Clinical and Experimental Psychology

Su et al., Clin Exp Psychol 2019, 5:2

Research Article Open Access

An ERP Study on Metaphors in Chinese Two-character Expression

Pei Su[1], Minghu Jiang[1]*and Chen Bai

[1]Lab of Computational Linguistics, School of Humanities, Tsinghua University, Beijing 100084, P.R. China
[2]School of Foreign Language and Literature, Tianjin University, Tianjin, 300000, P.R. China

Abstract

In this paper, we aim to study the metaphorical comprehension in Chinese two-character lexicons using event related potentials (ERPs). Focusing on ERP components such as N400 and P600, we have proven that: (1) The metaphorical effect revealed by ERPs not only shows in the sentence level of "A is B" form, but also shows in lexical level. The metaphorical stimulus evoked a more negative N400 compared with the literal ones. (2) While both conventional metaphor and literal lexicon expressions were rated similarly in familiarity and accesibility, the ERP results showed that the conventional metaphors required a short burst of additional processing effort when compared with literal sentences. (3) A significant P600 effect appeared in metaphorical words comprehending. It indicates that the metaphor lexicon (like "云游", yun2-you2, and wonder) can cause unexpectedness when it appeared after the targeted word ("云", cloud). And this unexpectedness triggered a significant P600. It suggests that in Chinese, people would process the literal meaning of the targeted word directly, and then rechecking it according to other contextual information. This indicates that incongruity is a strong factor to trigger the reanalysis process in both metaphors and literal sentences. Further studies are needed to give more evidence to the P600 effect in Chinese sematic incongruity condition.

Keywords: Metaphor; Chinese; ERPs; N400; P600

Introduction

Metaphors are general and pervasive in everyday language communication [1]. In our spoken language, we often use them to describe abstract concepts and ideas, to make them more concrete and vivid comparing with our literal language. For example, in the sentence "**老**师是**园丁**" (lao3-shi1-shi4- yuan2-ding1, teachers are gardeners), "**园丁**" (yuan2-ding1, gardener) is used to describe "people that are hardworking and devote himself to bring up someone else" by likening it to the more concrete concept of "**园丁**"(yuan2-ding1, gardeners). "**老**师"(lao3-shi1, teacher) and "**园丁**" (yuan2-ding1, gardeners) are connected by the same quality of hardworking and selfless [2]. By using metaphors, people can understand each other more directly and easily. And for centuries, human beings are doing effort to discover and describe how our brains work to understand each other. We are wondering if there's any different when understanding metaphors and literal meanings. According to previous studies, a variety of neurocognitive models have been proposed to describe the underlying processing of metaphors. The standard pragmatic model or hierarchical model Grice and Searle that the literal meaning of the phrase has to be understood and discarded before attempting to understand the metaphorical meaning [3]. For example, in the sentence "**老**师是园丁", the literal meaning of "**园丁**" (gardener) has to be computed first. The literal meaning is perceived as ill-formed (because teachers are not really gardeners), then the metaphor meaning "hardworking and selfless teacher" can be preceded. Literal and figurative meanings are processed in qualitatively different manners, with precedence of the literal one which is always automatically processed.

In contrast, other models [4] hold a parallel-processing view. They state that both metaphoric and literal meanings are processed concurrently and involve the same mechanisms. What's more, these models hold the view that processing metaphors or non-literal language does not require initial processing of the literal meaning and the metaphoric meaning can be accessed directly. For example, in the sentence "**老**师是园丁" (lao3-shi1-shi4-yuan2-ding1, teachers are gardeners), the metaphor meaning "Teachers are very hardworking and selfless" is directly accessed, without the literal meaning (Teachers do plant jobs as gardeners) of the whole sentence being constructed first or in parallel, as long as the context supports the metaphorical meaning.

Generally speaking, metaphors are more likely happened in the sentence type of "A**是**B" (A is a B). e.g. "That guy is a pig." "Unemployment is a plague." However, as Chinese writing system belongs to the ideogram, that Chinese characters symbolizing the idea (meaning) of a thing without indicating the sound used to say it, we can find metaphor not only in the sentence form of "A is a B", but also in two-character words in Chinese. For example, for the Chinese character "**云**" (yun2, cloud), we have "**云朵**" (yun2-duo3, cloud) for its literal meaning. We also have "**云游**" (yun2-you2, travel, wander) for its metaphor meaning. Such metaphor forming is not uncommon. We can list hundreds of examples of two-character words involving metaphor in its formation. As more and more Chinese researchers started to focus the processing of metaphors in Chinese using event related potentials (ERPs), they found that at least in the form "A**是**B" (A is a B), an obvious difference between literal and metaphor can be observed. This phenomenon brought up the question that if there exists the exact difference between literal and metaphor in lexical level.

In previous studies about the metaphor phenomenon in Chinese, researchers mostly use sentences to create a metaphor environment. Most English metaphors need a sentence, or at list a phrase, to create the necessary environment to understand a metaphor. However, our study needs to explore that if Chinese sentence is a necessary semantic environment for metaphor, if two-character Chinese expression is

***Corresponding author:** Minghu Jiang, Lab of Computational Linguistics, School of Humanities, Tsinghua University, Beijing 100084, P. R. China; E-mail: jiang.mh@tsinghua.edu.cn

Received: September 12, 2019; **Accepted:** October 03, 2019; **Published:** October 10, 2019

Citation: Su P, Jiang M, Bai C (2019) An ERP Study on Metaphors in Chinese Two-character Expression. Clin Exp Psychol 5: 211.

enough for us to differ a metaphor from a literal. This paper aim is to study the neural and cognitive processes involved in the literal meaning and metaphor meaning in Chinese two-character expression by observing the ERP effects, which provides measures of brain activity with very high temporal resolution, and if there exist a hemisphere preference.

Materials and Method

ERPs, or the event related potentials, are the EEG data stimulated by certain activities. Currently, the use of ERP technology has penetrated into many fields of scientific research in medicine, physiology, neuroscience, psychology, linguistics, artificial intelligence. Different processes are reflected as different ERP components, whereas variations in effort or difficulty are manifested as amplitude or latency differences in a specific component.

Electrophysiological recordings can provide measure of brain activity with very high temporal resolution, and it can help improve our understanding of the time course of metaphoric expressions processing. This study uses the ERPs to study the EEG waves respond to different stimulus.

Not very many studies have focused on metaphors by ERPs [5]. Most of the ERP research on language processing has focused on a particular ERP component, the N400, which is a negative deflection peaking approximately 400 ms after stimulus presentation. The N400 component is usually considered to be related semantic processing. Researcher found that the amplitude of N400 would increase with the stimulus of semantic violation sentence. When processing semantic information, the N400 vary systematically. The variation is considered to be related to the ease of difficulty of retrieving stored conceptual knowledge associated with a word [6].

Pynte et al. found that the increased N400 amplitudes can be elicited in both conventional and unfamiliar metaphors. In this experiment, participants were shown statements consisting of conventional metaphors ("Those fighters are lions"), unfamiliar metaphors ("Those animals are lions"). Although terminal words were associated with larger N400 amplitudes for unfamiliar words comparing to the conventional metaphors, this difference did not reach statistical significance. LPC (Late Positive Component) also did not reveal any effects of familiarity. In their Exps. 3 and Exps.4, the result showed that appropriate contextual information assisted meaning retrieval of conventional and unfamiliar metaphors decreasing N400 amplitudes in a similar way. However, there is a major weakness in the study. The study above did not have behavioral responses. The participants in that study were required to read the sentences in the screen, but it is possible that some of the sentences are not understood by the participants. What's more, this study only examined the conventional and novel metaphors. They are fulfilled without reference to literal expressions [7].

Most studies indicate that target words of metaphors evoke larger N400 amplitudes than final words of literal expression. Vicky et al. compared ERPs elicited by the same target word when it was used to end anomalous, novel metaphorical, conventional metaphorical and literal sentence [8]. They found that the amplitudes of the N400 component were more negative for anomalous sentences, novel metaphors, and conventional metaphors compared with literal sentences. Their findings were compatible with the models assuming an initial stage for metaphor mappings from one concept to another and that these mappings are cognately taxing. Yossi et al. compared the processing of two-character expressions denoting literal, conventional metaphoric, novel metaphoric meaning, as well as unrelated word pairs. Participants were required to judge whether each word pair conveyed a meaningful expression. N400 amplitude to the second word of the pair varied as a function of expression type in a graded manner increasing from literal expressions to conventional metaphors, to novel metaphors and to unrelated pairs.

Another ERP component related to metaphor processing is P600. Traditionally, P600 has been considered to be associated with syntactic processing. However, this P600 component is also reported in semantic violation conditions. It is also reported in thematic role animacy violations. They considered that the P600 component reflects a process of self-monitoring. The P600 component is considered to be sensitive to language unite that violates an expectation.

Participants

There were 32 participants (16 males and 16 females, mean age=23) joined the experiment. They were all native Chinese speaker that belong to the northern Chinese dialect area. They were all right-handed (according to the Edinburgh inventory, Oldfield RC 1971), and none of them reported has any history of hearing, language or neurological impairments. All participants provide informed consent and were compensated with 100 Yuan RMB for their participation.

Materials

204 words (51 quadrates (sets) with 4 word types in each quadrate) were created. For each target concept (character), 4 category of two-character lexicon was created, as shown in Table 1.

Then we found 46 students in Tsinghua University to grade the 204 word across plausibility, familiarity and figurativeness. The lowest was 1 point and the highest is 5 point. According to the grading score, 160 words (40 quadrates with 4 word types in each quadrate) were used in the ERP experiment, as shown in Table 2.

Procedure

Participants were tested individually in a sound attenuated room and gave an informed consent before the experiment started. The experiment consisted of a practice phase (to subjects familiar with the test) and a test phase which used different stimuli. When experiment start 400 ms of fixation (+) appeared middle of the screen in front of the subjects followed by the target concept (eg. 花, hua1, flower) with 400 ms. Then a mask of a meaningless character was appeared for 300 ms, to decrease the brain signal evoked by the character itself (thus only the meaning of the character can be remained). Followed by a blank of 400 ms, the two-character word is appeared for 400 ms. After these, a blank screen was presented for 400 ms before the question mark "??" for the participant to judge. With a blank screen for 1500 ms, one trail is ended.

Target concept	口 (kou3, mouth)	花 (hua1, flower)
Literal	口腔 (kou3-qiang1, mouth)	花朵 (hua1-duo3, flower)
metaphor	口袋 (kou3-dai4, pocket)	花边 (hua1-bian1, lacework)
Anomalous	果麦 (guo3-mai4, anomalous)	海团 (hai3-tuan2, anomalous)
anomalous1	口草 (guo3-cao3, anomalous)	花方 (hua1-fang1, anomalous)

Table 1: Examples of the 4 Lexicon types in the experiment.

Stimulus type	Literal	Metaphor	Anomalous	Anomalous1
Plausibility	4.77	4.5	1.9	1.8
Familiarity	4.82	4.41	1.5	1.4
figuativeness	2.26	3.47	1.67	1.69

Table 2: Characteristics of the 4 lexicon types.

Data recording

EEG data were recorded from 64 Ag/AgCl electrodes (sampled at 500 Hz, band-pass filtering=0.1-100 Hz, notch filtering=50 Hz) positioned in a BP (Brain Product GmbH, Munich, Germany) head-cap on the scalp, according to the international 10/20 system. One loose lead electrode was placed below the left eye to measure vertical electrooculography (EOG), and horizontal eye movements were monitored using another electrode placed on the outer canthi of right eye. Another two electrodes left and right mastoids with all of the electrodes referenced to the left mastoid during recording. Electrode impedance was below 10 KΩ for all channels. The Brain Vision Recorder software (Brain products, Munich, Germany) was used for data recording on PC running under Windows XP operating system Table 3.

Results

Behavioral results

As shown in the Behavioral results, the reaction time of the literal meaning words is significantly faster than other categories, the average is 451.67 ms, the accurate rate is also significantly higher than other categories, reaching 98%. The reaction time of anomalous (fake or nonsense word) words and metaphors is generally longer. The lowest correct rate is the metaphorical words of the target concept, with an accurate rate of 89%.

There was no significant difference in the response between groups, that is, the time required for subjects to make judgments when they saw different categories of words was consistent. This also proves that the corpus in this experiment is about the same level of familiarity for the subjects.

As is shown in Figure 1, a grading in N400 amplitudes was found, with the lowest found for literal expressions, increasing slightly in metaphor expressions, then for anomalous expressions the most negative was found. The N400 is thought to reflect the retrieval of the stored conceptual knowledge associated with the words. Thus in two-character Chinese lexicon, accessing meaning of the target words was easiest in literal expressions and most effortful in unrelated pairs. Accessing the meaning of target word in metaphoric expressions was more demanding than in literal expressions but less demanding than for unrelated words.

We chose Fz, F1, F2, F3, F4, F5, F6, FCz, FC1, FC2, FC3, FC4, FC5, FC6, Cz, C1, C2, C3, C4, C5, C6, CPz, CP1, CP2, CP3, CP4, CP5, CP6, Pz, P1, P2, P3, P4, P5, P6 totally 35 points for statistical analysis. The data were divided into 3 types across sentence type: literal, metaphor

	Literal	Metaphor	Anomalous	Anomalous1
RT	451.67	466.36	486.08	483.82
	(277.27)	(200.7)	(221.75)	232.34)
ACC	0.98	0.89	0.92	0.97
	(0.03)	(0.06)	(0.17)	(0.19)

Table 3: Reaction time and accuracy of 4 types (and Standard deviation).

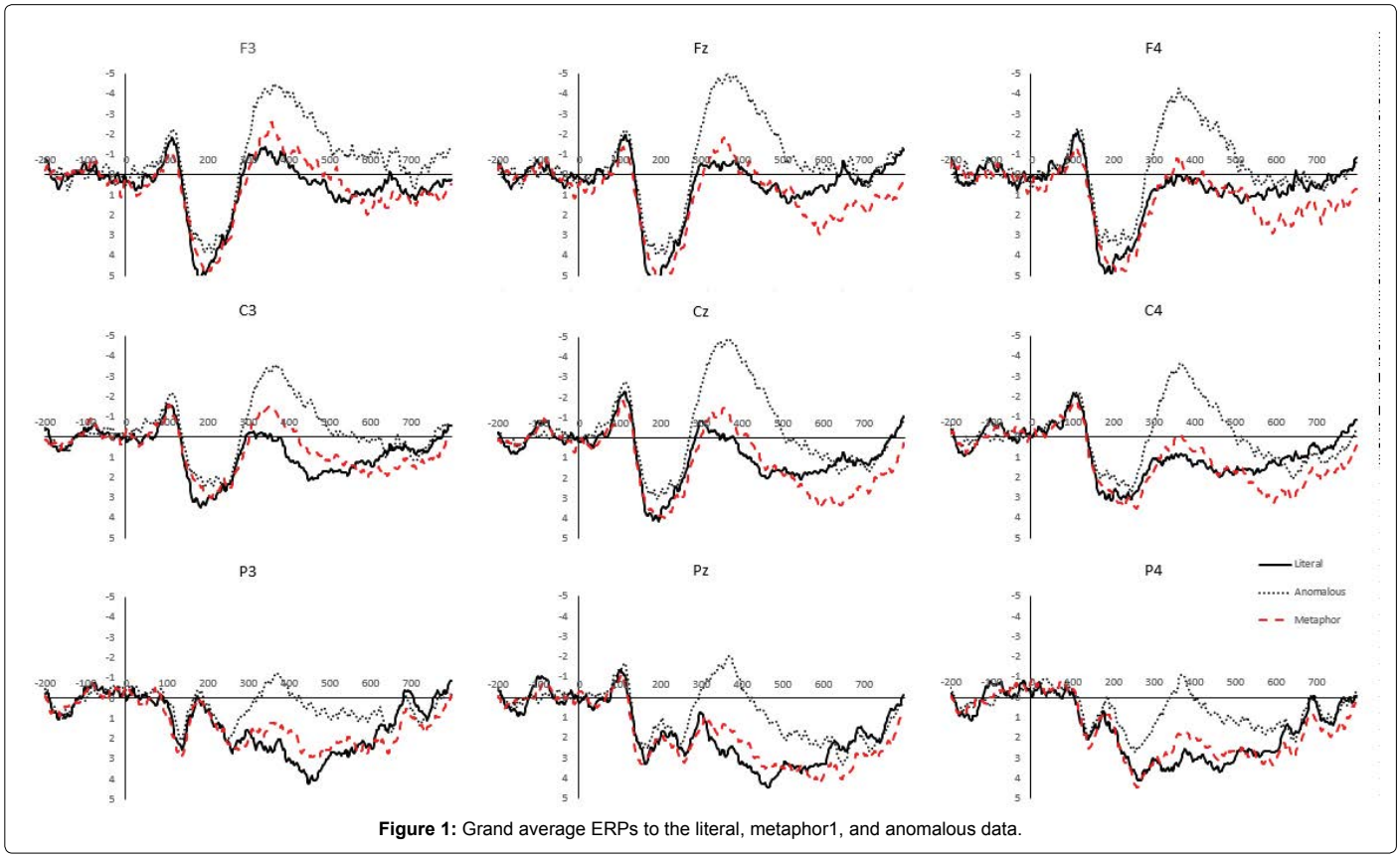

Figure 1: Grand average ERPs to the literal, metaphor1, and anomalous data.

and anomalous. For scalp distribution, we divided the data into front (F) and back(B), and left (L) and right (R). It is shown in Figure 2.

For the N400 effect, we chose the 320 to 450 ms time window. As the result shows, the waveform to the anomalous words was more negative than that evoked by the metaphors and literal words, and the waveform to the metaphorical words was more negative than that evoked by the literal words. The statistic result can be seen below.

A. Literal *vs*. Metaphor. Metaphorical words evoked a more negative effect relative to literal words. A significant main effect between metaphorical words and literal words [F (1, 68)=7.09, p<0.01] was shown in the statistic result (Table 4). For scalp distribution, no significant difference between AP distribution and Hemisphere preference can be seen across these two types. [S × AP: F (1, 44)=0.37, p=0.55, S × H: F (1,44)=0.13, p=0.72].

B. Literal *vs*. Anomalous. Anomalous words also evoked a more negative effect relative to literal words. A significant main effect between Anomalous words and literal words [F (1, 68)=126.22, p<0.001] was shown in the statistic result (Table 4). For scalp distribution, still no significant difference between AP distribution and Hemisphere preference can be seen across these two types. [S × AP: F (1, 44)=0.52, p=0.48, S × H: F (1, 44)=0.46, p=0.50].

C. Anomalous *vs*. Metaphor. The anomalous words showed a more negative N400 effect compared with the metaphorical words, but not that negative compared with the literal words. A significant main effect between Anomalous words and literal words [F (1, 68)=80.59, p<0.001] was shown in the statistic result (Table 4). For scalp distribution, still no significant difference between AP distribution and Hemisphere preference can be seen across these two types. [S × AP: F (1, 44)=1.77, p=0.20, S × H: F (1, 44)=1.12, p=0.30]

This word experiment also evoked a P600 effect. For the P600 effect, we chose the 620 to 750 ms time window.

A. Literal *vs*. Metaphor. Metaphorical words evoked a more positive effect relative to literal words. A significant main effect between metaphorical words and literal words [F (1, 68)=47.91, p<0.001] was shown in the statistic result (Table 4). For scalp distribution, no significant difference between AP distribution and Hemisphere preference can be seen across these two types. That means, compared with literal words, metaphorical words showed no difference in AP distribution and Hemisphere preference. [S × AP: F (1, 44)=0.02, p=0.89, S × H: F (1, 44)=0.37, p=0.55]

B. Literal *vs*. Anomalous. No significant main effect between Anomalous words and literal words [F (1, 68)=0.01, p=0.95] was shown in the statistic result (Table 4). For scalp distribution, still no significant difference between AP distribution and Hemisphere preference can be seen across these two types. [S × AP: F (1, 44)=1.33, p=0.26, S × H: F (1, 44)=0.51, p=0.48]

C. Anomalous *vs*. Metaphor. The metaphorical words showed a more positive P600 effect compared with the anomalous words. A significant main effect between anomalous words and metaphorical

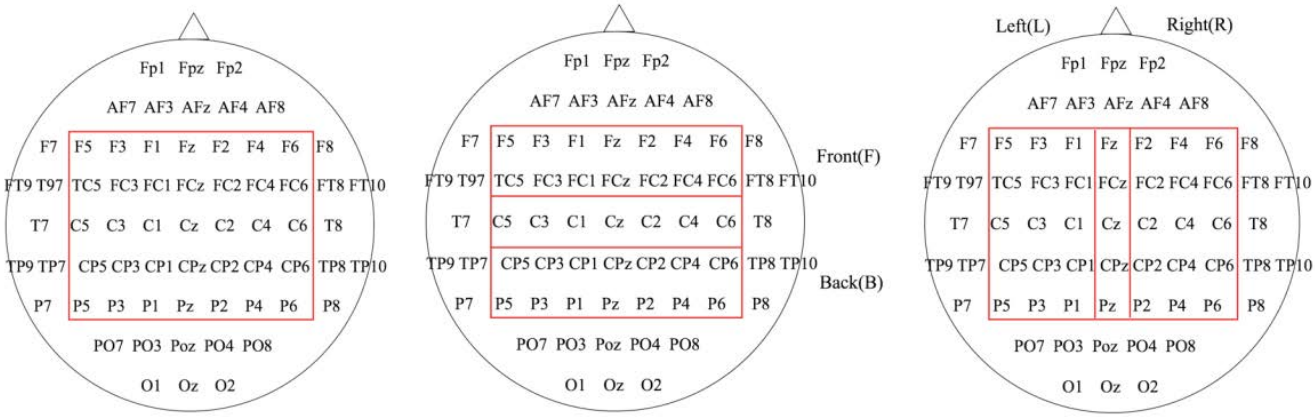

Figure 2: Chosen electrdes for analysis.

	Effec	N400 (320-450 ms)		P600 (620-750 ms)	
		F value	p	F value	p
Literal versus Metaphor	S	7.09	<0.01	47.91	<0.001
	S × AP	0.37	0.55	0.02	0.89
	S × H	0.13	0.72	0.37	0.55
Literal versus Anomalous	S	126.22	<0.001	0.01	0.95
	S × AP	0.52	0.48	1.33	0.26
	S × H	0.46	0.5	0.51	0.48
Metaphor versus Anomalous	S	80.59	<0.001	35.38	<0.001
	S × AP	1.768	0.2	1.24	0.27
	S × H	1.12	0.3	0.01	0.91
Metaphor	H	5	<0.05	-	-
	AP	38.56	<0.001	-	-

Table 4: Data analysis of each type in the N400 and P600.

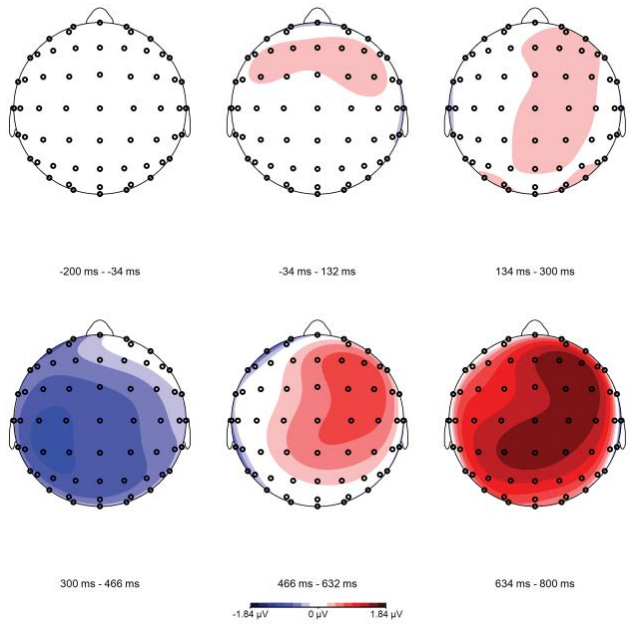

Figure 3: Scalp distribution over the -200-800 ms time window for metaphor1 compared with literal.

words [F (1, 68)=35.38, p<0.001] was shown in the statistic result (Table 4). For scalp distribution, still no significant difference between AP distribution and Hemisphere preference can be seen across these two types. [S × AP: F (1, 44)=1.24, p=0.27, S × H: F (1, 44)=0.01, p=0.91]

The scalp distribution also shows a strong negative effect across the 300-466 ms time window (Figure 3). We can also observe from the scalp distribution that the N400 effect mainly distributed in the central and posterior area. The left lateral behaves few more N400 effect than the right lateral area. There's statistic significant difference in metaphorical words in AP distribution [F (1, 22)=38.56, p<0.001] and Hemisphere preference [F (1, 22)=5.00, p<0.05] (Table 4).

Interestingly, the ERP data shows that accessing the meaning of an anomalous word would spend most effort compared with literal and metaphor. As the literal and metaphor words have the same familiarity, the result stands for the standard pragmatic model. The brain access the literal meaning first, if the language environment shows an objection, then the metaphor meaning is evoked.

Earlier studies usually consider P600 to be elicited by words that do not fit into the syntactic structure of a particular sentence. Recent study also reported P600 in thematic role mismatch conditions, suggesting the P600 component reflects a self-monitoring, or rechecking process. And the P600 component is trigger by language unit that violates an expectation. Yang et al. suggests that the P600 component in metaphor comprehension can be either rechecking or reanalysis process, especially during an encounter of unexpected stimuli. Surprisingly, in this experiment the P600 effect only appeared in metaphorical words comprehending, but not in literal or anomalous words comprehending. It indicates that the metaphor lexicon (like "**云游**", yun2-you2, wonder) can cause an unexpectedness when it appeared after the targeted word ("**云**", cloud). And this unexpectedness triggered a significant P600. What's more, this P600 component in the present study also suggest that in Chinese, people would process the literal meaning of the targeted word directly, and then rechecking it according to other contextual information.

Discussion

The main findings of this study are that, first, the N400 effect revealed by metaphors not only shows in the sentence level of "A is B" form, but also shows in two-character lexicons level. Second, while both conventional metaphor and literal lexicon expressions were rated similarly as familiar and interpretable, the ERP results showed that the conventional metaphors required a short burst of additional processing effort when compared with literal sentences. It suggests that the metaphoric interpretation was more difficult even with the similar familiarity [9]. This finding replicated Coulson and Van Petten, who found that metaphors elicited N400 more negative than literal sentences [10,11]. Third, a P600 effect was shown in metaphors in the two-character lexicon experiment, which indicate that metaphor lexicon can cause unexpectedness when it appeared after the targeted word. And this unexpectedness triggered a significant P600. What's more, this P600 component in the present study also suggest that in Chinese, people would process the literal meaning of the targeted word directly, and then rechecking it according to other contextual information [12].

In previous studies about the metaphor phenomenon in Chinese, researchers mostly use sentences to create a metaphor environment. However, this study finds that in Chinese language system, sentence is not a necessary semantic environment for metaphor. In two-character expression level, the semantic environment is enough for language user to differ a metaphor from a literal [13]. That is very different from English. Most English metaphors need a sentence, or at list a phrase, to create the necessary environment to understand a metaphor.

We considered that the reason for this phenomenon is that, Chinese writing system belongs to the ideogram. The POS (part of speech tagging) in Chinese is not that obvious. For example, for the character "云" (yun2, cloud), it can be understood as the cloud in the sky, noun [14]. It can also be understood as an adverb, "like the cloud", as in the word "云游" (yun2 you4, roam like the cloud). For Chinese language user, one character can evoke different meaning and different usage of it. However, for a single character, the literal meaning would be processed directly, and be adjusted according to other contextual information [15].

Over decades, different researchers have different views about the contribution of literal meaning during figurative processing. Some of the researchers hold the theory that the processor always starts from the literal meaning, others assume that only the relevant meaning is processed. The indirect and direct access account still continues and hasn't been fully answered.

Gibbs and Recanati argue for literal meaning to play only a local role: it is activated for single words within a figurative utterance but the processing of the literal meaning of the whole figurative utterance is not required [16]. Others consider literal meaning only provided the background of the meaning processing [17]. Gentner and Wolff considered the literal meaning of a word to be the carrier of the metaphor. In the beginning, the metaphorical is created from one sub-meaning of the literal meaning. However, in the course of repeated usage, the metaphorical meaning is stored in the lexicon. Thus, the metaphorical meaning is fixed up with the lexicon. When a language user encountered with a lexicon, to evoke the literal meaning or the metaphorical meaning is determined by the language environment [18]. Furthermore, non-literal language use encompasses many different phenomena, including irony, humor, hyperbole, simile, and so forth. Chinese is different from English; two-character Chinese expression is

enough for us to differ a metaphor from a literal, but English need a sentence, or at list a phrase, to understand a metaphor [19].

In this study, we suggest that the N400 effect mainly distributed in central lateral and left hemisphere, which contradict to some of the previous studies. Compared with right hemisphere-damaged patients, left hemisphere-damaged patients showed a preference to understand the metaphor meaning of adjectives [20]. This finding stands for Isabel C. Bohrn, Ulrike Altmann, and Arthur M. Jacobs and Zohar Eviatoa and Marcel Adam Just fMRI study that in metaphor comprehension requires the left hemisphere to fully understand the meaning of the metaphorical expression. Some previous studies suggest that the understanding of novel metaphor requires the right hemisphere to take part in. However, in this study, all the metaphors we used were conventional metaphors, or the so-called dead metaphor [21,22]. A pretty obvious left hemisphere preference was detected in two-character metaphor lexicons in Chinese. We also suggest that both hemispheres may sensitive to metaphorical meaning but the left hemisphere was stimulated around 400 ms. there is more than a single way that linguistic utterances can diverge from literality, a similar diversity in networks of brain areas may be observed to comprehend them [23]. Visual imagery or emotions may be evoked during experiments and simulate different brain areas. However, most studies of the hemisphere preference in metaphor and other figurative expressions are aimed in English [24]. The studies of the hemisphere preference in metaphor of Chinese and other language are rare. Further studies are needed to give more evidence to the hemisphere preference in Chinese metaphor compression [25-28].

Conclusion

The present demonstrated that the metaphor condition in lexical level in Chinese can also evoke a larger N400 effect. A significant P600 effect was shown in the two-character lexicon experiment with a matching condition between the targeted word and metaphor. It indicates that the metaphor lexicon caused unexpectedness after seeing the targeted word, which triggered the P600 effect. This indicates that incongruity is a strong factor to trigger the reanalysis process in both metaphors and literal sentences.

Acknowledgement

This work was supported by the National Natural Science Key Fund (61433015), National Social Science Major Fund (14ZDB154 & 15ZDB017) of China.

References

1. Arzouan Y, Goldstein A, Faust M (2007) Brain waves are stethoscopes: ERP correlates of novel metaphor comprehension. Brain Res 1160: 69-81.
2. Su P, Jiang MH, Bai C (2016) Metaphors in Chinese Two-Character Expression: An ERP Study. Proceedings of the IEEE International Conference on Signal Processing. 1392-1397. Chengdu, China.
3. Searle JR (1993) Metaphor. Metaphor and Thought Andrew Ortony 83-111.
4. Gibbs Jr RW (2002) A new look at literal meaning in understanding what is said and implicated. J Pragmat 34: 457-486.
5. Pynte J, Besson M, Robichon FH, Poli J (1996) The time-course of metaphor comprehension: An event-related potential study. Brain Lang 55: 293-316.
6. Kutas M, Hillyard SA (1980) Reading Senseless Sentences: Brain Potentials Reflect Semantic Incongruity. Science 207: 203-205.
7. Bambini V, Ghio M, Moro A, Schumacher PB (2013) Differentiating among pragmatic uses of words through timed sensicality judgments. Front Psychol 4: 938.
8. Lai VT, Curran T, Menn L (2009) Comprehending conventional and novel metaphors: An ERP study. Brain Res 1284: 145-155.
9. Coulson S, Matlock T (2001) Metaphor and the space structuring model. Metaphor Symb 16: 295-316.
10. Coulson S, Van Petten C (2002) Conceptual integration and metaphor: An event-related potential study. Mem Cogn 30: 958-968.
11. Coulson S, Van Petten C (2007) A special role for the right hemisphere in metaphor comprehension? ERP evidence from hemifield presentation. Brain Res 1146: 128-145.
12. Coulson S, Oakley T (2005) Blending and coded meaning: Literal and figurative meaning in cognitive semantics. J Pragmat 37: 1510-1536.
13. Coulson S, Van Petten C (2002) Conceptual integration and metaphor: An eventrelated potential study. Mem Cogn 30: 9588-9568.
14. Ferretti TR, Schwint CA, Katz AN (2007) Electrophysiological and behavioral measures of the influence of literal and figurative contextual constraints on proverb comprehension. Brain Lang 101: 38-49.
15. Gibbs RW Jr (1990) Comprehending figurative referential descriptions. J Exp Psychol Learn Mem Cogn 16: 56-66.
16. Giora R (1997) Understanding figurative and literal language: The graded salience hypothesis. Cognitive Linguistics 8: 183-206.
17. Giora R (2002) Literal vs. figurative language: Different or equal?. J Pragmat 34: 487-506.
18. Iakimova G, Passerieux C, Laurent JP, Hardy□Bayle MC (2005) ERPs of metaphoric, literal, and incongruous semantic processing in schizophrenia. Psychophysiology 42: 380-390.
19. Kintsch W (2000) Metaphor comprehension: A computational theory. Psychon Bull Rev 7: 257-266.
20. Kutas M, Hillyard SA (1984) Brain potentials during reading reflect word expectancy and semantic association. Nature 307: 161-163.
21. Laurent JP, Denhieres G, Passerieux C, Iakimova G, Hardy-Bayle MC (2006) Onunderstanding idiomatic language: The salience hypothesis assessed by ERPs. Brain Res 1068: 151-160.
22. Mc Glone MS (1996) Conceptual Metaphors and Figurative Language Comprehension: food for Thought. J Mem Lang 35: 544-565.
23. Osterhout L, Holcomb PJ (1992) Event-related brain potentials elicited by syntactic anomaly. J Mem Lang 31: 785-806.
24. Osterhout L, Nicol J (1999) On the distinctiveness, independence, and time course of the brain responses to syntactic and semantic anomalies. Language and Cognitive Processes 14: 283-317.
25. Reddy MJ (1979) The conduit metaphor: A case of frame conflict in our language about language. Metaphor and Thought 2:164-201.
26. Sotillo M, Carretié L, Hinojosa JA, Tapia M, Mercado F, et al. (2004) Neural activity associated with metaphor comprehension: spatial analysis. Neurosci Lett 373: 5-9.
27. Schmidt GL, Kranjec A, Cardillo ER, Chatterjee A (2010) Beyond laterality: a critical assessment of research on the neural basis of metaphor. J Int Neuropsychol Soc 16: 1-5.
28. Yang FPG, Bradley K, HuqM, Wu DL, Krawczyk DC (2013) Contextual effects on conceptual blending in metaphors: An event-related potential study. J Neurolinguistics 26: 312-326.