Acoustic Correlates of Contrastive Stress in Compound Words versus Verbal Phrase in Mandarin Chinese

Weilin Shen*, Jacqueline Vaissière*,*, and Frédéric Isel*,*,*

Abstract

Duanmu (2000) proposed that tonal languages, such as Chinese, follow the same Compound and Nuclear Stress Rules (Chomsky & Halle, 1968) for phrasal stress as English. This study investigates the acoustic correlates of contrastive stress between compound words and verbal phrases in Mandarin Chinese. We focused on the durational, fundamental frequency, and intensity correlates of stress within minimal pair MN modifier-head compounds and VO verb-object phrases. Our results demonstrated that (1) the final syllable was more lengthened in [VO] than in [MN] and that (2) the F_0 range was larger in [VO] than in [MN]. Moreover, the duration of the pause between the two syllables seems to play a role in distinguishing between [MN] and [VO]. In contrast, we showed that intensity contributed less to this distinction. Our results confirmed the right stress pattern in [VO]; however, we failed to find the lexical stress on the Left syllable we had expected, at least with the speakers we examined. Taken together, the present acoustic study lends support to the hypothesis that principles of stress upward of word level are universal through different languages.

Keywords: Morpholexical Ambiguity, Compounding, Compound versus Nuclear Stress, Acoustic Features.

1. Introduction

In stress languages, such as in English, most words have stable lexical stress patterns and it is often easy to tell which syllables have stress. For a typical tonal language, *e.g.* Mandarin, the word stress is often less obvious. Although, lexical stress has been shown to be highly

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language-dependent, principles of stress upward of word level (*i.e.* compound stress and phrasal stress) are more universal in different languages. Chomsky and Halle (1968) proposed two rules for English compound and phrasal stress.

- **Compound stress rule**: stress is assigned to the leftmost stressable vowel in nouns, verbs, or adjectives, *e.g.* bláckbird.
- Nuclear stress rule (NSR): stress is assigned to the rightmost stressable vowel in a major constituent, *e.g.* [the [black bird]].

It has been proposed that the Compound stress rule and NSR are true for Mandarin Chinese, and they permit one to distinguish between compounds and phrases (Duanmu, 2000). Nevertheless, there is no empirical evidence supporting this hypothesis to date. The first goal of the present study was to understand to what extent morphology affects abstract stress using acoustic-phonetic evidence. Moreover, we were interested in discerning the acoustic phonetic cues, which reflect abstract stress. In Chinese, a V-N construction is sometimes ambiguous, possibly representing both a modifier-head compound [MN] and a verb-object phrase [VO]. For example, a V-N construction 'chao-fan' (fry-rice) may be a compound, in which the verbal constituent 'chao' (fry) modifies the nominal head 'fan' (rice); it may also represent a verb-object relation (to fry rice). The ambiguous pairs have the same segmental characteristics and are assumed to differ from each other only in the stress pattern, showing left stress for compound stress and phrasal stress are implemented in [MN] compounds and in [VO] phrases in Mandarin Chinese.

Fraisse (1956) proposed two basic rhythmic tendencies 1) "*rythmitisation intensive*," sensitive to strengthening of the initial element, and 2) "*rythmitisationtemporelle*," building on the lengthening of the final element. The supposed basic rhythmic tendencies predict initial extra loudness and final lengthening. From phonetic studies on the acoustic correlates of stress since the 1950s, researchers have agreed that linguistic stress correlates with a complex configuration of events of increased duration, larger F_0 range, and raised intensity (Lehiste, 1970) and that several cues may be functionally equivalent cross-linguistically (Vaissière, 2004).

Duration

From a series of experiments, Fry (1955, 1958) showed that duration is a consistent correlate of stress at the word level in English and that it is a more effective cue than intensity. Since then, researchers have started to give up the classical view that stress is equated to a higher degree of intensity. Studies on the neutral tone (*i.e.* destressed syllable) in Chinese have confirmed the crucial role of duration on the perception of a destressed syllable for Chinese. Lin (1980, 1990) and Cao (1992) showed that duration of the destressed neutral tone syllable

is systematically shorter (reduced by approximately 50%) than a syllable with full tone.

Fundamental frequency

The F_0 has been showed to be a major acoustic manifestation of suprasegmental structures. It is claimed by some researchers to be the strongest cue of stress for stress languages (Cooper *et al.*, 1985; Lieberman, 1960; Gussenhoven *et al.*, 1997). Nevertheless, others have shown that F_0 is not a necessary cue because stress can be identified on the basis of duration and intensity alone (Cutler & Darwin, 1981). The situation is the same for tonal languages, such as Mandarin. The pitch range has been shown wider when syllables are stressed (Shen, 1985; Liu & Xu, 2005). More specifically, when a 3rd Tone is stressed, it is dipped lower and, when a 4th Tone is stressed, it starts higher and falls lower (Chao, 1968). Moreover, computational corpus studies (Kochanski *et al.*, 2003) have established quantitative F_0 predictions in terms of the lexical tones and the prosodic strength of each word. Shen (1993), however, found that stress in Mandarin could be identified without F_0 information.

Intensity

In literature, the role of intensity for stress is not agreed upon. Fry (1955, 1958) showed that intensity was a less effective cue than duration on the perception of linguistic stress patterns. Nevertheless, some authors have argued that the strongest cue to prominence is intensity for English (*e.g.*, Beckman, 1986; Turk & Sawusch, 1996). For Mandarin Chinese, the effect of the intensity is only secondary. Studies on the neutral tone in Chinese showed that the intensity of the destressed neutral tone is not necessary lower than the one with full tone (Cao, 1986). Moreover, the destressed neutral tone raises its intensity after Tone 3 (Lin, 2006). Phonetic data (Cao, 1992) has illustrated that the destressing of the neutral tone syllable is not related simply to its intensity. The intensity of a neutral tone syllable is lower than that of one with full tone in general, but the situation is reversed when it is preceded by a Tone 3 syllable.

The present study investigates the acoustic correlates of stress between compound and phrase in Mandarin Chinese. We focused on the durational, fundamental frequency, and intensity correlates of stress within minimal pair [MN] modifier-head compound and [VO] verb-object phrase. Our hypotheses were that 1) [MN] modifier-head compound and [VO] phrases differ phonetically with left stress in [MN] modifier-head compounds and right stress in [VO] phrases and that 2) a different prosodic pattern is reflected in acoustic features in F_0 , duration and intensity.

2. Methodology

2.1 Materials

One hundred thirty-five minimal pairs presenting a morpholexical ambiguity (*i.e.* [MN] modifier-head compound vs. [VO] phrases) were selected from the Contemporary Chinese Dictionary 5th edition (Lu & Ding, 2008). Each pair had the same segmental characteristics and was assumed to differ from each other only in the stress pattern. The target words were not recorded in isolation and were embedded in an utterance fragment:

1)我说的不是名词<u>编号</u>而是动词<u>编号</u>. II did not say nown "bion hao" but said york "bion ha

[I did not say noun "bian-hao" but said verb "bian-hao".]

The critical words in each pair change their position in the utterance fragment, giving

2)我说的不是动词<u>编号</u>而是名词<u>编号</u>. [I did not say verb "<u>bian-hao</u>" but said noun "<u>bian-hao</u>".]

In all, 270 sentences were created. The order of the sentences was randomized.

2.2 Recording Procedure

Before the recording session, the participants were instructed in the goal of the recording and how the recording would proceed. The material was carried out in the laboratory of Phonetics and Phonology of University Sorbonne Nouvelle Paris 3. Speakers were recorded individually in an acoustic chamber, using an attached microphone, placed at a distance of about 5 centimeters from the speaker's mouth. Speech samples were recorded digitally at 44,100 Hz, 16-bit mono.

2.3 Subjects

Three Mandarin speakers (two females) in Paris participated in the experiment. One female speaker is an international student aged 25 years that was born in Xi'an, China. Her mother tongue and language of schooling is Mandarin. The others speakers are Beijing Mandarin speakers (one female 26 years; one male 32 years).

2.4 Acoustic Measurements

The first syllable, the second syllable, and the pause between them for each critical word were manually marked in Praat, yielding four marks, one at the beginning of the first syllable, a second mark at the offset of the first syllable, a third mark between the offset of the first syllable and the onset of the second syllable, and a fourth one at the offset of the second syllable. A Praat script extracted the duration and intensity value of each segment in msec. F_0 onset and offset were measured at the beginning and at the end of the vowel. In the study, we divided the vowel into ten segments normalized in time, with the mean F_0 of the first segment as F_0 onset and the mean F_0 of the last segment as F_0 offset.

3. Results

Three-way repeated analysis of variance ANOVA tests were performed separately for each acoustic feature (duration, F_0 , and intensity). Word type ([MN] modifier-head compound vs. [VO] verb-object phrase) and syllable position (left syllable: S1 vs. right syllable: S2) were the within groups factors, and word position in the utterance fragment (*i.e.* final vs. non-final) was the between groups factor.

3.1 Duration

3.1.1 Left Syllable vs. Right Syllable

Results of the three-way ANOVA for the duration revealed a significant main effect for word type [$F(1, 134) = 440.8, p < 0.001; \eta_p^2 = 0.77$], a significant main effect for word position [$F(1, 134) = 25.6, p < 0.001; \eta_p^2 = 0.16$], a significant main effect for syllable position [$F(1, 134) = 105.3, p < 0.001; \eta_p^2 = 0.44$], a significant interaction word type x syllable position [$F(1, 134) = 87.4, p < 0.001; \eta_p^2 = 0.40$], and a significant interaction word position x syllable position [$F(1, 134) = 440.8, p < 0.001; \eta_p^2 = 0.77$]. Word position showed no interaction with word type. In order to increase the statistical power, we token the word position out, and ran a two-way ANOVA (word type x syllable position). The two-way ANOVA showed significant main effect for word type [$F(1, 269) = 846.7, p < 0.001; \eta_p^2 = 0.64$] and for syllable position [$F(1, 269) = 166.3, p < 0.001; \eta_p^2 = 0.38$] and a significant interaction word position x syllable position [$F(1, 269) = 166.3, p < 0.001; \eta_p^2 = 0.38$] and a significant interaction word position x syllable position [$F(1, 269) = 217.1, p < 0.001; \eta_p^2 = 0.45$]. Post hoc analyses showed a larger effect of syllable position for [VO] [$F(1, 269) = 217.0, p < 0.001; \eta_p^2 = 0.45$] than for [MN] [$F(1, 269) = 28.6, p < 0.001; \eta_p^2 = 0.10$].



Figure 1. Mean syllable durations in msec for each syllable in [MN] and [VO].

3.1.2 Duration of the Pause

As one can notice a pause between the two syllables in VO, we decided to perform measures of pause duration. The ANOVA on the average pause duration between the syllables showed a significant main effect for word type [F(1, 269) = 33.5, p < 0.001; $\eta_p^2 = 0.11$].

3.2 F₀

The F_0 was analyzed separately for each of the four tones. A three-way ANOVA with word type (MN vs. VO), syllable position (Left syllable vs. Right syllable), and measure point (onset vs. set) was applied to Tone 1 and Tone 4, and a two-way ANOVA with word type (MN vs. VO) and syllable position (Left syllable vs. Right syllable) was calculated on the difference between F_{0max} and F_{0min} for Tone 2 and Tone 3.

3.2.1 Tone 1

Results showed a significant main effect for measure point $[F(1, 45) = 10.7, p<0.01; \eta_p^2 = 0.19]$, a significant interaction between word type and syllable position $[F(1, 45) = 4.7, p<0.05; \eta_p^2 = 0.10]$, and a significant interaction between measure point and syllable position $[F(1, 45) = 6.6, p<0.05; \eta_p^2 = 0.13]$. Nevertheless, neither significant interaction between word type and measure point [F<1], nor significant interaction between word type, syllable position, and measure point [F<1] was found.



Figure 2. F_0 values on ten segments for Tone 1 for Left and Right syllable in [MN] and [VO].

3.2.2 Tone 2

Neither significant main effect for word type and syllable position [F < 1] nor significant interaction [F < 1] was found on the difference between F_{0max} and F_{0min} .



Figure 3. F_0 values on ten segments for Tone 2 for Left and Right syllable in [MN] and [VO].

3.2.3 Tone 3

In order to not confound tone sandhi influence for these analyses, we took out two items in our experimental material with a Tone 3-Tone 3 combination. The two-way ANOVA on the difference between F_{0max} and F_{0min} revealed a significant interaction word type x syllable position [F(1, 53) = 217.1, p < 0.001; $\eta_p^2 = 0.31$]. *Post hoc* analyses showed a larger effect of syllable position for [VO] [F(1, 53) = 37.9, p < 0.001; $\eta_p^2 = 0.42$] than for [MN] [F(1, 53) = 37.9, p < 0.05; $\eta_p^2 = 0.80$].



Figure 4. F_0 values on ten segments for Tone 3 for Left and Right syllable in [MN] and [VO].

3.2.4 Tone 4

Results showed a significant main effect for measure point $[F(1, 91) = 339.1, p<0.001; \eta_p^2 = 0.79]$ and for syllable position $[F(1, 91) = 14.0, p<0.001; \eta_p^2 = 0.13]$, a significant interaction between word type and syllable position $[F(1, 91) = 23.5, p<0.001; \eta_p^2 = 0.21]$, a significant interaction between measure point and syllable position $[F(1, 91) = 14.4, p<0.001; \eta_p^2 = 0.14]$, and a significant interaction of word type x measure point x syllable position $[F(1, 91) = 6.8, p<0.05; \eta_p^2 = 0.07]$. *Post hoc* analyses showed a main effect of syllable position for the Left syllable of [VO] $[F(1, 91) = 36.8, p<0.001; \eta_p^2 = 0.29]$, however, there was no main effect of syllable position for the Left syllable of [VO] [F<1].



Figure 5. F_0 values on ten segments for Tone 4 for Left and Right syllable in [MN] and [VO].

3.3 Intensity

A three-way ANOVA with repeated measure was performed on the average intensity. Results showed a significant main effect for word type $[F(1, 134) = 139.0, p < 0.001; \eta_p^2 = 0.64]$, a significant main effect for word position $[F(1, 134) = 234.8, p < 0.001; \eta_p^2 = 0.16]$, a significant main effect for syllable position $[F(1, 134) = 58.9, p < 0.001; \eta_p^2 = 0.31]$, a significant interaction word type x syllable position $[F(1, 134) = 87.4, p < 0.001; \eta_p^2 = 0.40]$, and a significant interaction word position x syllable position $[F(1, 134) = 440.8, p < 0.001; \eta_p^2 = 0.77]$. No interaction was found.



Figure 6. Mean intensity (dB) for each syllable in [MN] and [VO].

4. Discussion

This article investigated the acoustic correlates of linguistic stress on the ambiguous structure Verb-Noun (*i.e.* [MN] vs. [VO]) in Mandarin Chinese. Moreover, the acoustic feature associated with this stress pattern was analyzed. As explained in the introduction, duration, F_0 , and intensity are the main correlates of stress. Results showed the implication of duration, F_0 , and intensity in the production of compound and phrasal stress in Mandarin.

Our preliminary data showed that the duration was longer for the right syllable in [VO], which was consistent with previous studies on the acoustic correlates of linguistic stress for stress languages and for tone languages, such as Mandarin. Nevertheless, the 'assumed stressed' left syllable in [MN] was not longer than the Right syllable. We also performed measures of pause duration, and the results on the average pause duration between the Left and Right syllables showed that average pause duration is longer in [VO] than in [MN]. Nevertheless, we considered that this larger pause duration was not an acoustic manifestation of stress but a mark of the syntactic boundary in the verb-object phrase.

Despite the fact that, in tone languages, F₀ information should be attributed to its lexical

usage, our results showed that F_0 would be a reliable cue for the stress pattern in [MN] and [VO]. The F_0 range was shown to link to the stress for Tone 3 and Tone 4, which was in line with the predictions (Chao, 1968) that pitch range is wider for stressed syllables, specifically, when a 3rd Tone is stressed, it dips lower, and, when a 4th Tone is stressed, it starts higher. Our results showed that, for Tone, 3 the right syllable in [VO] had a larger F_0 range than the left syllable. For Tone 4 the left syllable in [MN] showed higher onset F_0 than the right one.

The analyses on the intensity were in line with previous studies, which showed a less important role of the intensity for stress. In our preliminary data, the intensity was shown to have larger amplitude in [VO] than in [MN] for the two syllables. Nevertheless, we failed to find the strengthening of the Left syllable in [MN], as proposed by Fraisse, that left-headed feet should show extra loudness on the initial syllable than the second initial. Our results showed the same pattern of intensity between [VO] and [MN]. Therefore, we considered that, unless the [VO] and [MN] were presented together, the intensity was not an effective cue for distinguishing between [VO] and [MN].

In sum, our preliminary data suggested an implementation of the final lengthening for the stressed syllable in [VO], but no initial extra loudness in [MN]. The F_0 information suggested that, for Tone 3, the Right syllable was stressed in [VO] and, for Tone 4, the Left syllable was stressed in [MN]. The results confirmed the right stress pattern in [VO]; however, with the only support in Tone 4, we did not consider a lexical stress on the Left syllable in [MN].

The prosodic information, such as stress, duration, and pause was shown to be critical for the processing of the compound words (Isel *et al.*, 2003). Once we have shown that compound word and verbal phrase present different acoustic patterns with respect to the position of stress, the next step would be to verify whether this stress pattern is used by the listeners to differentiate the two forms in cases of segmental ambiguities. For this purpose, we plan to conduct different perception and categorization experiments. At the same time, more speakers would be added to the production study.

5. Conclusion

Our results showed a right stress pattern in [VO] with longer duration in the Right syllable, larger range F_0 , and longer pause duration between the syllables; in contrast, no initial strengthening in [MN] was found. Only the F_0 range information in Tone 4 supported a lexical stress on the Left syllable in [MN].

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| 24 (EA, teach successor 94 (H) stablize the price fair price 26 (EA) pass on a ressage hearsay 96 (BA) to taste explorta 27 (H) to soport exports 97 (X) to taste explorta 27 (H) to soport exports 97 (X) to we dobt 28 (FA) to stock 38 (X) to dobt arount due 28 (FA) to stock 38 (X) to dobt a visa 31 (HA) concer from class origin 100 (V) Visa a visa 31 (HA) concer from a deposit 102 (V) to visa a visa 32 (FA) to dobgate a dobpat 103 (V) to visa a visa 33 (HA) to sore a dobpat 105 (V) to visa a visa 33 (HA) to sore a socre 100 (V) to visa a visa 34 (V) to sore a socre 100 (V) tar/V to visa a visa 35 (W | | | | | | | | |
| B (Fig) Box normal Participant Paritrepant Participant <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<> | | | | | | | | |
| 動産ののamessage hearsay 94 単株 lotaste usite 28 行政 bostock a stock 97 人数 owe debt 28 行政 bostock a stock 99 入版 to we debt 28 行政 bostock 99 入版 to we debt 28 行政 bostock 99 入版 to was a visa 31 出版 enter an item of expenditure in the accounts payment 101 EV to sign signature 31 化量 eteposit a delegate 103 EX to start beginning 31 化量 eteposit a delegate 103 EX to start a task 32 MU to store a score 106 EU a task 33 Tu to order a score 106 EU a task 34 Tu to def a score 106 EU a task <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | | | | | | | | |
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| 199 任後 tore up grain grain in stock 99 光度 100 地部 debt 30 出身 cone from class origin 100 地部 a visa a visa 31 出版 enter an item of expenditure in the accounts payment 100 地部 b visa a visa 32 行表 to deposit a deposit 100 地部 to start b beginning 34 行差 to delogate 100 地部 to start beginning 35 行数 to delogate a delogate 100 地部 to start beginning 36 行力 to score a score 100 地部 argue argument 37 定% deide on a verdict verdict 100 地部 a talk a talk 37 定% deide on a verdict verdict 100 地部 a talk a talk 38 Tift to order a score 100 地部 to talk a substitute terrest so deducted 39 Tigt to adde a protein final version 110 PT work as a substitute terrest so deducted 42 定版 to define the price final version 110 PT work as a substitute terrest so deducted 42 定版 to define the price final version 111 PZ work as a substitute terrest so de | | | | | | | | |
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| 11 出版 enter an tern of expenditure in the accounts payment 101 注字 to sign sign signalure 12 存放 to delegate a delegate 102 注か make a price starting price 34 含素 answ or questions in an examination paper answ or sheet 104 違か to start beginning 34 含素 answ or questions in an examination paper answ or sheet 104 違か to start beginning 36 得か to score a score 106 juit to tak a talk 37 定素 decide on a verdict verdict 107 juit carry a bag handbag 38 引 17 = to order an order 108 juit write an inscription an inscription 39 juit against the wind head wind 109 juit writes an inscription interest so deducted 40 juit more 112 guit inthe the price interest so deducted 41 juit make a price fixed price 111 guit inthe equanty of inthe equanty of 42 juit guantify norm | | | store up grain | 0 | | 欠账 | | |
| 122 存款 b deposit a deposit 102 起作 make a price starting price 33 代表 b delegate a delegate 103 起走 b to start beginning 34 俗表 a saw or questions in an examination paper answ or sheet 104 越行 b finance a finance 36 倒分 b score 108 足川 argument a talk at alk 37 定素 decide on a vardict Vardict 107 接位 bark a talk 37 定素 decide on avardict Vardict 107 接位 bark a talk 39 頂和 to order an order 108 昆川 work as asubsitute temporary worker 40 定結 finale a manuscript final varsion 110 持正 work as a subsitute temporary worker 40 定結 finale a price fixed price 111 投资 invest invest invest 41 定位 finale and price fixed price 111 投资 invest invest invest 42 定量 to define definite tree 113 展貨 invest invest invest 43 定时 definite tree 113 展貨 inter quantity of interest so deducted 45 定 to define a fina nurber 110 晶並 interest so deducted | 30 | 出身 | come from | class origin | 100 | 签证 | to visa | a visa |
| 133 代表 book book book book book book 136 符表 answer questions in an examination paper answer sheet 104 進売 bo finance a finance 137 行業 Geok argument book book argument a finance 137 行業 Geok carry a bag handbag argument a finance 137 行業 Geok carry a bag handbag an inscription an inscription 137 行業 Geok ansize the whol head wind 109 振見 pay interest interest so deducted 138 TGP to order an order 100 振見 pay interest interest so deducted 138 TGP trake a price fixed price 111 RgC invest invest investment 142 定量 to order ansine definite time 113 RgE inthe price intered quantity 141 定 offinite offinite 111 RgC invest investment deadine 142 定量 to define offinite 113 RgE inthe price intered quantity 142 定量 to definite 113 RgE inthe price intered quantity 143 定量 tast intered quantity deadine inte< | 31 | 出账 | enter an item of expenditure in the accounts | payment | 101 | 签字 | to sign | signature |
| 34 答卷 answ er questions in an examination paper answ er sheet 104 检密 to finance a finance 35 倒账 repudate a debt bad debts 105 使用 argument a tak 37 定案 decide on a verdict Verdict 107 提信 lotak a tak 37 定案 decide on a verdict Verdict 107 提信 lotak a tak 39 jū# to order an order 108 jum vite an inscription an inscription an inscription 39 jū# to order an ouscript final version 110 #L works as aubstitute temporary worker 41 ji£th rnake a price fixed price 111 #L works as aubstitute temporary worker 42 ji2th definea time definite time 113 #L final version 114 #L final version inrited quantity 44 ji2th roke and upone definite time 113 #L final version inrited price inrited quantity 44 ji2th roke and upone definite time 112 #L final versin dedine< | | | to deposit | a deposit | 102 | 起价 | make a price | starting price |
| 135 倒能 repudate a debt bad debts 105 说源 argue argument 36 得外 to score 106 说话 to talk a talk 37 定來 decide on a verdict verdict 107 浸៤ Carry a bag handbag 38 订单 to order an order 108 漫山 private an inscription an inscription 38 jīpt against the wind head wind 109 慢山 private an inscription an inscription 40 定結 finalze a manuscript final version 110 撞⊥ work as a substitute temporary worker 41 定位 finalze a manuscript final version 111 投空 work as a substitute temporary worker 42 定量 to quantity norm 112 投ご work as a substitute temporary worker 43 定行 designate members fixed number of staff members 113 限量 limited quantity 44 定义 to define definition 114 限令 order sb. to do sth. within a certain time an order 45 定行 designate members fixed number of staff members 115 限力 delect an option option 46 定社 selfect effect effect effect effect 47 msc laut faulage 118 μΔ contact renew an seruint </td <td>33</td> <td>代表</td> <td>to delegate</td> <td>a delegate</td> <td>103</td> <td>起头</td> <td></td> <td>beginning</td> | 33 | 代表 | to delegate | a delegate | 103 | 起头 | | beginning |
| 136 符分 to score a score 106 误话 to tak a talk 37 定案 decide on a verdict verdict 107 提位 carry a bag handbag 38 订单 to order an order 108 提減 write an inscription an inscription 39 顶风 against the wind head wind 109 繁悲 pwinterest interest so deducted 40 定稿 finaleze a manuscript final version 110 登工 work as a substitute temporary worker 41 定价 make a price fixed price 111 投资 invest investment 43 定时 definea time definite ime 113 限量 imit the price imited price 43 定时 definea time definite ime 113 限量 imit the price imited quantity 44 定文 to define definite ime 111 限量 imit the price imited quantity 44 定数 take seloct a venue permanent venue 116 显效 take effect effect 47 断层 fault faulage 117 虚频 fave a dialogue 118 虚数 take effect effect 48 对适 have a dialogue dialogue 118 虚效 explain some reason or fact historical novel 51 gain have a dialogue a fine 120 may inposea fine | 34 | 答卷 | answ er questions in an examination paper | answ er sheet | 104 | 融资 | to finance | a finance |
| 37 逆案 decide on a verdict verdict 107 提包 carry a bag handbag 38 订单 to order an order 108 Neile nerscription an inscription 38 174 to order investion investion investion investion 40 定積 finalize a manuscript final version 110 BTL work as a substitute temporary worker 41 定价 make a price fixed price 111 BTL invest investion 42 DEd norm 112 RtL invest investion investion 43 DEd definea definite time 113 RtL investion definite 45 DEd designate members fixed number of staff members 115 RtR set a time limit deadline 46 DL fault faultage 117 Ztg delect an option option 48 DEA have a dialogue a fine 119 #tke of free explain some reason or fact historical novel <td>35</td> <td>倒账</td> <td>repudiate a debt</td> <td>bad debts</td> <td>105</td> <td>说理</td> <td>argue</td> <td>argument</td> | 35 | 倒账 | repudiate a debt | bad debts | 105 | 说理 | argue | argument |
| 138 订单 to order an order 108 履词 write an inscription an inscription 39 顶风 agains the wind head wind 109 bit bit pay interest interest so deducted 40 定稿 finalize a manuscript final version 110 bit west as a substitute temporary worker 41 定位 make a price fixed price 111 bit met price interest so deducted 42 定量 to quantify norm 112 Rf int the price interest so deducted 43 定时 define time definite time 113 Rg limit the quantify of limited quantify 44 定之 to define definite time 113 Rg limit the quantify of limited quantify 44 pizz do designate members fixed number of staff members 115 Rg set a time limit deadine 45 定b designate members fixed number of staff members 117 Bg get an option option 46 cb ave a dialogue dialogue 118 Bg order an option option option 47 Bit Bave a dialogue dialogue 118 Bg perva worker an option option 50 Tit Bave a dialogue a fine 119 Pm borrow money on security a loan on security 60 Tit Bave a dial | 36 | 得分 | to score | a score | 106 | 谈话 | to talk | a talk |
| 139 頂风 against the wind head wind 109 貼息 pay interest Interest so deducted 40 定稿 final ea manuscript final version 110 倍工 work as a substitute temporary worker 41 定位 make a price fixed price 111 投资 movest investment 42 定量 to quantify norm 112 限C invest ment imited price 43 定量 to define definite time 113 限E imit the quantity of imited quantity 44 定义 to define definite time 114 限C order sb. to do sh. within a certain time an order 45 定L select a venue permanent venue 116 目並 get state imit dealine 47 膨后 faut fautage 117 速ភ delect an option option 48 pdit have a dialogue dialogue 118 限D borrow money on security a loan on security 50 罰素 inpose a fine a fine 120 減2 explain some reason or fact historical novel 51 支置 beak a rebate 122 ∬M locte citation 52 返差 to refurn return 122 ∬M locte citation 53 支置 beak seel 123 ∭B locose ords <td< td=""><td>37</td><td>定案</td><td>decide on a verdict</td><td>verdict</td><td>107</td><td>提包</td><td>carry a bag</td><td>handbag</td></td<> | 37 | 定案 | decide on a verdict | verdict | 107 | 提包 | carry a bag | handbag |
| 40 定箱 fnaize a manuscript fnai version 110 拉工 work as a substitute temporary worker 41 定价 make a price fixed price 111 投资 invest invest investment 42 定量 to quantify norm 112 限价 limit the price limited quantify 43 定时 definea time definition 114 限分 off | 38 | 订单 | to order | an order | 108 | 题词 | w rite an inscription | an inscription |
| 41 定价 make a price fixed price 111 投资 invest investment 42 定量 to quantify norm 112 股份 limit the price limited price 43 定时 definate ime definition 113 限量 limit the quantity of limited quantity 44 定义 to define at me definition 114 RQ order sb. to do sh. within a certain time an order 45 定量 designate members fixed number of staff members 116 Bax like effect effect 47 lbfZ fault faultage 117 Zip delect an option option 48 zbf fave a dialogue dialogue 118 Bax borrow money on security a loan on security 40 Tb fine 119 PBx borrow money on security a loan on security 50 Tb% invose a fine a fine 122 Ho negotiate a price negotiated price 51 Zbx lo rebate a rebate 123 HE tockes choise words choise of words 53 ZbxT to rebate seal 122 < | 39 | 顶风 | against the wind | head wind | 109 | 贴息 | pay interest | interest so deducted |
| 142 定量 to quantify norm 112 限价 limit the price limit ded quantity 143 定时 definea time definition 113 限全 limit the quantity of limit ded quantity 145 定功 definea definition 114 限全 offers b.to do sth. within a certain time an order 145 定功 designate members fixed number of staff members 115 限期 set a time limit deadline 146 定址 select a venue permanent venue 116 Bax take effect effect 147 断层 fault faultage 117 ½gg delect an option option 148 对话 have a dialogue a fine 119 bax borrow money on security a loan on security 149 罚金 to fine a fine 119 bax borrow money on security a loan on security 150 罚款 inpose a fine a fine 120 ½ ½ the negotiate a price negotiated price 151 发症 to return return return 122 jfm hoose words choice of words 152 发症 to return a rebate 123 file hoose words choice of words 154 发言 speak spech | 40 | 定稿 | finalize a manuscript | final version | 110 | 替工 | w ork as a substitute | temporary worker |
| 43 定时 definea time definite time 113 限量 limit the quantity of limited quantity 44 定义 to define definition 114 限令 order sb. to do sth. within a certain time an order 45 定员 designate members fixed number of staff members 115 限期 set a time limit deadline 46 定址 select a venue permanent venue 116 昆炎 take effect effect 47 断层 fault faultage 117 选项 deloct an option option 48 对话 have a dialogue dialogue 118 ట% renew a contract renew a laterm 49 司金 to fine a fine 120 減义 explain some reason or fact historical novel 51 及前 leaven dough 121 以价 negotiate a price negotiated price citation 53 返利 to rebate a rebate 123 捐活 choose w ords choice of w ords 54 分子 b seal seal 126 说利 meap unlar gains easy gains 56 分子 have as the boundary boundary 126 说型 to model modeling 57 折h to plough cultivated land | 41 | 定价 | make a price | fixed price | 111 | 投资 | invest | investment |
| 44 定义 to define definition 114 限令 order sb. to do sh. within a certain time an order 45 定员 designate members fixed number of staff members 115 限期 set a time limit deadline 46 定址 select a venue permanent venue 116 風效 take effect effect 47 断层 fault faultage 117 违项 delect an option option 48 讨话 have a dialogue dialogue 118 线约 renew a contract renew al term 49 罚金 to fine a fine 119 排散 borrow money on security a loan on security 50 罚款 mpose a fine a fine 120 说义 explain some reason or fact historical novel 51 发描 leaven dough leavened dough 121 议价 negotiate a price negotiated price 52 返程 to return return return 122 引例 to cite citation 53 返用 to rebate seal seal 125 逾利 reap unfair gains easy gains 55 封口 to seal seal 125 逾利 reap unfair gains easy gains 56 分升 have as the | 42 | 定量 | to quantify | norm | 112 | 限价 | limit the price | limited price |
| 45 定员 designate members fixed number of staff members 115 限期 set a time limit deadline 46 定社 select a venue permanent venue 116 显炎 take effect effect 47 断层 fault faultage 117 進项 delect an option option 48 对话 have a dialogue dialogue 118 投約 renew a contract renew alterm 49 罰金 to fine a fine 119 押載 borrow money on security a loan on security 50 罰款 mose a fine a fine 120 演父 explain some reason or fact historical novel 51 发面 leaven dough leavened dough 121 试价 negotiate a price negotiated price 52 返程 to rebute a rebate 123 用语 choose words choice of words 53 封口 to seal seech 124 约明 fix a date date of appointment 55 封口 to seal seal 125 遠和 reap unfair gains easy gains 56 分子界 have as the boundary boundary 126 這型 mondel modelling 57 耕地 to plough cultivated land 127 捕要 </td <td>43</td> <td>定时</td> <td>definea time</td> <td>definite time</td> <td>113</td> <td>限量</td> <td>limit the quantity of</td> <td>limited quantity</td> | 43 | 定时 | definea time | definite time | 113 | 限量 | limit the quantity of | limited quantity |
| 46 定址 select a venue permanent venue 116 显放 take effect effect 47 断层 fault faultage 117 选项 delect an option option 48 材活 have a dialogue dialogue 118 推访 renew a contract renew alterm 48 放活 have a dialogue a fine 119 押款 borrow money on security a loan on security 50 罚款 impose a fine a fine 120 演义 explain some reason or fact historical novel 51 反面 leaven dough leavened dough 121 iú/n negotiate a price negotiated price 52 返程 to return return return 122 引例 to cite citation 53 返利 to rebate 123 用语 choose words choice of words 54 发言 speak speech 124 約期 fix a date date of appointment 55 分月 have as the boundary boundary 128 控型 to model modeling | 44 | 定义 | to define | definition | 114 | 限令 | order sb. to do sth. within a certain time | an order |
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| 47 断层 fault faultage 117 选项 delect an option option 48 放话 have a dialogue 118 线约 renew a contract renew al term 49 罚金 to fine a fine 119 排散 borrow money on security a loan on security 50 罚款 impose a fine a fine 120 演义 explain some reason or fact historical novel 51 发面 leaven dough leavened dough 121 i公h negotiate a price negotiated price ication 52 这程 to return return 122 引刑 to cite citation 53 返利 to rebate 123 引用 choose words choice of words 54 发言 speak speech 124 約期 fix a date date of appointment 55 为口 to seal seal 125 強利 reap unfair gains easy gains 56 分界 have as the boundary boundary 126 遭型 to model modelling 57 | 46 | 定址 | select a venue | permanent venue | 116 | 显效 | take effect | effect |
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| 50 罚款 impose a fine a fine 120 演义 explain some reason or fact historical novel 51 发症 leaven dough leavened dough 121 议价 negotiate a price negotiated price 52 返程 to return return 122 引用语 choose words choice of words 53 返利 to rebate a rebate 123 別用语 choose words choice of words 54 发言 speak speech 124 約期 fix a date date of appointment 55 封口 to seal seal 125 溢利 reap unfair gains easy gains 56 分界 have as the boundary boundary 126 溢型 to model modeling 57 耕社 to plough cultivated land 127 指要 make a summary summary 58 管家 manage manager 128 掌能 steer a boat the man who steers a boat 59 鼓包 to lump a lump 129 fix solicit articles essay writing 60 fix 1// inrelabour hired labourer 130 thit trasolar the coming year | 49 | | | | 119 | | | |
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Table 1. One hundred thirty-five minimal pairs [MN] [VO] selected in the
Contemporary Chinese Dictionary 5th edition (Lu & Ding, 2008).

Weilin Shen et al.