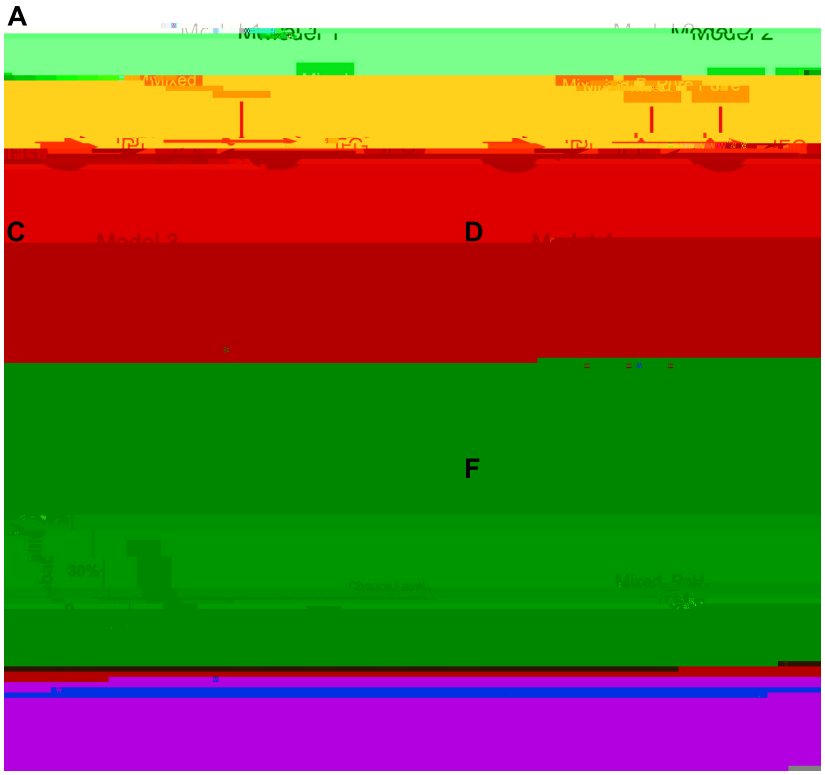
Van Orden et al., 1990; Coltheart et al., 1993; Plaut et al., 1996). Although it is widely accepted that phonological mediation plays a predominant role in accessing lexical semantics in reading alphabetic scripts (Frost, 1998), answers to these questions are more divergent for the Chinese logographic writing system. Unlike the alphabetic system, the basic meaningful units in the logographic system are characters, each of which corresponds to one morpheme and one syllable. However, given the limited number of syllables in the language, many morphemes or characters are homophonic, and these characters may or may not share orthographic features. Thus, a character•s pronunciation (i.e., syllabic representation) c... used to uniquely identify the meaning of the correspondi... pheme, reducing the ef“ciency of computation from ortho... input to semantic representation via phonological mediat...

Two contrasting views have been proposed for how semantics is accessed in reading Chinese characters. ... the •universal phonological principle,Ž is based on the i... the phonological mediation plays the same predominan... reading Chinese as it does with alphabetic scripts (Perfetti e... 1992). However, the empirical “ndings in support of this vie... proven dif“cult to replicate (see, for example, Chen and Shu, ... Xie and Zhou, 2003). The alternative view postulates th... to lexical semantics in Chinese is constrained by both ph... and orthography operating in interaction with each oth... that phonology has no inherently privileged role over or... phy in driving semantic activation (Zhou and Marslen-W... 1999, 2000).

Questions regarding the pathways to lexical semantic... be asked for compound words, which consist of two c... constituent characters (morphemes) and which make u... than seventy percent of modern Chinese vocabulary (Insti... of Language Teaching and Research, 1986). Taking adva... of the pseudohomophone effect in lexical decision, Zhou ... Marslen-Wilson (2009) demonstrated that lexical access in...

Table 3 | MNI coordinates of the activation foci revealed by three contrasts.

			PsH – control						Mixed PsH – control						Interaction					
						MNI coordinates						MNI coordinates						MNI coordinates		
Regions	H	BA	P_{FWE}	Max z-value	Voxel	x	y	z	P_{FWE}	Max z-value	Voxel	x	y	z	P_{FWE}	Max z-value	Voxel	x	y	z
IFG	L	44	0.000	4.82	490	−46	8													


A
Model 2
Mixed
C
D
F

information, such as orthography, phonology, and semantics, converge and interact. Zhou et al. (1999) suggested that, in the real-time processing of a Chinese compound word, both semantic representation of the whole word and the semantic representations of its constituent morphemes are activated in parallel, and that the semantic activation of constituent morphemes can be consistent or in con"ict with the activation of the whole word. It is plausible that the activation of the left angular gyrus for mixed pseudohomophones may re"ect this parallel activation and integration. Further studies are needed to investigate systematically the neural basis of competition and collaboration between semantic activation of whole words and constituent morphemes.

Direct contrast between the pseudohomophone effects for the mixed and pure pseudohomophones (i.e., the interaction analysis) did not show any activation of language-related areas such as the left IPL, IFG, and angular gyrus, although the interaction was found in the ROI analysis for these regions. Instead, the whole-brain interaction analysis showed the activation of the anterior cingulate cortex and medial orbitofrontal gyrus. These regions have long been associated with con"ict detection and cognitive control (van Veen et al., 2001; Milham et al., 2003; Stephan et al., 2003; Ye and Zhou, 2009). It is possible that a more effortful control process is needed when making •noŽ responses to mixed pseud