



Cognitive Mechanism of Language Transfer: Brain Potential Data Analysis in English Comprehension

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ABSTRACT

This study examines the effects of the differences between the deep meaning of the native language and the target language on language transfer in the cognitive process of English understanding from the aspects of behavior and cranial nerves. The experimental results show that besides the approximations in linguistic typology that impacts the formation of the cognitive mechanism of foreign language learner in the target language, the deep meaning relationship between the native language and the target language is also an important factor affecting language transfer, which affects the formation of the cognitive mechanism of foreign language learners to the target language. Specifically, English errors with the same meaning as Chinese cause significant N400 effect, while the error sentences with different meaning from Chinese do not cause the same brain potential effect. This study, from the perspective of cognitive neuroscience, supports the interpretation of language transfer by cognitive theory.

Key Words: EEG, Cognitive Mechanism, Language Transfer, Brain Potential, English Comprehension

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Introduction

In the 1960s and 1970s, the influence of the rise of cognitive science on linguistics and psychology, especially the proposition of Chomsky's linguistic theory, shifted the perspective of language transfer from the comparison of language morphology to the study of the general development of English acquisition. Researchers pay attention to the universal development law in the process of English acquisition, and discuss the generation process of "interlanguage" in language acquisition instead of the hypothesis theory of contrastive analysis (Aburabia and Shakkour, 2014). Therefore, language transfer is no longer a common interpretation of language misuse in the process of language acquisition, but interlanguage hypothesis theory. In recent years, the application of cognitive neuroscience in linguistics has brought new research methods for linguistic research. In

particular, the event-related potential (ERP) technique has higher time decomposition ability, and can record the change of the brain potential of the millisecond level in real time, which gives us a useful window to observe the electrophysiological activity of the brain in the normal language process state, and especially helpful to observe those implicit cognitive activities in language processing and to better explain the processing characteristics of language on the cognitive level "in linguistic research" (Deng, 2016). The classical ERP research finds that when the brain processes the words with the problem of semantic collocation in sentences, it tends to show a negative-phase brain potential change with a peak value of 300-500. The index is called N400 component, which reflects the processing of vocabulary meaning in the process of understanding sentences.

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The electrical component of the brain peaks in 600ms, and the brain wave patterns with positive phase change often appear in the brain's understanding of sentences with grammatical errors (Gao, 2016). The ERP technique has also been widely used in English acquisition research. ERP studies on language transfer have found that the ability to distinguish grammatical errors in English varies with the degree of similarity between the native language and the English language.

Definition and Classification of Language Transfer

Transfer is a psychological term originally and refers to the effect of learners' acquired knowledge or skills on the acquisition of new knowledge or skills in the course of learning (Michie *et al.*, 2008). Language transfer refers to the phenomenon that learners try to express their thoughts by means of their native language's pronunciation, meaning, grammar rules or cultural habits when they communicate in English.

Classification by process generated from language transfer

Felker divides language transfer into "transfer in communication" and "transfer in learning". Transfer in communication refers to that learners use the basic principles of the native language (or acquired language) to achieve temporary and individual communicative purposes or to help them understand the meaning of English, which occurs only when they speak and understand speech. This is the same as Cod's "borrowing" mentioned in language error analysis (Ito and Senholzi, 2013). This kind of transfer means that when learners cannot express their meaning in English in a certain situation, they use their native language or the components of acquired language to achieve their communicative purpose.

Classification by utility generated from language transfer

Psychological linguists at home and abroad divide language transfer into positive transfer and negative transfer. Positive transfer is also called promotion. When certain characteristics of native language are similar or completely consistent with English, positive transfer often occurs. For example, the basic word order of English and Chinese is subject + predicate + object (S+V+O),

and the similarity of sentence patterns can constitute positive transfer (Liu *et al.*, 2014). Negative transfer is commonly referred to as interference. When the native language or other acquired language knowledge is different from some characteristics of English, learners use the language rules of the language knowledge to replace English language rules, resulting in transfer and language errors.

Classification by language ranges resulting from language transfer

Psychological linguists at home and abroad divide language transfer into inter-language transfer and intra-language transfer. Inter-language transfer means that learners are not familiar with the grammar rules of English, but transfer the grammar rules of other acquired language to their native language. When an inter-language transfer results in an error, a negative inter-language transfer occurs. When inter-language transfer happens to say the right English, there is a positive inter-language transfer (Kim *et al.*, 2013). Inter-language transfer is not necessarily limited to one-way transfer from native language to English. When learners learn English to a certain extent, English also has an influence on the mother tongue. Intra-linguistic transfer is a phenomenon of negative transfer within the English language, and refers to that learners widely use some rules of the English language in a wrong way, which leads to over-generalization. Since the over-generalization is not appropriate, there will be errors. The concepts of inter-language transfer and intra-language transfer are the study of the researchers of applied psycholinguistics on errors in English learning from the perspective of error analysis (Diao, 2015). Researchers such as Du Lei and Bert believe that interference errors of mother tongue account for a very small proportion of language errors made by learners. English learning, like acquisition of mother tongue, is a creative learning process. English learners' English mistakes are of the same nature as children's acquisition errors of mother tongue, and have a transitional and self-established system (Caroline *et al.*, 2015).

This study attempts to analyze the classification of language transfer from a unified and hierarchical perspective, as shown in Figure 1 below:

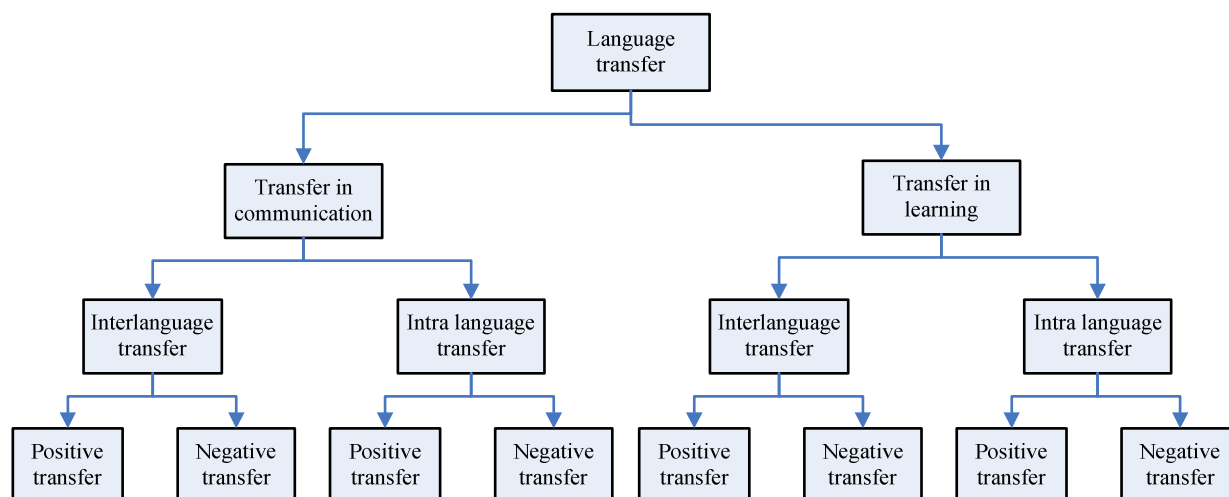


Figure 1. The classification of language transfer

Cognitive Mechanism is the Premise of Language Transfer

It is the primary task of the English discipline in China to introduce new theories and methods of linguistics abroad, to describe and explain English phenomena better and to reveal the rules of English in combination with practical English. The introduction of cognitive linguistics has at least two effects on English research: first, its theory and method can be used to explain the phenomena that have not been explained before; the second is to raise the scattered interpretation in the past to the level of cognition, and make it theorized and systematized (Salim *et al.*, 2013).

Table 1. Markedness theory and mother tongue migration

Type	Mother tongue	Target language	Interlanguage
1	Unmarked	Unmarked	Unmarked
2	Unmarked	Marked	Unmarked
3	Marked	Unmarked	Unmarked
4	Marked	Marked	Unmarked

Although cognitive linguistics takes a specific language as its object, it explores the commonness of languages in order to find out the universal laws of human cognition and languages.

Different languages are merely the choice and utilization of common laws under certain cultural constraints (Moghaddam and Araghi, 2013). Cognitive linguistics has found that basic categories and prototypes play an important role in the formation of concepts, metaphor and metonymy are important mechanisms of word meaning evolution and grammaticalization, language similarity and others have a general sense of the hypothesis, which has been tested in many languages. Commonness is the basis of studying individuality, knowing the commonness

for the differences. The ability to communicate and translate between languages is also based on commonness. The labeling theory and mother tongue transfer labeling are shown in Table 1.

Methods

To sum up, cognitive linguistics is oriented to commonness, which is a great development in the history of language research and is conducive to revealing the essence and mystery of languages. Cognitive linguistics is a generic linguistics that emphasizes the commonness of human cognitive processes, and language transfer results from the influence of similarities or differences between English and any other language that the learners acquired previously, which mostly results from the commonness of human cognition. Therefore, cognitive mechanism is the premise of language transfer.

Experimental subjects

A total of 20 English majors from the Foreign Languages Institute took part in the experiment (average age of 24, 3 men). They are all late skilled English learners. They began to learn English at the age of 18, with an average of 6 years in learning English. They have no living experience in English-speaking countries, with English proficiency of Level I of English proficiency test. All participants are right handed, with normal vision and corrected vision, and without history of mental and neuropathy. They are voluntary to participate in the experiment, signed informed consent and experimental agreement, and received corresponding reward after the experiment.



Experimental materials and design

The experimental sentences contain 160 English experimental stimulus sentences and 160 English fill-in stimulus sentences. Experimental stimulus sentences are divided into 4 groups, each containing 40 experimental stimulus sentences. In each group of experimental stimulus sentences, the meaning relationship 2 (the meaning relationship is the same, and the meaning relationship is different) X correct & wrong 2 (the correct, and the wrong) are operated respectively, to constitute four experimental conditions. By changing the case auxiliary after NP2, we construct correct sentences and incorrect sentences with same number. Especially for the experimental stimulus sentences, the correct sentence and the wrong sentence are distinguished only by exchanging the case auxiliary words after NP2. In this way, for the same condition and different conditions of the meaning relationship, except for the auxiliary word, the stimulation of other words maintain the consistency in the visual sense. Therefore, for the correct and incorrect judgment of the sentence, the participants can make the correct judgment only through the rationality of the collocation of the case auxiliary word with the later verb. The experimental stimulus sentences

auxiliary words are presented in accordance with daily English writing habits. Most words are Chinese characters. The mixed writing of Chinese characters and kana in verbs is based on the notation in English dictionaries. The principle of the electroencephalogram testing system is shown in Figure 2.

Experimental procedure

The experiment is conducted in a soundproof room with subjects sitting in front of a computer screen (60 cm apart), eyes looking horizontally at the screen, and horizontal and vertical viewing angles kept within ± 5 degrees. The participants are told that they would see a series of English sentences, each of which is continuously represented in the form of common English section: word + auxiliary. "+" indicates that the sentence is about to start, and "???" indicates that the sentence is over. The participants are asked to make a grammar right/error judgment on the presented sentence. As shown in Figure 1, the presentation time of the gaze point is 500 ms, the presentation time of the sentence segmentation is 600 ms, and then the empty screen of 400 ms appears, that's, the stimulation SOA is 1000 ms, and the ISI is 400 ms. The time of judgment for subjects is 1500ms, and the sentences that are not judged in time are treated as errors. The experiment requires the participants to make grammatically judgment on each stimulus sentence presented. For the correct sentence, they should quickly and accurately press the left key of the game handle, and press the right key to the wrong sentence (The configuration of left and right keys are balanced in the test). The experiment is divided into two sequences with 2-5 minutes intervals for test between sequences, and the whole task of judgment takes about 40 minutes.

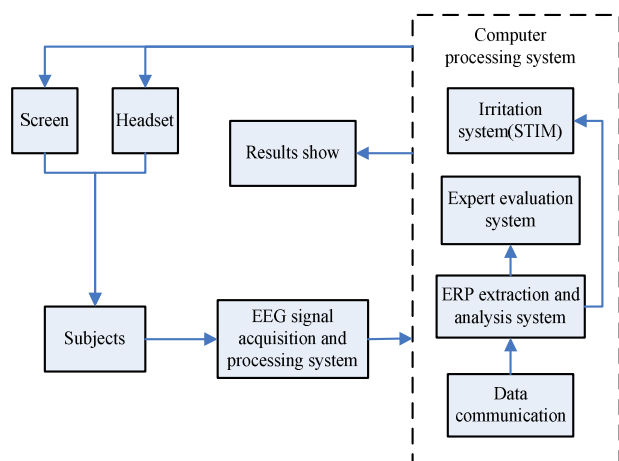


Figure 2. Schematic diagram of a brain wave test system

and the fill-in sentences are divided into two experimental sequences to be presented to the subjects in succession (the order of presentation is balanced). In order to ensure that experimental sentences expressing the same meaning do not appear at the same time as the presentation sequence, the correct and wrong sentences in meaning relationship are put into different sequences respectively. English words and

ERP record and analysis

A 32-channel EEG recorder is used in the experiment. The electrodes with Ag/AgCl are arranged in international 10 ~ 20 systems. The sampling rate of continuous EEG recording is 500Hz (electrode resistance < 5k Ω) and the bandwidth is 0.05 ~ 100Hz. AFZ is the ground electrode. The reference electrode of EEG is located in the left auricle, and the data in the late stages analyzed with the average reference of off-line two-ear connection. The horizontal and vertical eye EEG are recorded by two electrodes set respectively below the left eye and at the right



eye corner. The EEG off-line analysis used the first 200 milliseconds of target stimulation as the baseline brain wave. In data analysis at the later stage, BrainVision Analyzer 2, the EEG device attached software, is used to carry out 30Hz low-pass filtering (0.05Hz ~ 30Hz) for continuously recording EEG data. The eye EEG is corrected automatically for original data and the artifacts with amplitude of greater than $\pm 50\mu\text{V}$ are eliminated. From consecutive brain waves, each experimental condition is subjected to 1,200ms data segment sampling at a time interval of -200ms baseline to 1,000ms post-stimulus presentation, and the superposed average is completed by the segment sampling data.

Results

Because the correct judgment rate of 2-bit subjects is too low (<50%), the experimental data of the subjects are deleted from the statistical analysis. Table 2 shows the average judgment accuracy and reaction time (in parentheses) of 18 subjects under various experimental conditions. Analysis of repeated variance between subjects in the meaning relationship 2 (the meaning relationship is the same, and the meaning relationship is different) X correct & wrong 2 (the correct, and the wrong) indicates that for the average correct rate of judgment, the main effect of the meaning relationship is significant $F(1,17)=22.48, p<0.01$; the interaction effect between the meaning relationship and the correct & wrong is remarkable, $F(1, 17)=8.04, p<0.01$, under the condition of different meaning relations, the judgment of the correct sentence is superior to the wrong sentence (88% vs 82%). For the average reaction time, the main effect of meaning relationship is significant $F(1, 17)=4.25, p<0.05$, and there is no interaction effect ($F<1$). The correct rate of sentence judgment and reaction time under each condition is shown in Table 2, and the unit of number in parentheses is in milliseconds. The statistics of behavior data show that the meaning relationship has a significant influence on the accuracy and reaction time of the experimental sentences. The conditions with same meaning relationship are compared with different conditions, the accuracy and reaction time of the subjects are significantly improved. However, in the condition of the same meaning relation, there is no significant difference in the discrimination performance and reaction time between the right and wrong experimental stimulus sentences, and in the conditions of

different meaning relation, the discrimination performance of the right sentences is significantly higher than that of the wrong sentences, but there is no significant difference in the reaction time. The ERP data amplitude is shown in Figure 3. The statistical results of ERP data show that the right and wrong factors of the experimental stimulus sentences have significant influence on the average amplitude of the subjects, especially in the 300-500ms time window, and the wrong sentence judgment (column A) in the condition of the same meaning relationship leads to the significant negative phase waveform, which is distributed in the middle and back part of scalp, and the time window of its amplitude peak, showing that the waveform is N400 EEG component. In the same N400 time window, the wrong sentence judgment (column C) in the conditions of different meaning relationship does not produce significant N400 effect, and the waveforms of judging correct and wrong sentences coincide with each other. In the time window of 500 ~ 700ms, the negative phase waveform caused by right and wrong judgment under the condition of the same meaning relationship still persists, but in the condition of different meaning relation, the negative phase waveform caused by wrong sentence begins to appear, and the statistical tendency is significant in independent right and wrong average wave amplitude statistics. In the time window of 700 ~ 900ms, no P600 component or any late phase positive waveform component is found in ERP data statistics.

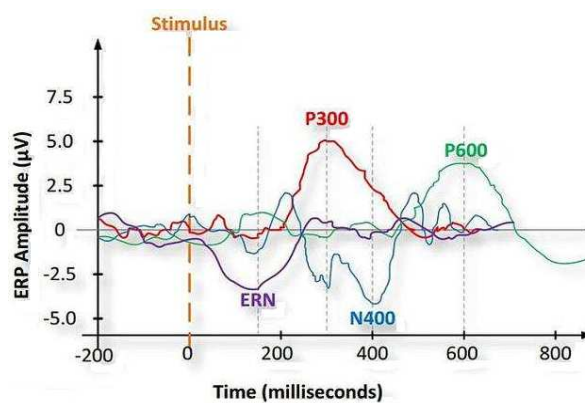


Figure 3. ERP amplitude data

Table 2. The correct rate of sentence judgment and reaction time under each condition

	Same	Different
Correct	92.85%(597.66)	87.69%(614.03)
Error	92.85%(601.46)	81.47%(633.78)



Conclusions

Through an empirical method of linguistic experiments, this study probes deeply into the influence of the deep meaning relationship of language on language transfer, and points out that the difference in the deep meaning relationship between mother tongue and target language should also be an important factor affecting the production of language transfer. The previous theories of language transfer pay attention to the differences in form and meaning between the mother tongue and the target language, and hold that the similarity in grammar and vocabulary between languages is the factor causing the phenomenon of language transfer in foreign language acquisition. This study compares English and Chinese, which differ greatly in language typology, to reduce the influence of the similarity of grammatical forms between languages on language transfer. At the same time, in order to reduce the influence of the similarity between English words and Chinese words on the transfer effect, the subjects are asked to make grammar judgment on English sentences to test their sensitivity to the allocation of case auxiliary words with verbs in English. The subjects in this experiment are all English learners with high proficiency. From the point of view of the correct discrimination rate of each experimental condition, the achievement exceeds 80% on average. It is found that the correct sentence and the wrong sentence are distinguished by the subjects according to the rules of English grammar rather than the similarity with Chinese words. The experimental results clearly show that language transfer is significantly influenced by the differences in the deep meaning relationship between Chinese and English.

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References

- Abu-Rabia S, Shakkour W, Siegel L. Cognitive retroactive transfer (CRT) of language skills among bilingual Arabic-English readers. *Bilingual Research Journal* 2013; 36(1): 61-81.
- Aburabia S, Shakkour W. Cognitive retroactive transfer (crt) of language skills among trilingual arabic-hebrew and english learners. *Open Journal of Modern Linguistics* 2014; 4(1): 1-20.
- Deng L. Cognitive theory of markedness and native language transfer. *International Research in Education* 2016; 4(1): 86-96.
- Diao X. Cross language transfer of metalinguistic awareness: A meta-analytic structural equation model for chinese-english bilingual children. *Brazilian Journal of Veterinary Research & Animal Science* 2015; 39(3): 129-35.
- Ito TA, Senholzi KB. Us versus them: Understanding the process of race perception with event-related brain potentials. *Visual Cognition* 2013; 21(9-10): 1096-120.
- Jing GA. Cognitive Language Transfer from Shandong Varieties to English Phonological Acquisition. *DEStech Transactions on Social Science, Education and Human Science*, 2016(icssd).
- Kim SI, Jeon KO, Son S. Effect of Caring for Potential Brain Death Organ Donors during the Organ Donation Process upon Physician Attitudes. *The Journal of the Korean Society for Transplantation* 2013; 27(3): 92-99.
- Liu H, Wang ZN, Wang Y, Ye Y, Fang HH. The cognitive processing mechanism of the double object structure of Chinese language in brain: evidence from event-related potentials. *Quarterly Journal of Chinese Studies* 2014; 3(1): 26-32.
- Michie PT, Budd TW, Fulham WR, Hughes ME, Jamadar S, Johnston P, Karayanidis F, Matthews N, Rasser PE, Schall U, Thompson PM. The potential for new understandings of normal and abnormal cognition by integration of neuroimaging and behavioral data: not an exercise in carrying coals to Newcastle. *Brain Imaging and Behavior* 2008; 2(4): 318-26.
- Moghaddam AN, Araghi SM. Brain-based aspects of cognitive learning approaches in second language learning. *English Language Teaching* 2013; 6(5): 55-61.
- Seer C, Fürkötter S, Vogts MB, Lange F, Abdulla S, Dengler R, Petri S, Kopp B. Executive dysfunctions and event-related brain potentials in patients with amyotrophic lateral sclerosis. *Frontiers in Aging Neuroscience* 2015; 7: 225-225.

