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Native Language Transfer in Vocabulary Acquisition: An Empirical Study From Connectionist Perspective

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***Abstract*—Since the 1940s, the behaviorist paradigm, contrast analysis hypothesis and mentalist model have focused much attention on explaining the L1 - L2 relationship and how it works in second language acquisition. These studies support that different linguistic features of L1 and L2 would lead to language transfer. Nevertheless, there are still some questions being asked: How does native language transfer occur? What are the effective teaching methods to help L2 learners overcome the challenges of native language transfer? This study investigates native language transfer among Chinese university students in second language vocabulary acquisition. The results show that the connectionist model can explain the cognitive process of native language transfer through a dynamic approach, and adequate language input with timely grammar correction can enhance learning efficiency. The connectionist teaching method is effective in second language vocabulary acquisition.**

***Index Terms*—native language transfer, second language vocabulary acquisition, the connectionist model**

I. Introduction

Native language transfer is always an exciting topic in second language acquisition research, and relevant theories have been coming forth, from behaviorist, mentalist, and cognitive views to the connectionist paradigm (PDP model). The Connectionist, or PDP model, developed by David Rumelhart and James McClelland (1986), recently has become a new theoretical framework under the interdisciplinary umbrella of cognitive, psychological, and neural science. They believe that, at the beginning stage of second acquisition, if the native language system is firmly established, it will strongly influence the learner's language use (O'Reilly & Rudy, 2001; Williams, 2003; Wang, 2009; Römer et al., 2014). All these studies and experiments either explicitly or implicitly support that the existed language system (native language patterns) will influence learners' second language vocabulary acquisition. Unlike Universal Grammar (UG), which studies static language ability, the connectionist model focuses on the dynamic language acquisition process, so it is much closer to language acquisition and application in reality (Tabor, 1997; Rohde & Plaut, 2003). Based on connectionist cognition, the learner constantly compares the second language acquisition (SLA) task with previous language experience, which will activate native language patterns spontaneously. Therefore, second language structure is mainly built upon native language construction and would be possibly influenced by the native language patterns (Kohnert et al., 1999; Luk & Bialystok, 2003; Moro et al., 2017).

Nevertheless, few researches studied the process of Chinese learners of the English language in the connectionist framework, and how connectionist teaching methods contribute to developing Chinese ESL learners' ability in vocabulary acquisition. The aim of this empirical study is twofold: (a) to verify the explanatory power of the connectionist model on language transfer; and (b) to figure out particular implications for EFL teaching and learning.

II. Literature Review

A. The Behaviorist View and Contrastive Studies: 1940s-1960s

Fries' and Robert Lado's language transfer studies focused on the factors that significantly influenced the L1 - L2 relationship and their roles in SLA. Fries (1945) formulated the need for contrastive analysis (CA). He proposed that the most efficient materials were based upon a scientific description of the language to be learned, and carefully compared with a parallel description of the native language of the learner. Harris (1954) developed a "transfer grammar" model based on Fries' contrastive analysis theory. Thereafter, the Contrastive Analysis Hypothesis (CAH), in its strong form, claimed to be able to make predictions about the difficulties which L2 learners of a particular L2 would experience, based on the language distance between L1 and L2. As Ellis put it: the degree of difficulty depended primarily on the extent to which the target language was similar to or different from a native language pattern (Ellis, 1994).

B. The Mentalist View: Late 1960s-1970s

By the 1970s, although some scholars questioned that contrastive analysis had no predictive power on the fact that learners would make language errors in an actual learning context, it cannot be simply denied that certain kinds of CA

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had the predictive ability with empirical evidence (Schachter, 1974). But how much a contrastive analysis can or should predict has remained a controversial question. Subsequently, language transfer studies were based on the idea developed by Dulay and Burt (1974) that, for children, second language acquisition was similar to first language acquisition, known as the "L2 = L1 hypothesis". Then, the morpheme order studies emerged, and there was justification in positing a "natural order" to acquire English morphemes. SLA was essentially no different from child native language acquisition, which basically conformed to the UG theory in language acquisition (Dulay et al., 1982; Anthony et al., 2017; Holzen et al., 2018).

C. The Cognitive Views: Late 1970s and Early 1980s – to Date

During the mid to late 1970s, the emphases of SLA were on determining how and when learners used their native language and explaining the language phenomenon. Thus, the study of language transfer has gradually come into the cognitive period. There were researches on language transfer in terms of linguistic universals and markedness theory, which inherited and developed the mentalist view in the cognitive framework.

Hyltenstam (1984) related the markedness theory to language transfer and believed unmarked categories from the native language were substituted for corresponding marked categories in the target language. Transferability was a relative motion depending on the psychotypology and prototypicality (Kellerman, 2008). The significance of these works is an attempt to place the study of transfer or cross-linguistic influence within a cognitive domain, and try to crack the code of neurolinguistic programming (Gooskens, 2007; Islam & Inkpen, 2008; Conneau & Guillaume, 2019; Kutsuki, 2021).

D. Summary

As for the language transfer studies, CA, morpheme order study, markedness theory, and Kellennan's prototypicality and psychotypology were the leading theories back then. By reviewing the development of studies on language transfer, we can see a series of substantial improvements; namely, the research in the cognitive view has provided various approaches to exploring why adult learners have particular troubles in L2 learning. They seem to be able to explain some problems that the behaviorist and mentalist domains failed to. Nonetheless, some questions are still being asked:

(1) How does language transfer occur?

(2) What are the effective teaching methods to help L2 learners overcome the challenges of language transfer?

This study is designed to apply the connectionist model in teaching Chinese university students of English, through which the mechanism, reason, and influence of native language transfer are expected to be explained from a new perspective.

III. Theoretical Framework of Connectionism and Connectionist Views on Language Transfer

A. Theoretical Basis of Connectionism

(a). The Notions of Neural Networks and Activation

A neural network consists of many units joined together in a pattern of connections. It is a feed-forward net, as demonstrated in Figure 1.

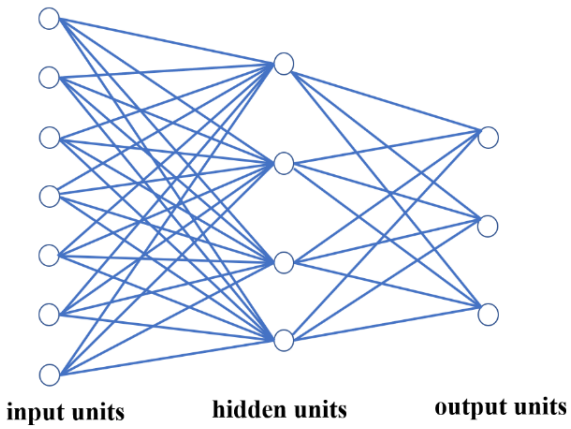

Figure 1 A Simple Neural Net

Outside stimulus flows from inputs to hidden units and then on to the output units. Each input unit has an activation value that represents a specific feature. An input unit transmits the value to the connected hidden units, and this signal is then transferred to output units or another layer of hidden units, and in the same way, those hidden units process their values similarly and send them along to their neighbors. Eventually, the signal at the input units expands through the net to determine the output units' values. Therefore, the weight of value represents the complexity of linguistic information processing.

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(b). The Rumelhart-McClelland Model

In standard PDP mechanisms, this model learns to map representations of present tense forms of English verbs onto past tense versions. It handles regular (talk/talked) and irregular (wear/wore) verbs, productively yielding past forms for novel verbs not in its training set. Besides, it distinguishes the variants of the past tense morpheme conditioned by the final consonant of the verb (walked versus jogged versus sweated). Furthermore, in doing so, it displays behaviors resembling children's cognition (Rumelhart & McClelland, 1986, 1987).

B. Connectionist Views on Second Language Vocabulary Acquisition

(a). On Learning

How word recognition occurs has been a critical issue for which the connectionist models try to account. In McClelland and Rumelhart's "interactive activation" model of word recognition, the network is entirely prespecified (i.e., it does not learn). It consists of a sequence of "layers" of units, as illustrated in the figure below.

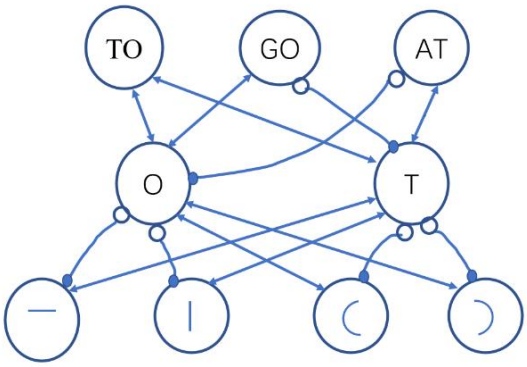

Figure 2 Connectionist Model of Word Recognition
(Excitatory connections are shown as arrows, whereas inhibitory connections have circular ends)
From Chater & Christiansen, 1999

Figure 2 shows that units in the first layer are specific to a particular visual feature of letters (in particular positions within the word). Units in the second layer stand for particular letters (also in particular positions within the word). Units in the third layer stand for words. Word recognition occurs as follows. Connectionists maintain that in language learning, one is not just learning a collection of unrelated items. Instead, the learning leads to a whole network of new connections (McClelland, 1989). In other words, the better connected the knowledge structure is, the more readily accessible it will be.

(b). On Language Transfer

Speakers of Chinese and English share a little in common culture, which results in differences in conceptual and grammatical organization. Furthermore, Chinese learners of English are more likely to feel confused about the differences in the beginning stage. According to Gass and Selinker (2000), there is a hierarchy of learning difficulties for second language learners, which also explains the challenges English language learners have been facing in China.

TABLE 1
HIERARCHY OF VOCABULARY ACQUISITION DIFFICULTY

Hierarchy of Vocabulary Acquisition Difficulty (Chinese as L1, English as L2)		
Category		**Example**
1	Differentiation	山-mountain/hill, kinship words
2	New Category	article system
3	Absent Category	classifier system
4	Coalescing	addressing words
5	Correspondence	the definition of concrete nouns and scientific terminology, syntactic location of nouns (as subject or object)

As illustrated in the table above, we classified the vocabulary acquisition difficulty for Chinese learners of English into five categories, which were through a continuum from comparatively easy to extremely difficult.

IV. THE EMPIRICAL STUDY

A. Research Questions and Hypothesis

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(a). Research Questions

Connectionists believe that adult learners of a second language have different acquisition mechanisms from children in native language acquisition, because second language learners start to acquire the target language after native language patterns are firmly established in the brain. Hence, they will inevitably encounter native language influence and language transfer.

The purpose of this study is to address the following questions:

RQ1: Can the connectionist model explain the language transfer process in Chinese learners' English vocabulary acquisition?

RQ2: Can enough frequency of input and timely correction facilitate learners' second language acquisition more efficiently?

The questions are worth answering with particular regard to Chinese university students, who comprise considerable Chinese ESL learners and have been struggling with English learning since elementary school.

(b). Hypothesis

It is hypothesized that enough frequency of language input and timely correction can facilitate learners' second language vocabulary acquisition more effectively.

The English teacher will vary the teaching methods with the classes. In the Experimental Group, the teacher will use the connectionist teaching method (as hypothesized). In contrast, in the Control Group, the teacher will continue to apply the traditional teaching method as before (mainly based on the Grammar Translation Method).

B. Research Design

(a). Subjects

The subjects of the study were first year non-English major university students from two natural classes (one for Experimental Group, the other for Control Group) in Business School and Criminal Investigation School. All students participated in 15-week classroom-based research. The subjects of the two classes were randomly from 31 provinces of China, aged 18 to 21. Before the experiment, they were in the same learning background of the English language: the same learning period, the same beginning book, and the same teacher. None had been informed that they would be selected for a teaching experiment.

(b). Materials

According to the university teaching program, non-English major students had three periods (2 hours) of English class per week this semester.

In the Experimental Group: as the connectionist teaching method suggests, the teacher designed teaching plans and collected specific materials to create a rich, contextualized, and naturally-occurring language environment. The teaching materials were mainly from the current English textbook, in which the passages cover the six hierarchical aspects in proper difficulty. Additionally, the teacher added necessarily relative complementary language materials from *A Course of New English Grammar* (Zhang & Dai，2016) and *Language and Culture* (Deng & Liu，2018).

In the Control Group: in this class, the teacher still adopted the same English textbook and traditional teaching method, *A Course of New English Grammar* (Zhang & Dai，2016), for reference.

(c). Method

1. Stages of the Experiment

The teaching experiment started from March 2nd to June 8th, 2022, for fifteen weeks, which consisted of three stages that both the Experimental Group and the Control Group experienced: (1) pre-test at the beginning of the experiment, (2) teaching activities in the whole experiment, (3) post-test at the end of the experiment.

2. Between-Group Design

All the students in the two classes were scored on two vocabulary tests: pre-test (before experimental teaching activities) and post-test (after experimental teaching activities). This study focused on three data pairs, so they were abbreviated respectively for convenience: 1. E (the pre-test scores of the original 40 students), C (the pre-test scores of the original 39 students); 2. E1 (the pre-test scores of 30 subjects in the Experimental Group), C1 (the pre-test scores of 30 subjects in the Control Group); 3. E2 (the post-test scores of 30 subjects in the Experimental Group), C2 (the post-test scores of 30 subjects in the Control Group). Between-group comparisons showed that E1 and C1 were at nearly the same level. Provided E1 and C1 do not differ significantly but E2 and C2 differ significantly, we can conclude that the connectionist teaching method is notably more effective than the traditional one in promoting Chinese ESL learners' second language vocabulary acquisition. Moreover, the Connectionist view has explanatory power on language transfer.

3. Statistic Analysis Methods

First, subjects for the empirical study were selected. Although all the students in EG and CG participated in the whole

experiment process, including the pre-test, teaching procedure, and post-test, some were trimmed out of the further experiment list. When we obtained the data in the pre-test, we chose the intermediate-level students with the same number in both classes. The scoring was reliable because the vocabulary test topics were chosen randomly from CET4 papers and grammar books. We applied the Cronbach's Alpha test in SPSS 26.0 to the scores of the subjects in the Experimental Group and the Control Group to ensure reliability. Moreover, the two vocabulary tests should be at the same difficulty level, so we randomly selected ten students from other schools of the university to complete the pre-test and the post-test within 80 minutes. Then we used the scores to conduct a paired-sample T-test to ensure that the difficulty of both pre-test and post-test were at the same level.

Independent-samples T-tests were used to make a between-group study (EG vs. CG in the pre-test and the post-test) to see if there was any difference between the EG and the CG in the pre-test and post-test. Exactly, there should be seven times T-tests separately for the six different sections and the total scores. We hypothesize that seven times T-tests demonstrate that subjects' scores in the Experimental Group and Control Group do not significantly differ in the pre-test but in the post-test.

(d). Procedure

1. Teaching Activities

The connectionist teaching method was applied to teaching English vocabulary in the Experimental Group. In contrast, the traditional way of teaching vocabulary (presentation and production) was applied in the Control Group by the same teacher and using the same teaching time frame (2 hours of English lesson per week for each class).

(1). Teaching Activities in the EG:

According to the connectionist teaching model, the classroom procedure for the Experiment Group was composed of three stages: training preparation phase, training phase, and consolidation phase. In the training preparation phase, it was necessary to raise students' consciousness of the general rules of the target language and to activate the schematic knowledge. To achieve the pre-training goal, we asked students to collect materials comparing Chinese and English vocabulary before class. The teacher guided them to present their findings through designed activities, such as group discussion, class reports, and presentations.

In the second phase, after the preparation in the first step, students gained a general understanding and awareness of the differences between Chinese and English vocabulary rules, so the teacher encouraged them to optimize their previous vocabulary learning methods. The training process comprised the following steps: firstly, students were asked to preview the learning materials and figure out difficult language points, because self-preparation would help them pay more attention to the languages phenomena (e.g., vocabulary rules); secondly, after the teacher briefly introduced the background information, learning points were presented, and those materials related to vocabulary acquisition became the target of specific drills. The vocabulary acquisition practice was organized in the following steps respectively:

Figure 3 Training Model for New Category
(not influenced by native language)

If the knowledge is a new category in a second language, students have no such pre-learning experience, which means there is no similar pattern in the native language. The teacher would keep enough input frequency to help students foster relative networks and patterns of the second language (as shown in Figure 3).

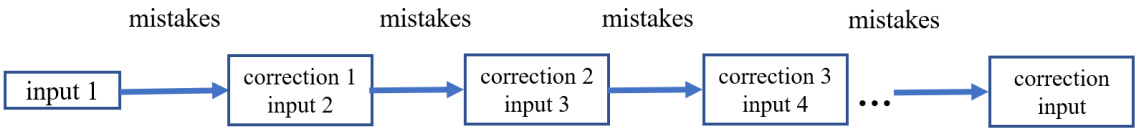

Figure 4 Training Model for Differentiation Category
(influenced by native language)

When the knowledge is a differentiation category including one-many, many-one, absent, and coalescing categories, the students will inevitably be interfered with by the previous firmly established native language patterns and thus make mistakes. In addition to the input frequency, the teacher should then pay attention to correcting language errors timely (as shown in Figure 4).

The last stage was the reflection and consolidation stage. Students were directed to reflect upon their performances. The activities in this stage included the teacher's explanation, exercises, tests, and assignments. Therefore, according to the research goal, the teacher should predict the difficulty levels of language materials in advance and design specific

and appropriate teaching plans and activities.

The study covered all the language materials (Unit 1 to Unit 5) in the fifteen experimental weeks. We take "Unit 1 How I got smart?" as an example to explain the experimental group's teaching procedures.

(1) At the beginning, two or three students were asked to share views on their teachers and list the differences in interpersonal relationships between "students – students" and "students – teachers" in both the Chinese and English cultures.

(2) Then, the teacher briefly introduced the background information, analyzed the organization of the text, and outlined the main language points.

(3) After students were more familiar with the text and language points, a set of exercises were designed for practicing (focusing on vocabulary acquisition), such as making dialogues with given words and drawing a vocabulary tree with relative Chinese and English expressions. Throughout the process, the teacher did not teach vocabulary rules but instead provided enough language materials for students to practice and find rules on their own.

(4) Debate was arranged at the end of the class after students could handle most of the language problems. The topic was "Self-driven force is more helpful than external encouragement for a person to face challenges." At this stage, the teacher was mainly an observer who would only offer a few suggestions in the process of debate. Afterward, the teacher commented on the students' performance, pointed out the language errors, and promptly corrected these mistakes.

(5) Students were assigned an after-class project to go further and do self-study on the relationship between "talent, hard work and success". They were asked to write an essay covering these vocabulary rules and main ideas they had just learned as a consolidation exercise.

(2). Teaching Activities in the CG:

The Control Group received the traditional Grammar Translation approach in English class. The teaching plan was illustrated as presentation, practice, and production. In the first stage, the teacher explained language points (e.g., grammar rules and vocabulary rules) in the native language to maximize the chances that the underlying rule would be understood and internalized. Secondly, students were asked to memorize language rules arranged by the teacher and do translation work. Finally, specific assignment based on vocabulary rules was given to students both in or after class, and the teacher collected the feedback from students' works.

"Unit 1 How I got smart?" was still an example of teaching activities in the Control Group.

(1). Check students' preview works. Students were also required to collect related information about the relationship between "talent, hard work and success"; then, the teacher asked several students to share their views, such as experiences of overcoming troubles and ways to stay optimistic and set up life goals.

(2). The teacher gave a background introduction and guided students through the text. Vocabulary rules in the text were marked out and explained in the native language, and students were asked to take the notes as the reciting materials later. For example, there was a word "hated" in "On the contrary, I hated compulsory education with a passion. …" Teacher listed the spelling rules of regular and irregular verbs: (1) "want" + "ed" (common verbs), (2) "invite" + "d" (verbs ended with letter "e"), (3) "study"→"stud" + "ied" (verb ended with "consonant + y"), (4) "thin" →"thinn" + "ed" (verbs ended with stress syllable and consonant letter), and then students were asked to memorize the rules.

(3). After the teacher presented these language rules in the class, relevant practices were incorporated to reinforce what they had learned. Translating English (Chinese) sentences into Chinese (English) has been the primary method for students to practice and apply language rules in formal situations, so students were required to do a set of English – Chinese translation works. Additionally, students were asked to do pair works such as making dialogues with given words to internalize the newly grasped vocabulary rules. These translation exercises were designed both in and after class.

2. Pre-Test and Post-Test

The EG and CG learning hours of English classes were guaranteed per week. Besides, each test was given at the beginning and end of the teaching experiment. The pre-test was designed to assess students' language level of second language vocabulary acquisition before the teaching experiment. The post-test was conducted at the end of the study to measure the subjects' final language level after the teaching experiment. Each test consisted of six sections representing the five difficulty levels in the hierarchy (Table 1). The duration of each test was forty minutes.

(1). Pre-Test

In the beginning, the pre-tests were conducted in the experimental and control classes. All the students in these two classes were required to finish the test of six sections in the same test environment.

No student was absent from this test, so it was possible to select 60 subjects from 79 students. These students (30 in each class) were selected as subjects according to the intermediate level of the scores for the Experimental Group and the Control Group.

(2). Post-Test

Approximately 75.95% of students were chosen as the subjects of the intermediate level of the experiment according

to their scores. At the end of the teaching experiment, another test was conducted in the same test environment, which also consisted of six sections of vocabulary rules. All 79 students participated in the test, but only the 60 subjects' scores were recorded for further analysis.

C. Results and Data Analysis

(a). Results of Pre-Test

The total score of both pre-test and post-test was 100 points, composed of six sections. In detail, section I 20 points, section II 20 points, section III 10 points, section IV 20 points, section V 20 points, and section VI 10 points.

Although all the students from the two classes participated in the whole experiment process, not all of them were selected as the subjects. That is to say, only the intermediate-level students were marked as subjects to ensure that the levels of subjects in the Experimental Group and the Control Group were not significantly different in language use before the teaching experiment. The average score of the two classes in the pre-test was 49.62069, so 15 students above and 15 below the average score were selected out of each class. Thus these 60 students were the subjects of this experiment.

Before the experiment, a paired samples T-test was conducted to testify the two test papers, to ensure the pre-test and post-test were at the same difficulty level and the six sections were respectively at the same level. We selected ten students with the same English background, age, and grade as the subjects to do the pre-test and the post-test within 40 minutes. Scores, including the total and these of the respective sections, were taken out to have a paired sample T-test to ensure that the two test papers and the six sections were at the same difficulty level. In Table 2 below, for Pair 1, the analysis of the total scores from pre-test and post-test shows that df = 9, t = .000, P = 1.000 which means the ten students' total scores of pre-test were the same as in the post-test by coincidence, so the two items of total scores did not differ at all; for Pair 2 to Pair 7, df are all "9" and t_2 = .279, p_2 = .782; t_3 = .320, p_3 = .761; t_4 = -.316, p_4 = .726; t_5 = -1.5000, p_5 = .168, t_6 = .176, p_6 = .864, t_7 = 1.5000, p_7 = .168. The results show that the ten students did not significantly differ in performance and vocabulary competence in the pre-test and post-test. Accordingly, we concluded that the two test papers and the six sections of vocabulary categories were at the same level in difficulty.

TABLE 2
PAIRED SAMPLES TEST ON THE DIFFICULTY LEVEL OF PRE-TEST AND POST-TEST PAPERS
PAIRED SAMPLES TEST

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 total 1-total2	.00000	2.47199	.81650	-1.84704	1.84704	.000	9	1.000
Pair 2 S(one)-S1	.10000	1.10060	.34801	-.68725	.88725	.279	9	.782
Pair 3 S(two)-S2	.10000	.99433	.31447	-.61137	.81137	.320	9	.761
Pair 4 S(three)-S3	-.10000	.87561	.27689	-.72636	.52636	-.361	9	.726
Pair 5 S(four)-S4	-.40000	.84319	.26667	-1.00324	.20324	-1.500	9	.168
Pair 6 S(five)-S5	-.10000	1.79173	.56667	-1.38189	1.18189	-.176	9	.864
Pair 7 S(six)-S6	.40000	.84281	.26667	-.20324	1.00324	1.500	9	.168

Then, a Cronbach Alpha test in SPSS 26.0 was applied to the scoring of the 60 subjects' proficiency in second language vocabulary to see if the scoring was reliable or not. As shown in Table 3, the test was reliable with Cronbach's Alpha .821.

TABLE 3
RELIABILITY ANALYSIS OF PRE-TEST
RELIABILITY STATISTICS

Cronbach's Alpha	N of Items
.821	8

Afterward, an independent samples T-test at the .05 level was employed to compare the scores of subjects assigned to the Experimental Group and those of subjects assigned to the Control Group, to see whether the two groups differ significantly. In Table 4, the Experimental Group and Control Group did not differ in their variances, for P_{total} = .301, P_{S1} = .720, P_{S2} = .911, P_{S3} = .451, P_{S4} = .931, P_{S5} = .443, P_{S6} = .957. Moreover, the two groups did not differ in their means of scores:

t_{total} (58) 0.05 = -.242 (two-tailed), P_{total} = .810;
t_{s1} (58) 0.05 = .273 (two-tailed), P_{S1} = .784;

t_{s2} (58) 0.05 = .250 (two-tailed), P_{S2} = .802;
t_{s3} (58) 0.05 = .320 (two-tailed), P_{s3} = .748;
t_{s4}(58) 0.05 = -.291 (two-tailed), P_{s4} = .770;
t_{s5} (58) 0.05 = .660 (two-tailed), P_{s5} = .512;
t_{s6} (58) 0.05 = -.551 (two-tailed), P_{s6} = .583.

Moreover, the mean difference was very slight, as demonstrated in Table 4. The results indicated that the 30 students selected for the Experimental Group were at the same level of vocabulary competence as the other 30 students in the Control Group at the beginning of the experiment.

TABLE 4
INDEPENDENT SAMPLES TEST ON PRE-TEST SCORES OF EXPERIMENTAL GROUP AND CONTROL GROUP
INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		T-test Equality of Means						
		F	Sig.	t	df	Sig. (2-dtailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
total	Equal variances assumed	1.087	.301	-.242	58	.810	-.36667	1.51656	-3.40240	2.66906
	Equal variances not assumed			-.242	56.162	.810	-.36667	1.51656	-3.40451	2.67118
section 1	Equal variances assumed	.128	.720	.273	58	.784	.13333	.48597	.83944	1.10611
	Equal variances not assumed			.273	57.656	.784	.13333	.48597	.83957	1.10624
section 2	Equal variances assumed	.013	.911	.250	58	.802	.26667	1.06152	-1.85819	2.39153
	Equal variances not assumed			.250	57.675	.802	.26667	1.06152	-1.85845	2.39178
section 3	Equal variances assumed	.576	.451	-.320	58	.748	-.13333	.41477	-.96358	.69691
	Equal variances not assumed			-.320	57.366	.748	-.13333	.41477	-.96377	.69711
section 4	Equal variances assumed	.007	.931	-.291	58	.770	-.13333	.45654	-1.04720	.78053
	Equal variances not assumed			-.291	57.838	.770	-.13333	.45654	-1.04725	.78059
section 5	Equal variances assumed	.598	.443	-.660	58	.512	-.33333	.50393	-1.34206	-.67539
	Equal variances not assumed			-.660	57.768	.512	-.33333	.50393	-1.34215	-.67548
section 6	Equal variances assumed	.003	.957	-.551	58	-.583	-.16667	.30280	-.77278	.43945
	Equal variances not assumed			-.551	57.909	-.583	-.16667	.30280	-.77280	.43947

(b). Results of Post-Test

Similarly, a Cronbach Alpha test was also made on the post-test scoring of the 60 subjects' proficiency in second language vocabulary. The result shows that the scoring was reliable, with Cronbach's Alpha as high as .878.

TABLE 5
RELIABILITY ANALYSIS OF POST-TEST
RELIABILITY STATISTICS

Cronbach's Alpha	N of Items
.878	8

In addition, an independent samples T-test at the .05 level was made on the scores of subjects in the Experimental Group and the Control Group, and the significance was considered by single-tailed. Table 6 shows that subjects in the Experimental Group and Control group significantly differed from each other in total scores, section 2, section 3, section 4, section 5, and section 6, for P_{total}, P_{s2}, P_{s3}, P_{s4}, and P_{s6} = .000 < .05, P_{s5} = .0174 < .05, except P_{s1} = .216 > .05. The results strongly supported the hypothesis: section I was a test of correspondence category which could be easily acquired and native language had little adverse influence on it, so subjects from the two groups did not differ from each other in their performance of this part, but section 2 to section 6 were differentiation categories, as hypothesized, the teacher should guarantee enough frequency of input and timely correct students' language errors to promote students' learning outcomes in second language vocabulary acquisition. Therefore, the Experimental Group subjects were significantly better than the Control Group subjects.

TABLE 6
INDEPENDENT SAMPLES TEST ON POST-TEST SCORES OF EXPERIMENTAL GROUP AND CONTROL GROUP
INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		T-test Equality of Means						
		F	Sig.	t	df	Sig. (2-dtailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
total	Equal variances assumed	5.387	.024	6.094	58	.000	14.56667	2.39044	9.78168	19.35166
	Equal variances not assumed			6.094	51.148	.000	14.56667	2.39044	9.76799	19.36534
section 1	Equal variances assumed	.094	.762	-.795	58	.216	-.36667	.46109	-1.28964	.55631
	Equal variances not assumed			-.795	57.901	.216	-.36667	.46109	-1.28968	.55634
section 2	Equal variances assumed	.000	.983	9.227	58	.000	8.10000	.87785	6.34280	9.85720
	Equal variances not assumed			9.227	56.939	.000	8.10000	.87785	6.34210	9.85790
section 3	Equal variances assumed	1.512	.224	4.932	58	.000	1.66667	.33790	.99029	2.34305
	Equal variances not assumed			4.932	56.156	.000	1.66667	.33790	.98981	2.34305
section 4	Equal variances assumed	.904	.345	3.911	58	.000	2.20000	.56256	1.07391	3.32609
	Equal variances not assumed			3.911	55.664	.000	2.20000	.56256	1.07290	3.32710
section 5	Equal variances assumed	1.395	.242	2.162	58	.0174	1.53333	.70911	.11390	2.95277
	Equal variances not assumed			2.162	57.306	.0174	1.53333	.70911	.11353	2.95313
section 6	Equal variances assumed	9.714	.003	4.911	58	.000	1.43333	.28721	.85842	2.00825
	Equal variances not assumed			4.911	45.387	.000	1.43333	.28721	.85500	2.01167

The above analysis found that by applying the connectionist teaching method to the Experimental Group for fifteen weeks, the 30 subjects made considerable progress in second language vocabulary acquisition. Other things being equal, except for the teaching approach, the mean score of the EG in the post-test was significantly higher than the one of the CG, which supported the hypothesis that enough input and appropriate correction would facilitate the students' competence in second language vocabulary acquisition.

D. Discussion

The connectionist model focuses on the dynamic process of second language acquisition rather than language rules learning. It believes previous learning experience has influences on the later learning input; that is to say, before acquiring a second language, learners have stored native language forms in their brain with fixed probabilistic patterns; the longer the native language is used, the more chances its probabilistic patterns will be activated, and the weight of native language knowledge will gradually increase. In learning a second language, the fixed native language pattern is probably activated if the second language has similar elements, and then language transfer occurs. If the transfer

patterns are different, the difference will hinder both learners' learning speed and accuracy in using the second language.

According to connectionist views on native language transfer in second language acquisition, our empirical study aims to answer two questions: whether the connectionist model has explanatory power on native language transfer in a natural teaching environment for Chinese ESL university students? And can the connectionist teaching methods enhance students' learning efficiency? The data demonstrated that subjects of EG significantly differed from the other 30 students of CG in vocabulary tests. In EG, the teacher adopted a connectionist teaching method to promote students' competence in second language vocabulary acquisition. Language materials were classified into different vocabulary categories based on the relative hierarchy of difficulty; specific teaching plans and practice organization were designed to facilitate students' vocabulary acquisition. During the teaching process, language materials were frequently and repeatedly presented to the students, who were required to practice in various forms.

Meanwhile, the teacher had timely correction of students' language mistakes. The teacher continued the traditional teaching method in the CG through presentation, practice, and consolidation. Apparently, and most importantly, the different ways of practice in EG and CG directly resulted in the subjects' divergence of vocabulary competence.

V. Conclusion

A. Findings and Implications

The empirical study conducted in the Experimental Group and Control Group found that no matter whether L2 words were introduced directly or indirectly, learners began acquiring words by processing those words as input, focusing on how and when target words were presented. Learners could not use a new word unless they had opportunities to perceive and process the form of the word and to activate at least some component of the word's meaning. Before learners can use target words, they need to process the new words as input in one way or another.

Unless alternative methods of processing new words were provided, students often looked up new L2 language points on vocabulary lists in textbooks as an initial learning way. In fact, many other approaches to presenting new L2 vocabulary as input are available. For example, by direct instruction, vocabulary can be introduced by pictures or drawings, pointing to and discussing real-world items, or providing definitions of target words and expressions. By indirect context-based instruction, vocabulary can be presented during topic discussions, while telling stories, or within reading passages. In addition to the basic need for new words to be presented as the input, presenting them frequently and regularly is also quite critical. We believe that all other things being equal, the memory for information will depend on the number of times learners have encountered or studied it. It has precisely illustrated connectionist views on language transfer: native language does influence second language acquisition, and enough frequency of input and corrections can help learners to overcome it. Positive effects of increased exposure to L2 words have been demonstrated in text-based and direct vocabulary learning (Hulstijn et al., 1996; Wu & Dredze, 2019).

B. Limitations

(a). Limitations of the Connectionist Model

The connectionist model cannot account for all areas of human cognition, although many try to resist external explanations. The connectionist model is good at the lower level of cognition, such as content addressability, low-level perception, and spontaneous generalization. However, there has been little success in discovering such examples at higher levels of cognition. We should not be trying to explain all things at all levels. Nevertheless, we could fall back on the idea of levels: capturing syntactic structure, developmental sequences, non-human behavior, and differences from symbolic processing.

(b). Limitations of the Empirical Study

Admittedly, with subjective and objective constraints during the experiment and as tentative and small-scale research, this study has some limitations.

This empirical research dealt with a minimal English learning population; that is, the samples were not large enough. Therefore, the results of the present study might not apply to students with different learning backgrounds. Furthermore, this drawback may affect the generalization of the teaching experimentation. Besides, the duration of the experiment was merely fifteen weeks, so it might be doubted whether the same results would still emerge in a longitudinal study. Also, the teaching object in the present study only focused on the English vocabulary rules. We still need to explore and answer whether the results apply to other types of language rules, such as phonologic, semantic, and syntactic rules.

We sincerely hope that, rather than being seen simply as a drawback in the present study, these limitations will be used as the ground for future research.

C. Further Research Suggestions

Since the present study is not perfect, using the connectionist teaching method remains an intriguing proposal that needs further study. The following are some suggestions. Firstly, we should conduct a longitudinal study to test the effectiveness of the connectionist teaching method in the language teaching field. Secondly, we should try to include a larger population with different backgrounds to find shreds of evidence for or against the applicability of the

connectionist teaching method. Finally, the present study involves university students who have learned English for several years and have reached the intermediate level. Attempts might be made to see whether the connectionist teaching method can also be applied to students at elementary levels.

So far, the short-term effects of the connectionist teaching method in teaching vocabulary rules have been recognized in this study. However, deciding which mode is more suitable for a particular group of students is sophisticated. Efforts should be made to prove the application or combination of different modes of instruction.

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