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# Parallelism Effects in Chinese Coordinate Structure: Evidence from Eye Movement Study

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## Abstract

When reading two phrases or clauses with the same structures, the second constituent of the parallel structure is processed faster when it parallels the first constituent, this phenomenon is named as parallelism effects. In English, parallelism effect occurs in coordinate structure which is also a common type of phrase structure in Chinese, so this effect also happens in processing Chinese coordinate structure. In Chinese, several coordinate phrase structures coexist such as coordinate structure with conjunction "HE"(and) or Chinese punctuation marker (、), as well as label free coordinate structure. In the present study, a single factor and two-level experimental design was carried out to explore the parallelism effects of different coordinate phrase structures in Chinese. By adopting eye tracker, the experiment involved 41 Chinese native coming from different schools of Hunan University. Results showed that: 1) There were parallelism effects in coordinate structures with "HE" and Chinese punctuation marker (、), while the parallelism effect in processing of label free coordinate structure is not obvious. 2) There were significant differences in eye movement among these three Chinese coordinate structures during reading process. 3) The parallelism effect in Chinese coordinate structure is a special form of syntactic prediction, and it is not the result of syntactic priming.

## Keywords

Parallelism Effects, Coordinate Structure, Syntactic Prediction, Eye Tracking

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## 1. Introduction

As early as 1984, Frazier and other scholars did several experiments to test subjects' understanding of five different types of sentences, finding that when two parallel phrases or clauses with the same syntactic structure wereprocessed by subjects, the latter fragment's procession might be promoted. They named this phenomenon as parallelism effect [7]. Since then, a series of studies have verified the existence of parallelism effect [1, 4, 9, 10, 14-16, 19].

Being similar to parallel structure, the coordinate structure of Chinese sentence is of great importance to Chinese syntactic structure analysis. Several words or phrases with same structure and syntactic role are combined in a sentence, which is able to make the sentence tense clear and logical and to further promote comprehension. Thus, coordinate structure in Chinese is a special form of parallel structure. The purpose of this research is to explore the parallelism effect in Chinese sentence processing, and three research questions are as the followings: 1) Whether there is parallelism effects in processing all these three types of Chinese sentence structures: the coordinate structure with "and", the coordinate structure with Chinese punctuation marker (、) as well as the label free coordinate structure? 2) What is the difference of eye movement indexes among coordinate structure with "and" or Chinese punctuation marker (、) as well as the label free coordinate structure in procession? 3) If there is parallelism effect in the processing

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of these three types of Chinese coordinate structures, what is the mechanism underlying parallelism effect, syntactic prediction or syntactic priming?

Only a few studies have been done to explore the parallelismeffect in Chinese coordinate structure. And the coordinate structure in Chinese sentences can be recognized no matter if it is accompanied with coordinating marker and conjunction or not. This kind of phenomenon is so special in Chinese language that it should be analyzed and discussed by experiments. In addition, much effort has been devoted to using eye tracking technology to do studies on the parallelism effect, which is a natural and online way to understand learners' implicit procession mechanism [2]. Thus, in the present study, Eyelink was adopted to study the parallelism effect in Chinese coordinate phrase structures including three types of coordinate structures with the conjunction "HE"(and), Chinese punctuation marker (、), as well as label free coordinate structure.

# 2. Parallelism Effect

## 2.1. Parallel Structure

Parallel structure refers to the two components in a sentence whose structure and syntactic role are similar to each other, that is, these two components get the same structure with similar grammatical forms in a parallel state. The new Oxford English Dictionary defines parallel structure as, "the use of successive verbal constructions in poetry or prose which correspond in grammatical structure, sound, meter, meaning, etc." Parallel structure is also a kind of rhetorical device which requires the parallel elements having the same important ideas, or concepts, and this device can make sentences maintain balance and coordination, thereby increasing the consistency of the language.

In several languages, the components in a parallel structure can be words, phrases, or sentences, which require that these constituents correspond to the same one type in a sentence. So, these components are frequently represented with conjunctions. There are many English conjunctions such as "and, but, or, as well as, rather.....than...." and so on. And the common coordinate conjunctions in Chinese are "HE" (and), "HUO"(or), "QIE" (and) etc, and research has been done to explore them [22, 23].

## 2.2. Coordinate Structure

The parallel structure represents a set of coordinate concepts that are not divided into primary and secondary. The meaning of coordinate structure is specific, and the similarity of the coordinate elements equips them with the feature of parallelism. In this term, coordination could refer to either two coordinate components with conjunction or without conjunction. In every language of the world, two kinds of the most frequent coordination means are, the speech pause and the conjunction words like "and". Speech pause in writing always uses the punctuation markers to illustrate. The punctuation markers are usually divided into two types: Chinese punctuation marker (、) and comma. Both of them can be utilized in Chinese language, in which the combined structure is also called the coordinate structure. And the joint items in a coordinate structure can be put together without any marker as well. Two or more parts are usually included in such a structure, whose relations are coordination, selection or progression.

The present research explored three types of coordination structure in Chinese:

1) structure with conjunction "HE"

Zhe li you hong se de hua he lv se de cao.

*There are red flowers and green grass.*

2) structure with Chinese punctuation marker (、)

Ta rang fu wu yuan jia yi ping mao tai 、liang ban lu cai.

*He lets the waiter serve a bottle of Maotai, two plates of pot-stewed meat.*

3) structure with no conjunction or punctuation marker

Nian qing ren bi jiao kan zhong fang zi che zi.

*The young men comparatively value house car.*

## 2.3. Studies on Parallelism Effect

Mehler and Carey [11], in their perceptual set studies, have shown that during theprocessing of a series of sentences, the syntactic or prosodic structure of the preceding sentence influences the processing of the following structure. From 1980s, many scholars have paid attention to this language phenomenon and they found this parallelism effect in some sorts of language structures. Frazier et al. [8] first studied the parallel structure and proved the existence of the phenomenon of parallelism effect. They defined it as is a phenomenon in which the second constituent of a coordinate structure is processed faster when it parallels the first constituent in comparison with when it does not parallel the first constituent [8]. Ageneral framework of parallelism effect has been provided by scholars from different perspectives. For procession mechanism, Dubey, Keller and Sturt [4] through the analysis of the corpus constructedPCFG model, which claims the possibility of the existence of one letter in readers' memory is inversely proportion to the processing cost. For influencing factors on parallelism effect, Duffield et al. [6], using VP-ellipsis structure from English and Dutch as

materials, found that second language learners and native speakers differed a lot in overall sensibility of parallelism effect for that they were influenced by other syntactic forms. Frank [7] found that coordinate structure was not the necessary factor to make parallelism effect happen. Crocker [3] adopted eye tracker to provide evidence for an across-the-board account of parallelism for processing and-coordinated clauses, in which both constituent order and semantic aspects of representations contribute towards incremental parallelism effects.

In Chinese, Wu Yunfang [20] through studying the coordinate structure based on Chinese corpus, found that there are two kinds of parallel distribution in coordinate structure: structure with quantitative attribute and “DE” attribute. The percent of these two sorts of coordinate structure above is over ninety percent, which indicates that the parallel structure in Chinese coordinate sentence widely exists. Li Ying et al. [10] studied the effect of Chinese compound structure and the serial-verb construction. Their experimental results show that parallelism effect exists in Chinese coordinate sentences with conjunction “HE”(and), but not in the serial-verb construction. The reason for this result is that there are strict requirements on the sentence pattern in the parallelism effect, and it only exists in the special sentence patterns.

### 2.4. Controversy on the Reasons of Parallel Effect

On the reasons of the parallelism effects, most of the scholars have conducted a more in-depth study. There are two main explanations: one is the syntactic prediction effect, and the other is the syntactic priming mechanism.

Some scholars said that parallelism effect is a special form of syntactic priming mechanism, which has two parallel components: start and goal. The procession of start will promote the procession of the target. This special syntactic priming effect is reflected in the process of reading comprehension [4], [5]. That is, the parallelism effect not only exists in the coordinate sentence, but also exists in non-coordinate sentences, which is a special form of syntactic priming. If a language unit is the same as another one in the syntactic form, the processing of the previous language unit will facilitate that of the latter [13]. This phenomenon is the syntactic priming effect, because readers prefer the syntactic form which has been used recently. The previous scholars in experimental studiesfound syntactic priming effect which not only exists in sentence production, but also exists in the process of sentence comprehension [12], [17]. In 2008, Dubey, Keller and Sturt [4] analyzed the parallel structure in coordinate and non-coordinate sentence through corpus analysis. They think the parallelism effect is a special example of syntactic priming effect, and a significant structure in the corpus. Although the trend in parallel sentences is more obvious, it is not restricted to the coordinate structure. In this paper, Dubey et al. [4] applied probabilistic analytical model (PCFGs) to prove that the parallelism effect is a special case of syntactic priming effect. Frank [7], throughthree eye movement experiments, proved that the parallelism effect exists both in the coordinate sentence and non-coordinate sentence. The result indicates that the effect of parallel processing advantages in parallel structure is not caused by special syntactic context, but the performance of syntactic mechanism.

The experiments of Apel & Frazier [1], Li Ying [10] deduce that the parallelism effect was related to the syntactic prediction effect. In 2000, Frazier et al. [9] have argued that parallelism effect occurs only in some special sentences, such as coordinate sentences. Two kinds of coordinate sentences were adopted: with and without the conjunction ‘and’. Under the condition of the absence of ‘and’, parallelism effect was not found in those sentences. That is to say, the word "and" is closely related to the production of parallelism effect. ‘And’ in the coordinate sentence is a function word with syntactic prediction. The processing speed becomes faster when it appears the sentence. In addition, the two parallel components in coordinate structure will effectively increase the procession of syntactic information belonging to the second component. Thus, its burden of memory would be reduced and the processing resources are released. Finally, all stages of sentence comprehension will become easier. Staub et al. [17] utilized English as material to investigate the syntactic prediction effect. The results show that if there is a prediction conjunction in a sentence, which will have an improvement in the reading speed. In 2007, Apel, Knoeferle and Crocker [1] took sentences of German language as the experimental materials by using eye tracking technology. They got the result that in parallel structure the subjects’ regression path time is shorter than that of non parallel structure and they also established the computational model of parallel structure processing. The experimental results show that the parallelism effect is related to the syntactic prediction. Furthermore, Coordination-Module is established by Apel et al. [1] to explain syntactic prediction effect. That is to say, the parallel syntactic structure has no effect on structural representation of a sentence, but the sentence plays a certain role in promoting a sentence’s understanding. About these two components, the process of the former will speed up that of the latter. The predictive role of conjunction promotes the formation of this effect. They argue that the syntactic priming effect exists in two syntactic contexts, while the parallelism effect is in one. The generation of syntactic priming effect requires the same verbs in the sentence pattern, and there is no such kind of situation in the parallel structure.

# 3. Methodology

A single factor and two-level experimental design was conducted by EyeLink 1000+ in the present research. Repeated measures ANOVAs and pair-wise comparison were carried out by SPSS 13.0.

## 3.1. Subjects

41 graduate students of Hunan University coming from different schools with an average age of 24 were included. The choosing standard was as follows: 1) all subjects are Chinese and a protest have been done to make sure they have a general understanding of Chinese culture and syntactic structure. 2) they should have the normal eyesight or corrected eyesight to make sure they can follow the black spot's movement on the computer screen. 3) all subjects are mature enough to finish this long-time operation carefully.

## 3.2. Materials

This research designed three main types of experimental sentences (coordinate structure with conjunction "HE", coordinate structure with Chinese punctuation marker (、), label free coordinate structure), including 15 experimental sentences and 15 control sentences for each. 20 more common sentences were conducted to be interference sentences. In order to ensure the acceptability of these sentences, before the experiment, 11 students who did not participate in the formal experiment evaluated these syntactic structures and meanings. The purpose of evaluation is to discard the unreasonable sentences and make the experimental materials more reasonable.

The design of the experimental materials was based on the research of Sturt et al. [18]. Some typical materials are presented in Table 1.

**Table 1.** Examples of experimental materials.

| |
|---|
| di shi si jibu ting de bao yuan zhe *zao gao de tian qi he**shi hua de lu mian*。 |
| *The taxi driver is continually complaining the *bad weather and**slippery road*.* |
| (NP1=Noun phrase, NP2=Noun phrase) |
| di shi si ji zai lu shang bu ting de *bao yuan zhe tian qi he**shi hua de lu mian*。 |
| *The taxi driver on the way is continually *complaining the weather and**slippery road*.* |
| (NP1= Verb phrase, NP2=Noun phrase) |
| pianliang de fu wu yuan gei ta duan lai le*ke kou de niu pai、**xiang la de lu cai*。 |
| *The beautiful waitress served him *delicious steak and**spicy food*.* |
| (NP1=Noun phrase, NP2=Noun phrase) |
| pian liang de fu wu yuan yopu yi ci gei ta*duan lai le niu pai、**xiang la de lu cai*。 |
| *The beautiful waitress again *served him delicious steak and**spicy food*.* |
| (NP1= Verb phrase, NP2=Noun phrase) |
| ma mashuoxian zai de nian qing ren jie hun dui*fang zi**che zi*dou hen you yao qiu。 |
| *Mom says young people are now married with the very demanding of *house** car*.* |
| (NP1=Noun phrase, NP2=Noun phrase) |
| F. ma ma shuo xian zai de nian qing ren jie hun dui *gou mai**che zi*dou hen you yao qiu。 |
| *Mom says young people are now married with the very demanding of *buying** car*.* |
| (NP1= Verb phrase, NP2=Noun phrase) |
| G. yi bu fen cheng nian ren wang wang rong yi ba yi xie shi qingkan de tai guo yu yan zhong。 |
| H. *Some adults tend to take certain things too seriously.* |

Note: "、": a Chinese punctuation marker.

## 3.3. Procedure

The present experiment was composed of pretest and formal experiment. Pretest had 12 sentences for subjects to be familiar with the experimental procedure. The procedure and instruction in pretest is the same as the formal one, but the statistics was not recorded.

The formal experiment was divided into two sections, where each section is a group of sentences consisting of 55 sentences. It is ensured that each section has all kinds of materials. Each section costs about 30 minutes and there is a 10 minutes' rest between two sections. All sentences in each section are randomly presented in the experiment. The specific procedure for the formal experiment is as the followings: subjects prepared – instrument adjusted – instruction presented-experimental material presented – subjects responded-experiment replicated – experiment ended.

## 3.4. Data Analysis

The experimental data are processed by SPSS 2.0, and the One-way ANOVA analysis has been taken into consideration.

# 4. Major Results

Associative data were collected about four dependent variables (first run dwell time, second run dwell time, regression path duration and dwell time).

## 4.1. First run Dwell Time

The average reaction time of reading sentences and difference test in three coordinate structures were selected to analyze the existence of parallelism effect. Here are

one-way ANOVA tests and some basic information in the following tables. Firstly, the variance analysis of the first dwell time measured in coordinate structure with conjunction "HE" or Chinese punctuation marker (、) as well as label free coordinate structure was carried out. The exact data are presented in Table 2.

**Table 2.** Means for FRDT and its Variance on Three Coordinate Structures.

| Sentence Type | Means (milliseconds) | *F* | *Sig* |
|---|---|---|---|
| "HE" | 750.80 ms | .09 | .756 |
| "HE"-pair | 791.57 ms | | |
| "、" | 828.10 ms | 1.47 | .225 |
| "、"-pair | 845.88 ms | | |
| Label Free | 776.91 ms | 1.43 | .232 |
| Label Free-pair | 785.41 ms | | |

Note: "HE"-coordinate structure with conjunction "HE";
"HE"-pair - control structure of "HE" sentences;
"、" - coordinate structure with "、";
"、"-pair - control structure of "、";
Label free - label free coordinate structure
Label free-pair - control structure of label free sentences
"、": a Chinese punctuation marker.

According to the Table 2, no significant difference was found between three types of coordinate structure and their corresponding control pairs ("HE": *F*=.09, *p=.756*>.05; Chinese punctuation marker (、): *F*=1.476, *p=.225*>.05; Label-free: *F*=1.430，*p=.232*>.05). However, the reaction time of experimental sentences is always shorter than that of control sentences ("HE": 750.80ms<791.57ms; Chinese punctuation marker (、): 828.10ms<845.88ms; Label-free: 776.91ms<785.41ms). Subjects had the shortest first run dwell time in processing coordinate structure with "HE"(750.80ms) and the longest one in processing coordinate structure with Chinese punctuation marker (、) (828.10ms).

**Table 3.** Variance for Three Coordinate Structureson FRDT.

| Sentence Type | F | Sig |
|---|---|---|
| "HE" &"、" &Label Free | **162.71 | .000 |
| "HE" &"、" | **35.19 | .000 |
| "HE" & Label Free | **18.84 | .000 |
| "、" &Label Free | **20.15 | .000 |

Note: "、": a Chinese punctuation marker.

In Table 3, the variance of proceeding time of three kinds of sentences was conducted. It is clear that there is a great difference among threecoordinate structures with "HE", Chinese punctuation marker (、) and label free structure (***F*=162.71, *p=.00*<.05). According to paired-comparison, there is always a great difference between any two different coordinate structures (coordinate structure with "HE" & coordinate structure with Chinese punctuation marker (、): ***F*=35.19, *p=.00*<.05; coordinate structure with "HE" & label free coordinate structure: ***F*=18.84, *p=.00*<.05; coordinate structure with Chinese punctuation marker (、) &Label free: ***F*=20.15, *p.00*<.05). During the process of reading materials, subjects spent rather different time in processing these three syntactic structures. In terms of some certain sentence structures, it took much more time to be read by readers. So, on the index of FRDT, the difference in processing coordinate structure with "HE" or Chinese punctuation marker (、) as well as label free structure is obvious.

## 4.2. Second Run Dwell Time

In addition, about the second run dwell time in reading these three sentences, the data of experimental sentences and control sentences are also calculated as follows:

**Table 4.** Means for SRDT and its Variance on Three Coordinate Structures.

| Sentence Type | Means (milliseconds) | *F* | *Sig* |
|---|---|---|---|
| "HE" | 92.35 ms | *5.666 | .018 |
| "HE"-pair | 143.08 ms | | |
| "、" | 174.68 ms | *4.594 | .033 |
| "、"-pair | 230.93 ms | | |
| Label Free | 73.544 ms | .009 | .923 |
| Label Free-pair | 129.568 ms | | |

Note: "、": a Chinese punctuation marker.

According to Table 4, subjects always used less time in second reading when they processed three types of coordinate structures than when they processed three types of corresponding control sentences respectively ("HE": 92.35ms<143.08ms; Chinese punctuation marker (、): 174.68ms<230.93ms; Label-free: 73.544ms<129.568ms). For coordinate structure with "HE" and its control pair, a difference was found in second run dwell time (*F=5.666, p=.018<.05). With respect to coordinate structure with Chinese punctuation marker (、) and its control pair, there was a difference as well (*F=4.594, p=.033<.05). However, no significant difference was shown between label free structure and its pair (F=.009, p=.923>.05). The shortest second run dwell time was found in reading label free coordinate structure (73.544ms), followed by coordinate structure with "HE" (92.35ms).

**Table 5.** Variance for Three Coordinate Structureson SRDT.

| Sentence Type | F | Sig |
|---|---|---|
| "HE" &"、" &Label Free | **166.60 | .000 |
| "HE" &"、" | **20.04 | .000 |
| "HE" & Label Free | **25.39 | .000 |
| "、" &Label Free | **25.30 | .000 |

Note: "、": a Chinese punctuation marker.

According to Table 5, Subjects spent rather different time processing and comprehending three parallel structures in Chinese. A significant difference was found among coordinate structure with "HE", Chinese punctuation marker (、) and label free structure (***F*=166.60, *p=.00*<.05). From the

paired-comparisons among threecoordinate structures, there is alwaysa great distinction (coordinate structure with "HE" & coordinate structure with Chinese punctuation marker (、): ** *F*=20.04, *p*=.*00*<.05; coordinate structure with "HE" & label free coordinate structure: ** *F*=25.39, *p*=.*00*<.05; coordinate structure with Chinese punctuation marker (、) &Label free: ** *F*=25.30, *p*=.*00*<.05).

## 4.3. Regression Path Duration

The regression path duration in these three sentence types are listed here. The data are put in the form accordingly, from which the significance can be seen easily.

**Table 6.** Means for RPD and its Variance on Three Coordinate Structures with "HE".

| Sentence Type | Means (milliseconds) | *F* | *Sig* |
|---|---|---|---|
| "HE" | 985.49 ms | *5.014 | .026 |
| "HE"-pair | 1130.35 ms | | |
| "、" | 1266.40 ms | *6.024 | .014 |
| "、"-pair | 1348.35 ms | | |
| Label Free | 960.76 ms | 1.695 | .194 |
| Label Free-pair | 1080.27 ms | | |

Note: "、": a Chinese punctuation marker.

From this table, the regression path duration of three coordinate structures in Chinese was shorter than that of control groups ("HE": 985.49ms<1130.35ms; Chinese punctuation marker (、): 1266.40ms<1348.35ms; Label-free: 960.76ms<1080.27ms). In terms of sentence type coordinate structure with "HE", the variance analysis illustrated that the main effect of the sentence types in regression path duration was obvious (*F=5.014, p=.026<.05). And there was significant difference between experimental and control sentences of coordinate structure with the punctuation marker Chinese punctuation marker (、) (*F=6.024, p=.014<.05). Nevertheless, no difference occurred between label free structure and it is pair (F=1.695, p=.194>.05). In processing coordinate structure with Chinese punctuation marker (、), the longest path regression duration was used (1266.40ms), followed by coordinate structure with "HE" (985.49ms).

**Table 7.** Variance for Three Coordinate Structures on PRD.

| Sentence Type | F | Sig |
|---|---|---|
| "HE" &"、" &Label Free | **145.20 | .000 |
| "HE" &"、" | **29.06 | .000 |
| "HE" & Label Free | **36.63 | .000 |
| "、" &Label Free | **28.50 | .000 |

Note: "、": a Chinese punctuation marker.

From the table above, on the index of PRD, there wasa great differencelying among three types of coordinate structures (**$F$=145.20, $p$=.*00*<.05). From the paired-comparisons among threecoordinate structures, there is alwaysa great distinction (coordinate structure with "HE" & coordinate structure with Chinese punctuation marker (、): ** *F*=20.04, *p*=.*00*<.05; coordinate structure with "HE" & label free coordinate structure: ** *F*=29.06, *p*=.*00*<.05; coordinate structure with Chinese punctuation marker (、) &Label free: ** *F*=28.50, *p*=.*00*<.05).

## 4.4. Dwell Time

To get the relevant information of dwell time in three coordinate structures, here the recording data and some basic information are shown in following table.

**Table 8.** Means for DT and its Variance on Three Coordinate Structures.

| Sentence Type | Means (milliseconds) | *F* | *Sig* |
|---|---|---|---|
| "HE" | 845.40 ms | * 4.214 | .041 |
| "HE"-pair | 948.76 ms | | |
| "、" | 1057.54 ms | *5.946 | .015 |
| "、"-pair | 1184.71 ms | | |
| Label Free | 858.75 ms | .886 | .347 |
| Label Free-pair | 947.50 ms | | |

Note: "、": a Chinese punctuation marker.

According to Table 8, there was a difference in dwell time between "HE" structure and its pair, Chinese punctuation marker (、) and its pair ("HE" and "HE"-pair: *F=4.214, *p*=.041<.05; Chinese punctuation marker (、) and "Chinese punctuation marker (、)-pair: *F=5.946, *p*=.015<.05). But no difference was shown between label free and its pair (F=0.886, *p*=.347>.05). with respect to mean, the dwell time of three coordinate structures in Chinese was shorter than that of control groups ("HE": 845.40ms<948.76ms; Chinese punctuation marker (、): 1057.54ms<1184.71ms; Label-free: 858.75ms<947.50ms). Subjects spent the shortest dwell time while reading coordinate structure sentences with "HE" (845.40ms) and the longest one in label free coordinate sentences (1057.54ms).

**Table 9.** Variance for Three Coordinate Structures on DT on DT.

| Sentence Type | F | Sig |
|---|---|---|
| "HE" &"、" &Label Free | **127.27 | .000 |
| "HE" &"、" | **30.03 | .000 |
| "HE" & Label Free | **28.48 | .000 |
| "、" &Label Free | **19.43 | .000 |

Note: "、": a Chinese punctuation marker.

Likewise, the data in this table illustrate that there was great difference in dwell time among three coordinate structures (**F=127.27, *p*=.*00*<.05). According the variance results of sentence pairs, coordinate structure with "HE" & coordinate structure with Chinese punctuation marker (、) (**$F$=30.03, $p$=.*00*<.05), coordinate structure with "HE" & label free coordinate structure (**$F$=28.48, $p$=.*00*<.05), coordinate structure with Chinese punctuation marker (、) &Label free ($F$=19.43, $p$<.05), which all indicated significant difference.

## 5. Major Findings and Discussion

This paper mainly explored the parallelism effect in three coordinate structures in Chinese by adopting eye tracker technology. Based on the above results, three parts would be discussed: the parallelism effect in three Chinese coordinate structures, differences of eye movement indexes in processing there coordinate structures and the procession mechanism of parallelism effect in them.

Firstly, the variance analysis results show that parallelism effect exists in both coordinate structure with "HE" and coordinate structure with Chinese punctuation marker (、). This result is similar to precious research. For example, Frazier et al. [9] think parallelism effect only appears in special coordinate sentences. In the experiment, they used the coordinate structure with the conjunction "and" as experimental materials, in which they found parallelism effect. It indicated that the word "and" having prediction function was closely related to the production of this effect. When the conjunction appeared, the processing speed of a sentence would become faster. Although Chinese and English belong to two different linguistic systems, both of them are equipped with coordinate sentences. In the present experiment, the Chinese coordinate structure with "HE" is similar to English coordinate sentences with "and". And it was found that parallelism effect is indeed produced in the procession of Chinese coordinate structures connected by "HE". According to the model established by Apel et al. [1], it can be reasonably inferred. The conjunction "HE" in the sentence is a predicted parser. After the presentation of the former parallel composition, there is a prediction function of the latter sentence structure when the parser "HE" appears. When the following sentence is in accordance with the predicted structure, it is immediately activated, so that readers get the language information quickly.

In terms of Chinese coordinate structure with the Chinese punctuation marker (、), which is an unique Chinese form. The punctuation marker is not like the word "HE" which obviously belongsto conjunction. It is just a punctuation marker connecting two parallel components, which is commonly the internal minimum pause between words or phrases in a sentence. In the present research, the Chinese punctuation marker (、) connects two parallel phrases whose procession produces parallelism effect. According to Apel et al. [1] and Frazier et al. [8], it can be inferred that there is an implication function from the Chinese punctuation marker (、), which would be applied to subjects. This kind of implication is of great help to predict the structure of following coordinate phrase, so the subjects can rapidly access to the latter language information after getting the former elements. Thus, It can be concluded that there is an almost similar function in the Chinese punctuation marker (、) and the conjunction "HE".

However, there is no parallelism effect of label free coordinate structures in which there is no obvious connecting conjunction or marker between two coordinate phrases. This result differs from the hypotheses proposed by Pickering and Ferreira [13], which concludes that if a language unit has the same syntactic form as another language unit, the procession of the previous unit will facilitate the procession of the latter one. In this experiment, the label free parallel structure accords with conditions induced by Pickering and Ferreira [13], but it didn't turn out the expected result. Owning to the minimum distance between two combing phrases, phrases in label free coordinate structure could be recognized as a whole phrase to process, which deserves a further study to verify.

Secondly, when subjects processed three kinds of coordinate structures in Chinese, a significant difference was shown in their eye movement. According to Yan Guoli et al. [21], the first run dwell time demonstrate the real-time influence from interest area, belonging to the first stage procession. The second run dwell time, regression path duration and dwell time are three indexes in the later procession period, which is related to lexical access and integration of processed information. In processing coordinate structure with "HE", subjects have shown the shortest first run duration time, path regression time and dwell time. In other words, as the most obvious and common coordinate structure in Chinese, "HE" parallel structure is of great help for readers to predict and process the information appearing after "HE". However, while processing the coordinate structure with Chinese punctuation marker (、), subjects used the longest time in all four indexes. Although Chinese punctuation marker (、) gives a signal for the following coordinate structure, Chinese punctuation marker (、) combines not only noun phrases sharing the same verb, but also verb phrases sharing the same syntactic structure. During the procession, it cost some time to figure out the exact function of Chinese punctuation marker (、) and the kind of phrase combined together.

Finally, there is no consensus yet about the mechanism for the existence of parallelism effect. Some researchers think the effect is the result of syntactic prediction while some believe that parallelism effect is a special form of syntactic priming mechanism. In order to explore the parallelism effect in Chinese syntactic structure, two kinds of structures were studied----Chinese coordinate structure with the conjunction "HE", as well as the serial-verb construction. They found there was parallelism effect in coordinate

structure but not in serial-verb construction. The explanation was that the syntactic context played a great role in the production of this effect [10]. The present research studies parallelism effect in three syntactic forms. According to the analysis of the experimental data, there is significant parallelism effect in both coordinate structures with "HE" and Chinese punctuation marker (、), which have a kind of prompting function before processing the component of the later part in a sentence. So the processing behind will speed up due to the prediction function. However, there is no obvious conjunction word between label free parallel structure. Although there are parallel structures in the other two syntactic forms---composition is the same, the parallelism effect is not significant. Therefore, not all Chinese coordinate structures have the parallelism effect during the process of reading and processing. This effect exists in special context, in which the two components have similar forms and same grammatical status, and are connected by a conjunction word or punctuation marker. The existence of this phenomenon can be explained by syntactic prediction effect.

## 6. Conclusion

Throughout the experiment, three types of sentences are investigated by using the method of eye tracking technology. In this study, Chinese coordinate structures are used as experimental materials----- parallel structures to investigate whether three Chinese parallel syntactic structures are able to produce parallelism effect. And the mechanism behind these Chinese coordinate structure processing is further explored.

The experimental data show that the parallelism effect exists in Chinese parallel structures connected by the conjunction "HE"(and) and the Chinese punctuation marker (、). And this effect appears in the late stage of sentence processing, that is to say, among four dependent variables of eye movement, the first run dwell time does not witness a significant difference. In addition, there is no parallelism effect in label free coordinate structure. Compared with the results of previous studies, the parallelism effect of Chinese parallel sentence structure is closely related to syntactic prediction mechanism, and there is no phenomenon of syntactic priming. Parallelism effect, as a special syntactic processing effect, is restricted by syntactic context and exists in special syntactic contexts, such as the coordinate structure with conjunctions or punctuation markers.

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