MORPHOLOGICAL PRODUCTIVITY IN CHINESE [A N]: A CORPUS-BASED STUDY

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Albert Einstein says: “God does not throw dice.” To which Niels Bohr responds: “Einstein, stop telling God what to do.” It is a well-known dialogue between two greatest minds in the 20th century I quoted to guide my presentation delivered in a graduate seminar. After that, my mentor Dr. XU Zheng remarked that I have had my own philosophy on language. I believe it is partly because I have studied philosophy for four years before venturing into the new research field: linguistics. Over the past three years, I am indebted to the significant impact Dr. XU has on my study, in particular he introduced me to the delights of morphology, which I think would be the core topic of my future research. This thesis would not exist without Dr. XU’s constant support, guidance and encouragement. Moreover, I would like to express special thanks to Professor Mark Aronoff who gave me insightful input about both morphological theory and my own thesis topic: morphological productivity. All of these are my fortune.

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SUMMARY

This thesis makes a preliminary investigation of morphological productivity in Chinese adjective-noun compounds ([A N]). I argue that Hay and Baayen's (2002) Parsability Hypothesis does not work well for Chinese [A N]. Constraints on productivity cannot be ascribed to the parsability based on relative frequency. Instead, a heterogeneous set of constraints are shown to override the effect of the morphological parsability on the productivity of Chinese [A N]. Hay and Baayen's model also posits a link between morphotactics and productivity. It, however, cannot account for the ordering of adjectival modifiers in Chinese [A [A N]]. A categorical frequency based constrain is proposed to account for the ordering of adjectival modifiers in Chinese [A [A N]].

This model provides a psycholinguistic explanation for why morphological productivity varies among word formation processes. It argues that productivity is largely affected by the morphological parsability measured by the relative frequency (f-derivative against f-base). An affix that appears in more parsed words tends to be more productive than one that appears in less parsed words. For example, the derivational suffix *-less* is more productive than *-ity* because words affixed with *-less* are more parsable than those affixed with-*ity* (Hay and Baayen 2002). However, the Chinese [A N] data shows that the explanatory power of the parsability based on relative frequency is limited. My calculation result shows that there is no significant correlation between relative frequency and productivity in Chinese [A N]. Both unproductive ones (e.g. [*mei* N]) and productive ones (e.g. [*bai* N]) are highly parsed according to the relative frequency. Instead, a heterogeneous set of constraints are shown to override the effect of the morphological parsability.

The Parsability Hypothesis also fails to account for the ordering of adjectival modifiers in Chinese [A [A N]]. In light of Hay and Baayen's model, the morphotactics (ordering of morphemes) is constrained by productivity. More productive affixes tend to be located outside less productive ones and less productive affixes are closer to the bases (Baayen 2009). However, productivity of adjectival modifiers cannot explain their order in Chinese [A [A N]]. Adjectival modifiers that are closer to noun heads are not less productive ones. Thus, restrictions on the ordering of adjectival modifiers cannot be ascribed to the parsability either. As an alternative, I propose a categorical frequency based constraint that can account for the ordering of adjectival modifiers. Based on corpus data, I find a positive correlation between the ordering of adjectival modifiers in Chinese [A [A N]] and their categorical frequencies. Adjectival modifiers with lower categorical frequency tend to precede immediately noun heads while those with higher categorical frequency are located further away from the noun heads.

Overall, the result of this study shows that constraints on morphological productivity cannot be simply ascribed to morphological parsability based on relative frequency. Both grammatical restrictions and processing constraints should be taken into account in the study of morphological productivity. Additionally, no parsability effect in Chinese [A N] may provide new evidence to show that Chinese compounding is more likely by the whole rather than by decomposition, which in turn supports the findings of this thesis.

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LIST OF ABBREVIATIONS

A: adjective

[A N]: adjective-noun compounds

C: morphological category

n_1: hapax legomena

N: noun / corpus size

N (C): total number of tokens in the corpus for a given category C

P: Baayen's symbol of productivity

V (1, N): number of words of *any* category that occur only once in a corpus of N tokens

V (1, C, N): number of words of category C that occur only once in a corpus of N tokens

V(C, N): number of word types of morphological category C

X: lexical slot

Chapter 1 Introduction

1.1 Thesis structure

Morphological productivity refers to the phenomenon that some word formation processes are used frequently to form new words, whereas others do so occasionally. Until recently many linguists attempt to explain why one word formation pattern is more productive than the other (Aronoff 1976, van Marle 1985, Baayen 1992, 1993, Plag 1999, Bauer 2001 and among others). As an alternative to traditional approaches focusing on grammatical restrictions, the most recent modelling approach, the Parsability Hypothesis (Hay and Baayen 2002, 2004, Hay 2003 and later works) provides a psycholinguistically plausible account of the emergence of productivity.

According to Hay and Baayen 2002, affixes that appear in many derived words that are parsed in language perception will be more available for word formation, i.e. more productive. For example, according to this model, words derived from X-*less* are divided into (i) rule-driven ones where the derived words are highly parsed (e.g. *tasteless*), and are accessed via constitutive parts and (ii) memory-driven ones where the derived words appear more lexicalized, and tend to be characterized by the-whole rather than decomposition (e.g. *listless*). Based on this model, whether a derived word is parsed depends heavily on the relative frequency (defined as *f*-relative = *f*-derivative / *f*-base). If the derivative is less frequent than the base (e.g. *taste* > *tasteless*), it tends to be parsed; if the derivative is more frequent than the base, it is likely in the process of becoming monomorphemic or lexicalized (e.g. *listless*>*list*). Hay and Baayen argue that the former set (high parsability) facilitates productivity much more strongly than the latter one (low parsability). Thus, there is a possible relationship between parsability and morphological productivity. Increased rates of parsability lead straightforwardly to increased productivity. (Hay and Baayen 2002: 203-204)

Moreover, this model posits a link between affix ordering and morphological productivity. It predicts that in order to maintain the activation level in the lexicon, more productive affixes that are also more easily parsed out tend to be further away from their bases. In this way, more productive affixes do not occur within less productive ones, since the attachment of a less separable affix to a more separable one is difficult for speakers to process. This property reinforces the idea that morphological productivity emerges as a result of parsability (Hay and Baayen 2002, 2004, Baayen 2009). The psycholinguistic foundation of Hay and Baayen's model makes it appealing for many researchers. So far this model has been widely evaluated in a variety of languages. The model manages to apply to some languages, for example, English (Hay and Plag 2002, Hay 2003), French (Vokovskaia 2010) and Russian (Eugenia 2012) but does not work very well in other ones such as Dutch (Baayen and Plag 2009), Italian (Gaeta 2008) and Bulgarian (Manova 2010). It is an open question that whether the Parsability Hypothesis can provide an explanatorily adequate analysis of word formation.

In this thesis, I extend the empirical scope to compounding to examine the validity of Hay and Baayen's model. The data is based on adjective-noun compounds ([AN], hereafter) in Mandarin Chinese. Over the past years, there has increasing evidence showing that there is no sharp boundary between compounding and derivational affixation (Booij 2005, 2010, Naumann and Vogel 2000, Singh 1996, ten Hacken 2000, Ralli 2010 and among others), and both derivation and compounding constitute instances of word formation and should be accounted for by the same pattern. **[1]** Constraints on productivity "should equally apply to compounding"(Bauer 2005:316)

[1] More previously, many linguists have implicitly assumed a unified treatment of compounding and derivation within the same grammatical domain, e.g., Lieber 1980 remarked that both affixes and stems are part of lexical entries of the permanent lexicon. Lexical morphology approaches also assigned compounding and derivation to different levels of a stratified lexicon (Kiparsky 1982, Mohanan 1986).

and derivational affixation. The data from Chinese [A N] argue against the parsability as a constraint on morphological productivity. I argue that morphological productivity is shaped by a heterogeneous set of constraints including selectional restrictions, the Blocking Principle and semantic transparency. I also argue that categorical frequency rather than the parsability plays an important role in adjectival ordering in Chinese [A [A N]].

This thesis is structured as follows. In the rest of this chapter, I will briefly review the quantitative approach to productivity and the notion of relative frequency embedded in the Parsability Hypothesis. Chapter 2 explains how the data were selected and discusses the methodology used for analyzing these data. I adopt the notion of constructional idiom and the corpus-based approach to measure productivity in Chinese [A N]. Chapter 3 and Chapter 4 discuss the predictions derived from the basic idea of the Parsability Hypothesis. It is shown that relative frequency fails to predict degrees of productivity in Chinese [A N] and the order of adjectival modifiers does not positively correlate with morphological productivity. Conclusions are made in Chapter 5.

1.2 Measuring productivity

Traditional approaches to morphological productivity have investigated in finding out grammatical explanations for productivity which is seen to be inversely proportional to a number of grammatical restrictions (Booij 1977). That is to say, the more restrictions on a word formation process, the less productive it will be. However, Baayen argues that grammatical restrictions as such do not directly drive morphological productivity (Baayen 2009:908). From a quantitative point of view, measuring productivity by the amount of restrictions on word formation is limited in

that such restrictions cannot be directly measurable, so to what extent grammatical restrictions affect productivity is unknown (Baayen and Renouf 1996: 87). Alternatively, Baayen proposes a corpus-based method, claiming that degrees of productivity can be measured based on the *hapax legomena* (Baayen 1989, 1992, 1993), which refers to a word that occurs only once in a given corpus. The basic idea behind this approach is that *hapax legomena* can represent the active state of a morphological process. As Aronoff and Fudeman (2011: 242) claim, "[w]ords that appear only once in a large corpus are more likely than words that are used repeatedly to have been formed by a productive rule." For example, a *hapax legomena* like giggle-gaggle hardly can be found in a dictionary, but it can represent a very productive pattern in English as semi-reduplication: *chitchat, jingle-jangle, flip-flop, zigzag*.

The corpus-based method is mathematically formalized as [P = V (1, C, N) / N (C)] (Baayen and Lieber 1991, Baayen 1992, 2001, 2009, Hay and Baayen 2002), where V(1,C, N) means the number of *hapax legomena* for morphological category C in a corpus and N(C) means the token frequency of all derived words. It predicts that more productive word formation would result in higher index under this kind of calculation. According to Baayen 2009, Dutch has several different suffixes for creating nouns denoting female agents. The most productive one of these suffixes is *-ster*, as in *verpleeg-ster*, 'female nurse'. There is also a verb-forming prefix *ver-* as in *ver-pleeg-en,* 'to nurse', which is described as less productive. For Dutch native speakers, it is easier to think of new well-formed words in *-ster* but very hard to think of a well-formed word in *ver-*. This fact could be predicted by potential productivity indices of them (*ver-*: P = 0.001 and *–ster*: P = 0.031).

This corpus-based approach has been widely adopted in different languages

such as in Dutch (Baayen 1989, 1992), English (Baayen and Liber 1991, Baayen and Renouf 1996, Hay and Baayen 2002, etc.), Italian (Gaeta and Ricca 2006) and Chinese (Sproat and Shih 1996, Nishimoto 2003). Sproat and Shih 1996 use the model to demonstrate that root compounding is a productive word-formation process in Mandarin Chinese[2]. Their argument is supported by the indices used in Baayen's approach. For example, *shi* 'rock-kind' and *yi* 'ant-kind' have the productivity indices of 0.129 and 0.065, respectively. By contrast, unproductive *bin* and *lang* in *binlang* 'betel nut' are found to have zero productivity. In addition, Nishimoto 2003 measured and compared productivities of four Chinese suffixes (*-men*, *-zi*, *-r*, *-tou*) with this approach. It confirms that *-men* and *-r* are very productive while *-zi* and *-tou* are unproductive in Mandarin Chinese. These studies show that Baayen's corpus-based approach may provide a reasonable prediction on morphological productivity.

1.3 Parsability Hypothesis

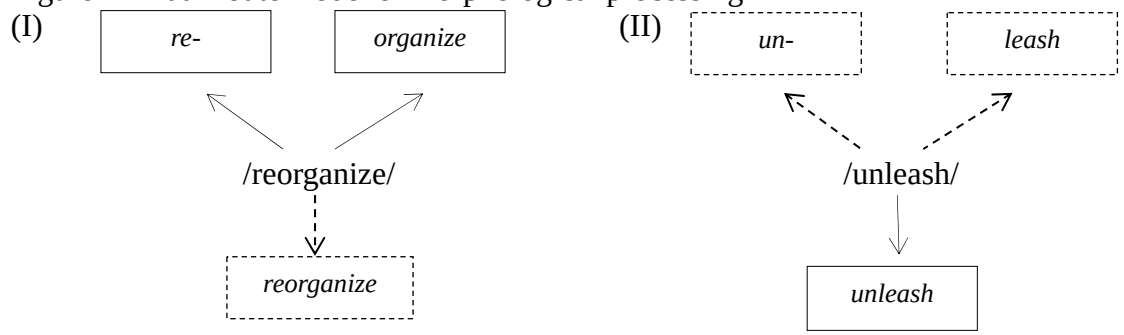
Hay and Baayen's model is distinct from others in that it attempts not only to measure degree of morphological productivity, but also to explain it. Contrary to the certain traditional claim that (type or token) frequency of an affix does not affect productivity. Hay and Baayen 2002 argue that productivity is in fact intimately linked to frequency. Instead of referring to absolute (token or type) frequency, relative frequency can predict the degree to which an affix is likely to be productive (Hay and Baayen 2002:203). Hay and Baayen suggest that the more parsed words in which an affix occurs, the more productive a word formation process with this affix will be. The basic idea behind this approach comes from the dual-route race model in

[2] There is no overt suggestion in the literature to prevent this formula from applying to compounds.

morphological processing of psycholinguistics (Baayen 1993, Hay 2001, 2002, 2003).[3]

Now consider Figure 1. If the base is more frequent than its derivative, it is accessed faster for speakers, and the decomposition route (in which it is accessed via constituents) wins, as in *reorganiz*e, while if the derivative is more frequent, it is retrieved as a whole word in our mind before base + affix is accessed, as in *unleash*. In other words, in production, *unleash* is in the process of becoming independent of its base word, i.e. becoming more like a monomorphemic word; in comprehension, *unleash* is in the process of becoming more likely to be understood by memory. If we name type (I) as rule-driven words and type (II) as memory-driven words, morphological productivity can be understood as follows: affixes that tend to appear in rule-driven words are more productive than those that tend to appear in lexicalized words. The parsability of a word formation process is measured by the proportion of type (I) words derived from it.

Figure 1 Dual-route model of morphological processing



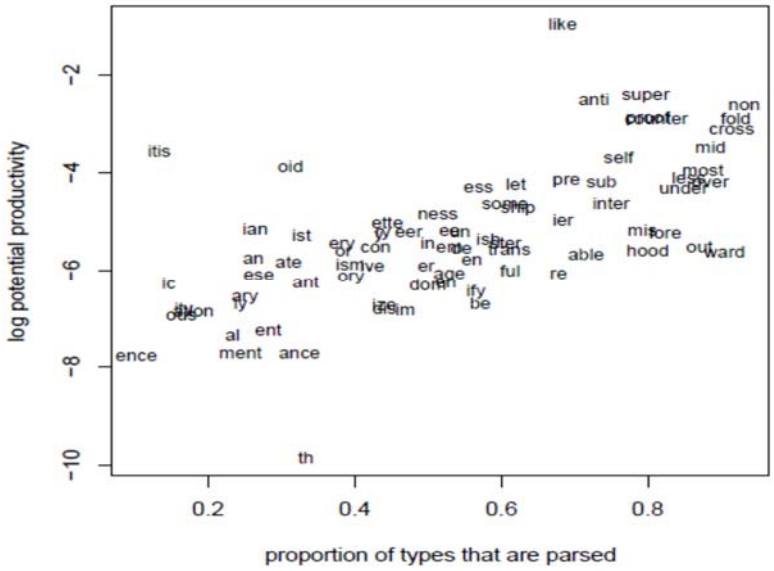
f-relative (*reorganize*) < *f*-relative(*unleash*)

Hay and Baayen 2002 argue that the parsability is positively correlated with productivity. Consider Figure 2 (cited in Baayen 2009). Hay and Baayen find that whether a word is accessed by decomposition (parsable) or by the-whole (non-parsable) can provide a good prediction about the degree to which is likely to be productive. The same result is reduplicated by Hay 2003. High parsability straightforwardly leads to

[3] The relative frequency effect was first found in a psycholinguistic experiment in English (Hay 2001).

high potential productivity in the lexicon. For example, some of the words that are affixed by *un-* are highly decomposable, as in *unveil*, whereas other affixed words appear more opaque, and tend to be processed by whole word, rather than parsing, as in *unleash*. Regardless of the absolute frequency of them, the former facilitates productivity much more strongly than the latter because the base *veil* is more frequent than the derivative *unveil*, so it increases the potential productivity of *un-*. Conversely, *unleash* has a base that is less frequent than the derivative, so it decreases the potential productivity of *un-*. It means that the affix used to form more parsing derivatives must be more productive.

Figure 2 Log potential productivity and the proportion of types that are parsed in the model of Hay and Baayen 2002. According to Hay and Baayen(2002), humans apt to process frequency information in a logarithmic manner - with differences amongst lower frequencies appearing more salient than equivalent differences amongst higher frequencies (e.g. the difference between 100 and 200 is more obviously salient for us than the difference between 10100 and 10200).

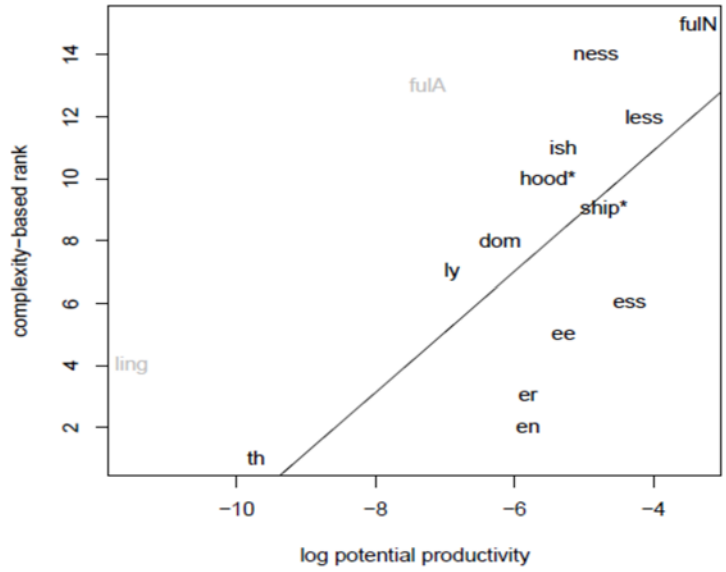


This model seems to apply to Chinese compounds as well. Given the morphemic nature of Chinese (one morpheme≈one syllable≈one character), it might be expected that the frequency or parsability will show the same robust influence on Chinese compounds. If an [A N] is more likely to be parsed, such as *huang chenshan* (yellow shirt) ‘yellow shirt’, the modifier *huang* ‘yellow’ and the head *chenshan* ‘shirt’ can more freely combine with others to form new words. If an [A N] is lexicalized,

such as *heiban* (black board) ‘blackboard’, the compound becomes independent of its constituent parts; it thus becomes difficult to extract either the modifier or the head to form new words. Sproat and Shih 1996 claim that nominal root compounding in Chinese is productive. However, Packard 2000 argues that all Chinese compounds are listed in the lexicon. He provides substantial psycholinguistic evidence to show that the-whole route rather than the decomposition route takes precedence in Chinese compound processing. Nevertheless, most previous studies focus on absolute frequency while relative frequency has not been taken into consideration. It is thus an open question whether the relative frequency would make any difference. This thesis shows that relative frequency is still inapplicable to Chinese [A N].

The other noteworthy issue concerns the relationship between affix ordering and morphological productivity. Based on the Parsability Hypothesis, in order to maintain the activation level in the lexicon, more productive affixes which are also easily parsed out tend to be located outside less productive ones. According to this constraint, **home-less-ity* is ungrammatical simply due to the fact that *-less* is more productive than *-ity* and hence should not be closer to bases. Strong evidence for the model comes from a hierarchy of English suffixes found by Hay and Plag 2004. The hierarchy is about the order in which these suffixes can occur in complex words. Consider Figure 3, based on table III of Hay and Plag 2004 which was in turn cited in Baayen 2009. As the log-transformed potential productivity of suffixes increases, the suffixes’ combinatorial rank increases as well. Given that a suffix has rank *r*, suffixes with rank greater than r may follow that suffix in a word, while suffixes with rank lower than r will never follow it. For example, *-less* is more productive than *-hood,* it is predictable that for a new coined word affixed with them, **child-less-hood* should be impossible while *child-hood-less* would be fine.

Figure 3 Potential productivity and suffix ordering



In other languages, however, affix order is found to be less constrained by parsability than in English (Dutch: Baayen and Plag 2008; Italian: Gaeta 2008, cited in Manova 2010). Baayen et al. 2009 refine the model and extend it to English compounding. Their study seems to make a compromise by suggesting the combinatorial ordering constraints may vary across different languages. In a study of an inflecting-fusional morphological type represented by the South Slavic language Bulgarian, Manova 2010 shows that in order to increase productivity, the Bulgarian word exhibits three domains of suffixation, but the hierarchical suffix ordering is found not due to the parsability. Manova's study on inflection makes the question quite open that whether Parsability Hypothesis can adequately explain morphological productivity.

The data from Chinese compounds may contribute to this issue. In Chinese [A [A N]]'s, multiple adjectives can simultaneously modify noun heads and the positions of adjectival modifiers cannot be switched freely, as in *da bai panzi* (big white plate) 'big white plate' vs. * *bai da panzi* (white big plate) and *xiao hong hua* (small red flower) 'small red flower' vs. * *hong xiao hua* (red small flower). There is a fixed order of adjectival modifiers in Chinese [A [A N]]. If Hay and Baayen's model is correct in Chinese [A[A N]], there would be an adjectival hierarchy in which less

productive adjectival modifiers are closer to noun heads than those more productive ones. Contrary to such a prediction, I argue that Hay and Baayen's model fails to account for the order of adjectival modifiers in Chinese [A [A N]. The order is constrained by the semantic relevance to noun heads and the categorical frequency rather than their morphological productivity.

1.4 Summary

In this chapter, I have introduced Hay and Baayen's modeling approach to morphological productivity, the Parsability Hypothesis. This model, which has been tested in different languages, suggests a significant correlation between the relative frequency (the bases against derivatives) and morphological productivity. I have shown the psycholinguistic foundation of Parsability Hypothesis and how the relative frequency effect can affect productivity of a particular word formation process. In addition, affix order is proved to be predictable from productivity. More productive affixes tend to be located outside less productive ones.

When it comes to Chinese [A N], two questions arise. One is whether the correlation between relative frequency and productivity would be found in Chinese compound. The other is whether adjectival ordering can be determined by productivity in light of the Parsability Hypothesis. As pointed out in the very first section, the particular focus of this paper is to test whether the Parsability Hypothesis works well for Chinese [A N] data. I conducted a corpus-based study of Chinese [A N]. To create a primary dataset of Chinese [A N], Chinese National Corpus (CNC) is taken as the source for the study. In Chapter 2, I explain how the data were selected as well as the methodology for analyzing these data.

Chapter 2 Data and Methodology

This chapter provides an overview of the data and methodology. The dataset is built up on Chinese National Corpus[4]. I propose a constructional idiom approach to explain how to measure productivity and relative frequency (*f*-relative = *f*-derivative / *f*-base) in Chinese [A N]. I argue that morphological productivity of an [A N] can be measured by the productivity of adjectival modifiers. I also argue that the base frequency (*f*-base) of an [A N] should be the summed frequency of all [A N]'s and [N N]'s that contain the same nominal root as the right constituent.

2.1 The data

This thesis is based on a dataset of Chinese [A N]'s extracted from Chinese National Corpus (CNC), a genre-mixed balance corpus with 20 million characters. Considering productivity of word formation is primarily of interest, all of the stylistic influences of texts will be ignored in the study. The CNC provides the segmentation by part-of-speech tags for all characters, presupposing that one Chinese character can be equivalent to one word, which is consistent to our understanding of Chinese morphology. All texts in this corpus are machine-readable and compatible with any third-side tools if one wants to assure the accuracy of the segmentation or for other purpose. The corpus also provides a separate and filterable word list containing information of frequency and syntactic category of occurrence in the corpus. Nouns, adjectives and [A N]'s in the corpus are the objects to be exploited.

A necessary step is to identify adjectives in the corpus. An extremely large number of words (nearly 80,000 words) are tagged as A (adjectives). It is simply impossible and unnecessary to get through every single '/a' in the corpus. Theoretical treatments on [A N] have convincingly provided insights that can guide the extraction

[4] An online text corpus (*www.cncorpus.org*) built by The National Language Committee of China.

procedure. In this thesis, tow criteria are adopted: (i) the monomorphemic constraint and (ii) adverbial modification.

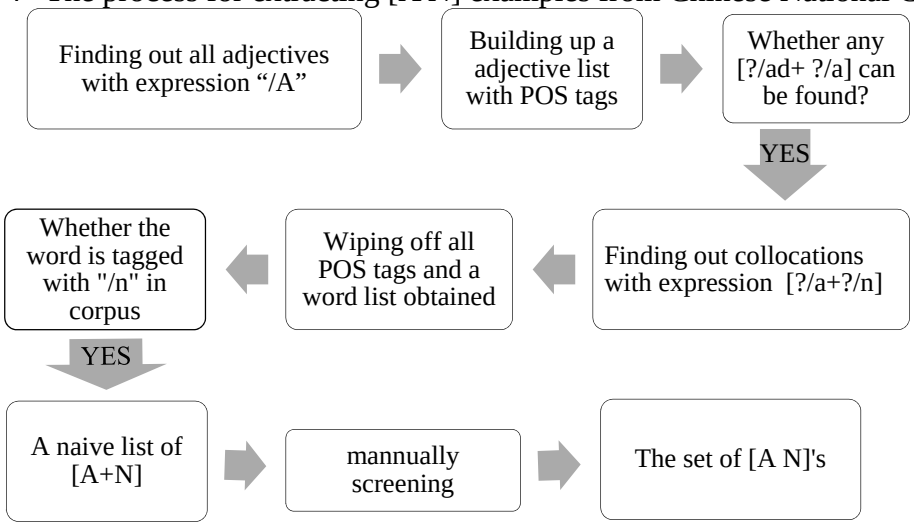
According to Z. Xu 2012, adjectives that are permissible in [A N] need to be monomorphemic. But exceptions are still observable in the data pool and whether bimorphemic adjectives can occur in [A N] remains controversial. To minimalize the chance of errors and increase the reliability of data, adjectives consisting of two or more morphemes are discarded from our sample.

According to Quirk et al. 1985, there are four criteria for the identification of adjectives (in decreasing order of their significance for the definition of the class of adjectives; cf. Quirk et al. 1985: 402–404): (i) attributive use. (ii) predicative use after the copula ‘seem’. (iii) premodification by degree adverb. (iv) gradability. For Chinese, only (iii) and (iv) can clearly distinguish adjectives from other classes say, nouns which may also satisfy (i) and (ii). Adverbial modification is thus adopted in the present analysis. Some words which are tagged as ‘adjective’ in CNC will be excluded in terms of adverbial modification. For example, although *gu* can modify nouns in words such as *gu-du* (ancient capital) ‘ancient capital’ and *gu-zhai*(old house) ‘old house’, it is not considered as adjectives in this thesis because **hen gu* (quite classical) ‘quite classical’ is ungrammatical.

With these criteria, a set of adjectives was collected. Because my investigation is related to measure relative frequency and productivity, adequate frequency counts must be guaranteed. If the word list given by a corpus developer is inaccurate due to segmentation error, calculation results would be undoubtedly problematic. Re-check focusing on the plain texts is thus required such as applying the independent tool to produce another list. In a word, corpus-based analysis relies on size and accuracy of the dataset. Synthesizing all above, the extracting process is implemented as order and

consequently results in a set of monomorphemic adjectives as modifiers in [A N]. The last step is to manually screen data of the set and get out of those naive strings (e.g. '*gao*' denoting a kind of family name). The process of data selection is shown in Figure 4, 56 adjectives and 2685 compounds are included in the dataset.

Figure 4 The process for extracting [A N] examples from Chinese National Corpus



All adjectives can be subcategorized according to their semantic sense. It should be noted that the classification of adjectives is for describing data only. The semantic category of adjectives does not necessarily correlate with their productivity. The paper takes the taxonomy of adjectives proposed by Dixon 1982, 2004 who argues that adjectives belong to six subcategories: DIMENSION, PHYSICAL PROPERTY (hereafter, PHYSICAL), COLOR, VALUE and AGE as illustrated below in Table 1.

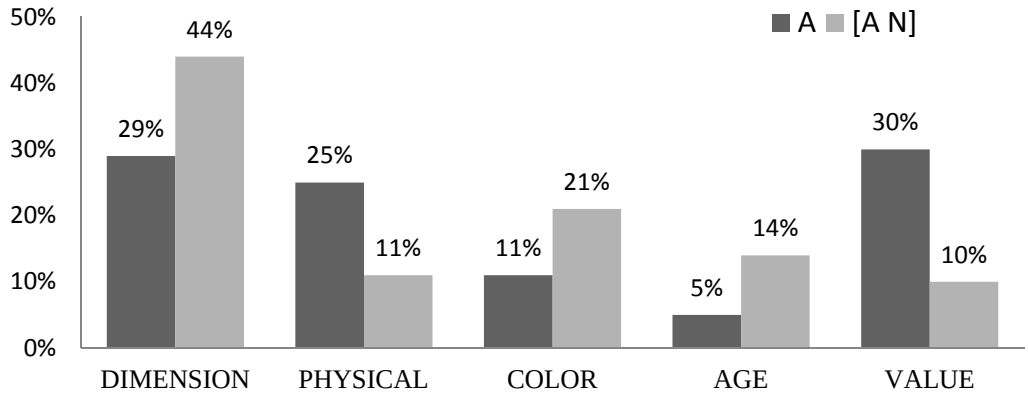
Table 1 Classification of Adjectives in Chinese [A N]'s

Subclass	Numbers	Basis/Explanation	Examples
DIMENSION	16	length, size, height, etc.	*da 'big', chang 'long', gao 'high'*
PHYSICAL	14	texture, taste, weight, etc.	*ruan'soft',qing'light', tian'sweet'*
COLOR	6	Colors	*hong 'red', bai 'white', hei 'black'*
AGE	3	age, newness	*lao 'old', xin 'new', jiu'past'*
VALUE	17	attitude-based	*hao 'good',ruo 'weak', qiang 'strong'*

Some categories seem to be more likely to be used to form compounds, whereas others

tend to remain inactive. Consider Figure 5. It is shown that the numbers of adjectives of a category do not correlate with the numbers of [A N]'s. This indicates that productivity is not subject to categorical frequency of adjectives. In general, VALUE adjectives, along with PHYSICAL adjectives are much less productive than DIMENSION and COLOR adjectives. AGE adjectives appear most productive. However, these facts do not entail a cause-and-effect between productivity and semantic categories. Different taxonomies may result in different distribution of productivity with regard to semantics. For example, if we take SIZE adjectives and SHAPE adjectives) as independent categories (like Sproat and Shih's taxonomy, see Sproat and Shih 1991), the whole picture of the correlation would be seriously affected. More evidence and inferential analyzing are thus required to unveil the possible relationship (see the discussion in 4.1).

Figure 5 Percentage of [A N]'s by semantic categories



2.2 Methodology

In current linguistic literature, there is no consensus on the notion of base in compounds. But the identification of the base is prerequisite for the issue concerned in this thesis since that the base is the set of words to which a word formation process can apply and so is the key to measure the relative frequency and productivity. Several

approaches to the base of compounds will be discussed in this section. I argue that the notion ‘constructional idiom’ can determine which constituent of a compound should be regarded as the base.

2.2.1 A constructional idiom approach

In the spirit of the notion ‘constructional idioms’, which are morphological or syntactic schemas with both lexically specified positions and open slots that are represented by variables (Booij 2005, 2010, Goldberg 1995, 2006, Jackendoff 1997,2002,Wray 2002), either compounding or derivation can be replaced with a constructional idiom with lexically specified positions and open slot, represented by the variable ‘*x*’. For example, derivation as [[*x*]$_V$ [*er*]$_N$]$_N$ ‘one who V’s ’ as in *seller*, *player*, *singer* and compounding as [[*x*]$_N$ man]$_N$ as in *Spiderman*, *Batman*, *postman*, *gunman*.

Under this framework, the difference between compounding and derivation is merely in that the lexically specific part in derivation has no lexical label since it does not correspond to a lexeme. On the whole, compounding and derivational affixation do not differ as word formation means. A word formation process can be construed as an application of a constructional idiom, and the productivity is the likelihood a constructional idiom is applied to form new words, i.e. how many variables can possibly occupy the open slot. For example, the productivity of the suffix *-er* can be measured by the likelihood of that a root or stem can occupy the open slot in [X-*er*]. According to Z., Xu 2012, Chinese [A N] can be represented as the constructional idiom [A [*x*]$_N$]$_N$, where “ A ” (adjectives) are lexically specified, “ [*x*]$_N$ ”(nouns) are the independent variables as open slots.

Based on the constructional idiom, one can imagine that the productivity of

Chinese [A N] is the productivity of its adjectival modifiers. The adjectival modifier in Chinese [A N] occupies the lexically specified position. The productivity of an [A N] can be seen correlated with how many nouns can occupy the open slot and form new words with the adjectival modifier. In addition, the statistical result supports the adjective as the key to measure productivity of Chinese [A N]. Among 2685 Chinese Adjective-Noun combinations in the dataset, only 56 types of adjectives are attested. The high re-usage means that adjectives play a dominating role in adjective-noun combinations. Correspondingly, the nominal root that occupies the X slot in a Chinese [A N] should be identified as the base.

If my analysis is correct, one group of [A N]'s formed by one particular adjective represents a constructional idiom. For instance, all [A N]'s modified with *mei* 'beautiful' can be generalized into $[[mei]_A\ [x]_N\ ]_N$. The number of words created by such a constructional idiom is seen as the number of word types. A distinction is made between word tokens and word types here. To give the simplest example, if we have three occurrences of *mei* in a small corpus, the token frequency of *mei* is three, and the type frequency of *mei* is one. In the case of compounding, for example, if we have a corpus of nouns that has {*mei jiu*, *mei nü*, *mei jing*, mei jiu}, the token frequency of [*mei* N] is four (the sum of all these occurrences initialed by *mei*) while the type frequency of [*mei* N] is three (*mei jiu, mei nü, mei jing*). Based on this method, the actual distribution of [*mei* N] in my corpus is shown in Figure 6. For [*mei* N]'s, those with a higher rank is overwhelmingly frequent than those with a lower rank. The distribution shows that most of [*mei* N]'s are not actively used by native speakers. Therefore, *mei* should be unproductive to form new compounds, which is borne out by the facts.

Figure 6 [*mei* N] in Chinese National Corpus

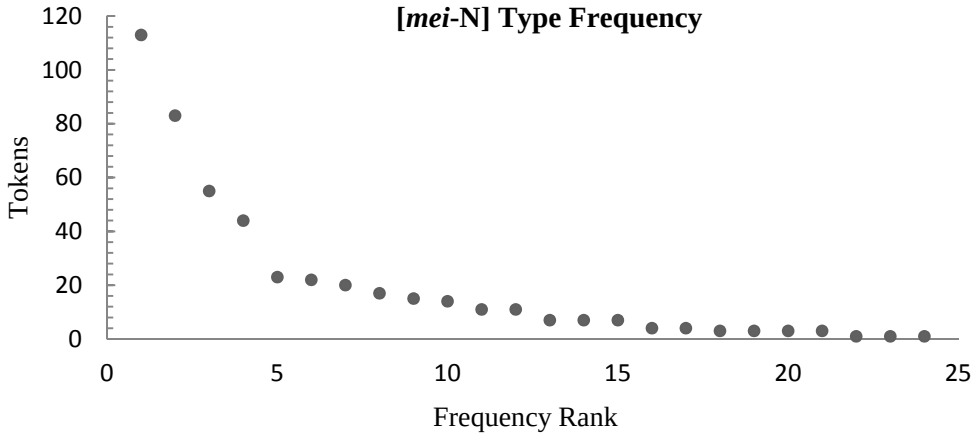


Table 2 below displays a partial result of productivity based on Baayen's formula. The numeric zero in productivity means these Chinese [A N]'s are barely used to produce any new types (words). The most productive [A N] come from [*ai* N] while [*da* N], which is widely considered to be very productive, does not occur within top 10. One explanation may be that the productivity of [*da* N] has been saturated after being productive for long and has formed as many compounds as possible. The evidence is that the type number of [*da* N] is higher than the rest of the dataset. For the most productive [*ai* N], we find that [*ai* N]'s are barely conventional words listed in the lexicon, which facilitates the productivity of the word formation process.

Table 2 Top and bottom 10 [A N]'s by productivity

Rank	[A N]	Gloss	V	V(1, C, N)	N(C)	P
1	[*ai* N]	low	31	3	107	0.0280
2	[*huang* N]	yellow	83	25	927	0.0270
3	[*lü* N]	green	47	15	593	0.0253
4	[*ku* N]	bitter	46	11	463	0.0238
5	[*jiu* N]	old	64	16	684	0.0234
6	[*bai* N]	white	192	60	2587	0.0232
7	[*chou* N]	smelly	13	2	88	0.0227
8	[*xian* N]	idle	14	3	151	0.0199
9	[*xiang* N]	fragrant	40	11	591	0.0186
10	[*ruan* N]	soft	28	6	330	0.0182
47	[*huai* N]	bad	15	1	460	0.0022

48	[*xi* N]	slim	29	3	3567	0.0008
49	[*shu* N]	familiar	3	0	98	0.0000
49	[*xian* N]	salty	5	0	50	0.0000
49	[*zang* N]	dirty	5	0	30	0.0000
49	[*nan* N]	difficult	6	0	394	0.0000
49	[*qiong* N]	poor	8	0	217	0.0000
49	[*chou* N]	ugly	9	0	75	0.0000
49	[*xian* N]	fresh	13	0	95	0.0000
49	[*leng* N]	cold	22	0	576	0.0000

The other issue is about the base frequency in Chinese [A N]. As mentioned above, the base of a Chinese [A N] should be a nominal root that occupies the X slot. I argue that when to calculate base frequency for compounds and Chinese [A N], we should consider the positional factor rather than simply take the absolute frequency of the head as the base frequency. Unlike derivation where the root is relatively fixed and easily identified (e.g. prefixes *un*-X or suffixes X-*ment*), a root in compounding is flexible in its position. In Chinese, a noun that occupies the head position is distinct from the same one that occupies the non-head position. For example, *nü* 'woman' can occur both on the left as modifiers like *nü*-X (*nü laoshi* (female teacher) 'female teacher', *nü xuesheng* (female student), 'girl student', *nü siji* (female driver) 'female driver' etc.) and on the right as heads like X-*nü* (*xiannü* (faery woman) 'faery', *meinü* (beautiful woman) 'beauty' etc.).Accordingly, the token frequency of the base in Chinese [A N] is actually the positional cumulative root frequency. When it comes to the base *nü* 'women', for example, the base frequency[5] should be the summed frequency of all [A N]'s and [N N]'s that contain *nü* as the right constituent, i.e. the nominal head.

2.2.2 Alternative approaches

In this subsection, I discuss two alternative approaches to the issue of the

[5] In line with Hay and Baayen's approach, the log frequency is drawn in this thesis.

compound base. These approaches argue that headedness can determine which part is the base. I argue that headedness is not a reliable means and the positional factor must be taken in account when calculating the base frequency.

Fernández-Domínguez et al. 2007 have noticed that the evaluation of the relative frequency of compounds raises a problem linked to the clear identification of the base. He suggests that the base frequency of compounds can be measured according to three possible variants: (a) by adding the frequencies of the separated constituents; (b) by dividing the sum of the frequency by the number of constituents to calculate the average frequency of constituents; (c) by using only the frequency of the head of the compound. The biggest problem with this approach lies in its ignorance of the morphology itself. A same morpheme may be repeatedly used, but the word formation process it is involved may be different. For example, for the root (stem/lexeme) *page*, its status is distinct in *page-marker* from in *title-page* although both of them are noun-noun compounds. In the former, *page* is a modifier, while in the latter it is a head. Without considering the position, the base frequency would be overestimated. The other evidence favoring the importance of position factor is Baayen et al. 2009. They show that constraints favoring acyclicity in English suffix ordering also govern the sequences of constituents in noun-noun compounds ([N N], hereafter): nouns can be ordered in a hierarchy such that for any nouns A, B and C, given the existence of compounds A-B and B-C, the compound C-A is unlikely to exist as well.

The other alternative argues that the base should be not the head of a compound (Voskovskaia 2010). The rationale is: in a derived word, the base is a free morpheme to which an affix can be attached and a suffix is generally a head and bears the syntactic and semantic characteristics of a word. In other words, the base must be a non-head because the affix is the head. Accordingly, the base of a compound is a non-

head. However, this approach is also problematic since headedness is not a reliable means to determine the base. Consider the examples of *redo* and *doable*, where the stem *do* is absolutely the base of both words.

	Head	Base
[[*do*]$_{V}$ [*able*]$_{A}$]$_{A}$	*-able*	*do*
[[*re*]$_{prep}$ [*do*]$_{V}$]$_{V}$	*-re*	*do*

In *doable*, *-able* is the head because it changes the syntactic category, so the base is the non-head *do*. However, in *redo,* the stem *do* is the head as well as the base. It shows that headedness cannot determine the base, since both the head and the non-head can be the base. Instead, the constructional idiom approach can account for the case. As seen above, either in [X-able] or in [re-X], the stem *do* occupies the open slot. It is better to suggest that the base of a word formation process should be the variable '*x*' in terms of constructional idiom.

2.3 Summary

This chapter has discussed the data preparation and methodology. Two notions crucial for the analysis have been addressed.

One is how to measure productivity in [A N]. The notion of constructional idiom is adopted to unify the base for both derivation (e.g. X-*ness*) and compounding (e.g. X-*man*). By this approach, any lexical unit filling the slot (X) will be identified as the base. Word formation process of [A N] is thus replaced by the construction template [A[X]$_{N}$]$_{N}$. Accordingly, productivity in Chinese [A N] has actually to do with how much (or whether) the construction templates will be used to form new words. For example, productivity of *mei* "beautiful" in Chinese [A N] can be seen as productivity of construction template [*mei* N]. This approach is compatible with the corpus-based

method to productivity, which focuses on the language usage.

The other issue is how to measure the base frequency in Chinese [A N]. It is shown that nominal roots are sensitive to the position in compounding. Same roots may occur both in modifier position and head position. It is unfair to take the absolute frequency of the root as the frequency of the base regardless of the positional factor. With regard to Chinese [A N], I argue that the base frequency of an [A N] should be the summed frequency of all [A N]'s and [N N]'s that contain the same nominal root as the right constituent.

Based on the analysis, a list of productivity indices and the parsability ratios of Chinese [A N]'s has been produced to test the Parsability Hypothesis in the next chapter.

Chapter 3 Relative frequency and Productivity

In this chapter, I test the prediction of the Parsability Hypothesis against data from Chinese [A N]. I argue that relative frequency cannot be correlated with productivity in Chinese [A N]. Instead, language-specific selectional restrictions should be taken into consideration. I also argue that the semantic transparency can provide an explanatorily adequate account of productivity either in derivational affixation or in compounding.

3.1 Relative Frequency Effect

In light of the Parsability Hypothesis, if the base is more frequent than the whole word, it will be used as own or combined with other lexical units. As a result, both constituents of the word would be more likely to be parsed and so freely combine with others. Consequently, a word formation processes will become more productive. Hay and Baayen suggest that it is derived from the dual-route race model. In word productions derived by a certain word formation process, some are accessed by decomposition, which will facilitate productivity of the word formation process, while the rest are accessed by the whole, which will decrease its productivity. By which route a complex word is accessed can be predicted from its relative frequency ratio between the base and the derivative. Such an explanation seems to work well for Chinese [A N]. According to Sproat and Shih 1996, some nominal roots in Chinese are quite productive in compounding, which will enable the [A N] to be decomposable. On the other hand, in some of [A N]'s, adjectives are semantically bleached as in *hei-ban* (black-board) 'blackboard', *hong-hua* (red-flower) 'safflower', or are redundant as in *da-suan* (big-garlic) 'garlic'; *da-xiang* (big-elephant) 'elephant'. These words will undoubtedly be accessed by the whole since their modifiers do not contribute to the

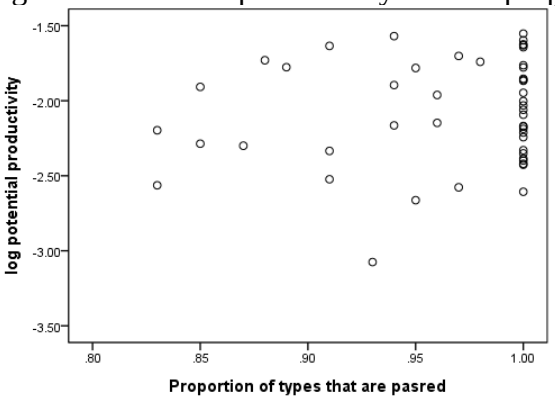
meaning of the whole compounds.

Therefore, it is plausible to hypothesize that in order to maintain high productivity, Chinese [A N]'s must be parsed sufficiently so that the resting activation level remains high. In this way, productivity is actually tied to decomposition. High rates of decomposition should ensure the productivity of an adjective in [A N]. Conversely, an adjective in words characterized largely by the direct route (as a whole) is unlikely to be productive. That is to say, relative frequency ratio should be correlated with productivity.

3.2 Result and Discussion

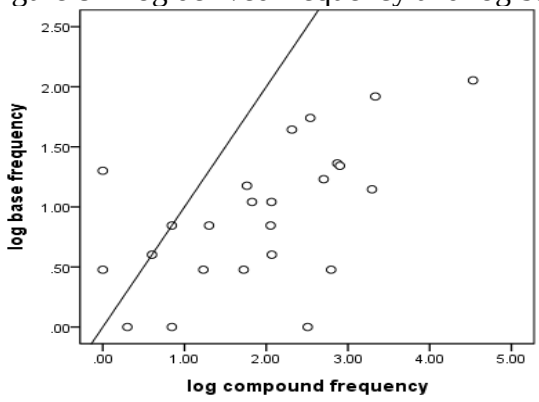
To test the prediction that productivity is correlated with relative frequency, I conduct a hypothesis testing with two rival statements. *Null Hypothesis* (H_0) states that there is no correlation between relative frequency and productivity, while the *Alternative Hypothesis* (H_1) states that such a correlation does exist. The calculation result, as illustrated in Figure 7, shows that the model' prediction fails to work well for Chinese [A N]. It suggests that all [A N]'s should be in decomposition-route, which is contradictory to the facts. In addition, no significant correlation is found between parsability ratio and productivity. The distribution is quite random regardless of the productivity or parsability of an [A N]. That is to say, the relative frequency cannot explain why, for example, [*mei* N] is unproductive while [*bai* N] is highly productive. Therefore, we fail to deny the null hypothesis and have to conclude that there is no statistical correlation between relative frequency ratio and productivity.

Figure 7 Potential productivity and the proportion of parsed types in Chinese [A N]



The result further shows that the parsability based on relative frequency cannot predict whether an [A N] is processed by decomposition or by the whole. For example, as mentioned in Figure 6, [*mei* N] is not productive. According to the Parsability Hypothesis, the parsability of [*mei* N] should be low. However, see the Figure 8, most of [mei N]'s are parsed.

Figure 8 Log derived frequency and log base frequency for [*mei* N]



The failure of this model may be caused by the idiosyncrasy of Chinese compounds: no morpheme frequency effect. For a Chinese [A N], constituent frequency alone has little influence shaping its productivity. The statistical result shows that the frequency of the noun head (the base) does not affect productivity of [A N]. Besides the head frequency, the modifier frequency is also not correlated with productivity either (recall the Figure 5 in Chapter 2). This statistical result is in line with the discoveries by a series of psycholinguistic experiments (Chen and Chen 2006,

2007, Janssen, Bi and Caramazza 2008, cited in Myers 2012).Chen and Chen 2006, 2007 find that there is no morpheme frequency effect in Chinese compound production. They explain the lack of morpheme activation in Chinese compound as deriving from the lack of re-syllabification. For example, English compound *pop art*, syllabified *pop-art*, not *po-part* as a monomorphemic word would be. By contrast, Chinese compound never re-syllabify, regardless of the morphological structure, for example, true compound like *yayi* (dent doctor) 'dentist' and disyllabic monomorphemic word like *fengliu (*wind flow*)* 'romantic' show no systematic phonological differences. So the lexeme of the whole compound does not need require the activation of its constituting morphemes.[6] All of these may explain why processing constraints like relative frequency cannot predict morphological productivity in Chinese [A N].

3.3 Alternative accounts of morphological productivity in Chinese [A N]

In this subsection, I discuss alternative accounts of morphological productivity in Chinese [A N]. I argue that productivity is affected by a heterogeneous set of constraints including selectional restrictions, blocking and semantic transparency. These constraints are superior to parsability since they can account for both derivational affixation and compounds like Chinese [A N]'s.

3.3.1 Selectional restrictions

There are selectional restrictions on Chinese [A N] to limit potential adjective-noun combinations. As the result, some potential combinations are attested while others are ruled out. Consider the examples of [*shen* N] and [*duan* N]. Examples (1)-(4) are from Z., Xu 2012. As seen in (1). Some nouns that could be access to [*shen* N] will

[6] Similarly, in a picture naming task, Janssen et al 2008 find that higher frequency of morphemes in a compound does not indicate shorter response time to access that compound for Mandarin Speakers.

be ungrammatical and ruled out by the restriction that requires *shen* to express physical depth but not profoundness in [A N] as seen in (2).

(1) *shen shui* *shen jing* *shen keng*
deep water deep well deep whole
'deep water' 'deep well' 'deep whole'

(2) **shen shu* **shen wenzhang* **shen wenti*
deep book deep article deep problem
'deep book' 'deep article' 'deep problem'

When the adjective *duan* 'short' in [*duan* N] modifies a concrete noun, the noun must express a small object that can be described in terms of length. See (3) and (4)

(3) *duan chi* *duan dao* *duan xiuzi*
short ruler short knife short sleeves
'short ruler' 'short knife' 'short sleeves'

(4) **duan he* *duan *gonglu* *duan *tielu*
short river short highway short railway
'short ruler' 'short knife' 'short sleeves'

In derivational affixation, selectional restrictions would also systematically rule out some potential word formation. See (5) and (6). Examples are based on a simple test for native English speakers. It shows that the English negative prefix *un-* prefers bases that are not themselves negative in meaning. Strong selectional restrictions on the base reduce the productivity of [*un*-X].

(5) unlovely *unugly
unreal *unfake

unhappy *unsad

unwell *unbad

In comparison, consider the examples in (6). The selectional restrictions in (6) are much weaker than in (5). Only *fake* cannot be derived as in **fakeness* (because of the Blocking Principle, see 3.3.2) Weaker selectional restrictions on the base increase the productivity of [X-*ness*].

(6) loveliness ugliness

realness *fakeness

happiness sadness

wellness badness

Similarly, Rainer 2005 claims that it is commonly observed in derivation that words of the same category tend to choose the same affix. For example, the Spanish relational suffix *-uno* is attached almost exclusively to nouns referring to animals as seen in *vaca* 'cow' → *vacuno* 'relating to cow' (Rainer 2005: 349). Another case as such is the English suffix *-ee*. The referent of *-ee* as in *advisee*, *addressee* and *employee* must be sentient, having participated in an event of the type corresponding to the base and lack of volitional control over the event (Baker 1998, cited in Bauer 2001, see also Rainer 2005, Aronoff and Fudeman 2011).

From all of these examples, one can imagine that selectional restrictions can influence the range of a word formation process. There seems an inverse correlation between selectional restrictions and the productivity of a word formation process: "the stronger restrictions apply (to a word formation process), the fewer bases it will have available to it, and the fewer words it will be able to derive" (Lieber 2011: 65).

3.3.2 The Blocking Principle

Although slectional restrictions may delimit the potential adjective-noun combinations, not every word satisfying selectional restrictions has the same chance of entering into a compound as a constituent. Consider the examples in (7) and (8), which are from Z.Xu 2006. (7) differs from (8) only in the length of the nouns. But the ones in (7) are accessible into [A N] while those in (8) are not.

(7) *mei* *nü* *ying gutou* *ruan daoizi*
beautifu woman hard bone soft sword
'beauty' 'hard bone' 'soft sword, a way of harming people imperceptibly'

(8) **mei* *nüren* **ying gu* **ruan dao*
beautifu woman hard bone soft sword

I argue that the impossibility of the combination in (8) because of the Blocking Principle, i.e., because of the existence of the forms in (7), the production of forms in (7) is blocked. The Blocking Principle was first proposed by Aronoff 1976. See (9) (Aronoff 1976: 44)

(9)

Xous	Nominal	*-ity*
various	*	variety
curious	*	curiosity
glorious	glory	*gloriosity
furious	fury	*furiosity

The potential derivational affixation is blocked by the synonymous nominal. *glorious* and *furious* have their corresponding nominal forms *glory* and *fury.* Due to the type blocking, the occurrence of **gloriosity* and **furiosity* is unacceptable. By contrast,

various and *curious* do not have nominal forms such as *vary and *cury, the formation of variety and curiosity is not blocked. In the spirit of Aronoff 1976, Z.Xu 2006 proposed a blocking principle in Chinese [A N] as seen in (10)

(10) The Blocking Principle: An [A N] which is listed in the lexicon blocks the production of other synonymous and formally similar [A N]'s. (Z. Xu 2006: 475)

Following the blocking principle in (10), the existence of [AN]'s in (7) blocks occurrence of the synonymous and formally similar ones in (8). In addition, the Blocking Principle explains the unacceptability of some potential productions in Chinese [A N]'s with polysemous adjectives. Consider the examples in (11) and (12). *gao* may mean *gao*$_1$ 'tall' or *gao*$_2$ 'remarkable'. Only *gao*$_2$ can directly modify the nominal root *ren* 'person' meaning 'remarkable person' while *gao ren (tall person) 'tall person' is bad although *gao*$_1$ can modify nouns in other cases in (12).

(11)	*gao ren*	* *gao ren*
	remarkable person	tall person
	'remarkable person'	'tall person'
(12)	*gao shan*	*gao nüren*
	tall mountain	tall woman
	'high mountain'	'tall woman'

According to the blocking Principle, I argue that **gao ren* (tall person) 'tall person' is unacceptable since its occurrence is blocked by the existence of the word *chang ren* (long person) 'tall person' which indicates the same meaning and has been listed in the lexicon. Hypothetically, Chinese [A N]'s with polysemous adjectives has a comparative advantage of becoming more productive since they have more chances to

form new words. The theoretical advantage in word formation, however, will be weakened by the Blocking Principle.

3.3.3 Semantic transparency

Productivity can also be affected by semantic transparency. Consider the (13) and (14). Examples are from Lieber (2011: 65). It is clear that the English suffix *-ness* is much more productive than *-ity*. It means that the productivity of [X-*ness*] is higher than that of [X-*ity*]. I argue that this is due to the difference of semantic transparency. For all derivatives in (13), it is easy to divide the complex words into base and suffix and the suffix always creates a noun meaning 'state of being X(adjective) ', whatever the X(adjective). All words formed by the constructional idiom [X-*ness*] are transparent, which also makes the [X-*ness*] perfectly transparent.

(13) hard hardness
pure pureness
odd oddness
horrible horribleness
pink pinkness
common commonness
happy happiness

By contrast, as seen in (14), these words have meanings that cannot be reduced to the meaning of the base combined with the meaning of the suffix. For example, *oddity* does not mean 'the state of being odd' but referring to someone or something that is odd. As for *authority,* the base *author* 'professional writer' does not seem to be part of the meaning *authority*. It is clear that [X-*ity*] are much less transparent than [X-*ness*].

(14) available availability

pure purity

dense density

timid timidity

odd oddity

local locality

author authority

Semantic transparency can affect the productivity of a constructional idiom. High transparency means that it is easier to acquire the relevant semantic generalization, and thus to use it to form new words. More transparent derivatives will increase the semantic transparency of the constructional idiom and so facilitate its productivity. Therefore, [X-*ness*] is much more productive than [-Xity] because [X-ness] is much more transparent than [X-ity].

This approach works for Chinese [A N] as well. More transparent compounds like *huang-chenshan* 'yellow shirt' formed by a type of [A N] will facilitate its productivity, while more opaque compounds like *heiban* 'blackboard' formed by a type of [A N] will decrease its productivity instead. That is to say, for a particular Chinese [A N], the more transparent compounds derived from a [A N], the more productive it will be. For example, there are a large number of lexicalized words in [*da* N] that are listed in the lexicon (e.g. *da-suan*, *da-xiang*, *da-gua*r) while for [*shen* N], although selectional restrictions may rule out some potential nouns, many words formed by [*shen* N] are semantically transparent. Consequently, higher semantic transparency would make [*shen* N] more productive than [*da* N] which is less transparent. This analysis is well supported by their quantitative indices ([*da* N], P =0.0046, [*shen* N]. P= 0.0071). Since there are a large number of forms in Chinese [A N], it seems to be

impractical to check the semantic transparency manually one by one. To what extent the semantic transparency of a constructional idiom determines its morphological productivity is an open topic that is beyond the scope of this single paper.

3.4 Summary

In this chapter, I have examined the major prediction of the Parsability Hypothesis through a statistical analysis. Processing constraints like the relative frequency that applies to derivational affixation do not have the same effect for Chinese compounds ([A N]). The attempt to reduplicate the same correlation between relative frequency effect and productivity in Chinese [A N] has failed. The result indicates that Chinese speakers may be not sensitive to morpheme frequency in creation of new words. The Parsability Hypothesis does not consider many other grammatical factors that may affect the productivity. I have shown that constraints including selectional restrictions, the blocking and semantic transparency manage to apply to both derivational affixation and compounds like Chinese [A N] while the parsability fails to do so. The evidence clearly shows that morphological productivity is affected by a heterogeneous set of constraints that cannot be simply ascribed to the parsability based on relative frequency.

Chapter 4 Ordering of Adjectival modifiers

In this chapter, I examine another prediction of the Parsability Hypothesis to see whether productive adjectival modifiers tend to be located outside less productive ones. Hay and Baayen 2004 defend their theory by arguing that besides relative frequency, all factors involved in word segmentation may influence the parsability. I argue that even assuming the parsability might be able to affect productivity, the model still fails to explain the order of multiple adjectival modifiers in Chinese [A [A N]. Instead, I propose a categorical frequency based constraint on the ordering of adjectival modifiers in Chinese [A [A N]]. I also show that this constraint must apply under Constructions Morphology (CM) (Booij 2010).

4.1 The Ordering of Adjectival modifiers and Productivity

In the spirit of the Parsability Hypothesis, an affix that is further away from its base tends to be more productive. Hay and Baayen find that the order of an affix is predictable from its productivity and regard it as evidence that productivity is actually the result that emerges from the parsability (Hay and Baayen 2003, Baayen 2009).

In fact, the order issue can be found both in derivation and compounding. A derived word can be the base of the other word as seen in (16).

(16) care → [[care] [ful]]$_{careful}$ → [[care] [ful]] [ness]]$_{carefulness}$

Similarly, a compound is also able to re-enter into the other compounding processes as smaller units. See (17). *bai panzi* (white plate) ‘white plate’ as a noun can also occupy the X slot in [*da* [X]$_N$] (*da* ‘big’) to form a new word *dai bai panzi* (big white plate) ‘big white plate’.

(17) [A [X]$_N$] [*da bai panzi*]

/\

[A [X]$_N$] [[*da*]$_A$ [*bai panzi*]$_N$]$_N$

/\

[A N] [[*da*]$_A$ [[*bai*]$_A$ [*panzi*]$_N$]$_N$]$_N$

As the result of the unification (see Booij 2010, Z.Xu 2012), multiple adjectival modifiers are able to simultaneously modify the noun head. It is widely accepted that the adjectival modifiers ordering in Chinese [A N] obey the adjectival ordering restrictions (AOR) proposed by Sproat and Shih 1991 as Quality > Size > Shape > Color> Provenance. If we convert it to the adjective taxonomy adopted in this thesis, the order should be Value >Dimension >Physical property >Age >Color. It is almost the same with the one proposed by Dixon (1982), who claimed that adjectival ordering is arranged based on semantic categories of adjectives.

If the Parsability Hypothesis can really work for Chinese [A [A N]], the productivity rank of adjectival modifiers should be nearly identical with the order based on their semantic categories. To test this hypothesis, a Chi-square (χ^2) test was conducted to examine the correlation between the productivity rank of an adjective and its semantic category. The former is chunked into 5 categories representing different degrees of productivity (see table 3).

Table 3 Productivity Ranking * Semantic Category Cross tabulation

		semantic category					Total
		COLOR	AGE	PHYSICAL	DIMENSION	VALUE	
productivity rank	1~10	3	1	4	1	1	10
	11~20	2	0	2	2	4	10
	21~30	0	0	4	5	1	10
	31~40	1	1	0	6	2	10
	41~50	0	0	3	1	5	9
Total		6	2	13	15	13	49

Two competing hypotheses are given. One is no relationship between semantic category and productivity of an individual adjective, as the null hypothesis. Alternatively, such a correlation is expectable. See Table 4, the result χ^2 value 25.357 and p =0.064 > 0.05 (the test of significance of the p-value gives the probability that there is no correlation between the test variables) means that we fail to reject the null hypothesis but have to conclude that there is actually no significant relationship between productivity of an adjective and its semantic category. The statistical result means, for example, for example, productivities of *da* 'big' and *bai* 'white' cannot determine which one is closer to the noun head.

Table 4 Chi-square test on correlation between semantic category and productivity

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.357[a]	16	.064
Likelihood Ratio	29.984	16	.018
Linear-by-Linear Association	6.601	1	.010
N of Valid Cases	49		

a. 25 cells (100.0%) have expected count less than 5. The minimum expected count is .37.

Besides the productivity of an individual adjective, categorical productivity also fails to predict the order. The calculation result in Table 5 shows an irrelevant order with the one of adjectival modifiers in Chinese [A [A N]].

Table 5 Categorical productivity of adjectival modifiers

[A N]	P (mean)
$[COLOR]_A$-N	0.0184
$[PHYSICAL]_A$-N	0.0108
$[AGE]_A$-N	0.0102
$[DIMENSION]_A$-N	0.0078
$[VALUE]_A$-N	0.0065

To briefly summarize, the Parsability Hypothesis suggests that morphotactics (morpheme order) may be determined by productivity. It has been argued that affix ordering is predictable from the productivity of affixes. Less productive affixes

precede more productive ones. However, the data from Chinese [A [A N]] seems to argue against the Parsability Hypothesis. The ordering of adjectival modifiers according to productivity is not borne out by the facts. For example, according to the Parsability Hypothesis, when modifying *panzi* 'plate', *bai* 'white' should precede *da* 'big'. However, the combination **bai da panzi* 'white big plate' is an ungrammatical form for Chinese native speakers. All of statistical results above indicate that the Parsability Hypothesis does not apply to Chinese [A [A N]].

4.2 Alternative accounts of the order of adjectival modifiers

In this subsection, I discuss alternative accounts of the order of adjectival modifiers in Chinese [A [A N]]. One argues that AOR arise because of phrasal syntax (Feng 2001, Paul 2005, Schafer 2009). The other one is a semantic relevance account (Z.Xu 2012), which suggests that AOR are derived more likely from semantics rather than syntax. In line with the latter, I propose a categorical frequency based account of AOR in Chinese [A [A N]].

4.2.1 A phrasal syntax based account of AOR

I have shown that the Parsability Hypothesis cannot predict an order in line with AOR. A possible refutation of my argument is that AOR do not apply because Chinese [A N]'s are not compounds but phrases and AOR arise because of phrasal syntax. Feng 2001 argues that, in Chinese [A [A N]], some are subject to the restriction while others are not. See the examples in (18) and (19) (Feng 2001: 168, cited in Z.Xu 2012). In (18) *da panzi* 'big plate' is subject to Size > Color. The adjective *bai* 'white' must be closer to the noun than *da* 'big'.

(18) *da panzi* *da bai panzi* **bai da panzi*

big plate big white plate white big plate

'a big plate' 'a big white plate'

By contrast, in (19), AOR seem to fail to account for the ordering of *da* and *bai* in the case of *bai da-guar*, 'an unlined long gown' because that *bai* cannot be inserted into *da-guar*.

(19) *da-guar* **da bai guar* *bai da-guar*

big gown big white gown white big gown

'an unlined long gown' 'a white unlined long gown'

Based on these observations, Feng (2001) argues that most of Chinese [A N]'s are actually phrases. He also argues that Chinese [A N]'s that are subject to AOR are phrases and those that are not subject to AOR are compounds. AOR apply for compounds because of the Lexical Integrity Hypothesis that the internal structure of compound is invisible for phrasal constraints.

However, these exceptions arise simply due to the bleached semantics of adjectival modifiers. For example, *da* 'big' is semantically bleached in *da-guar* (big gown) 'an unlined long gown' as it is no longer denoting the property of 'big'. Z.Xu 2012 argues that the underlying constraint of AOR is similar to the semantic relevance principle proposed by Bybee 1985 in inflectional morphology.

'[A] meaning element is *relevant* to another meaning element *if the semantic content of the first directly affects or modifies the semantic content of the second*.' (Bybee 1985 p.13, cited in Z.Xu 2012)

So in order to maintain the conventional sense of compound, *da-guar* (big-gown) 'an

unlined long gown' must immediately precede the noun head and any in-between adjectival modifiers like *bai* 'white' would be rejected. More examples like *xiao-dou* (small-bean) which is a conventional term for 'azuki bean' or 'Vigna angularis'. Its conventional sense will be lost if *xiao* does not immediately precede the noun head as seen in that *xiao hong-dou* (small red-bean) expresses 'Indian Licorice or Abrus precatorius that is small' rather than 'azuki bean' or 'Vigna angularis' as it does as before. Therefore, AOR are semantically like based and not phrasal-level.

4.2.2 A categorical frequency based account

I propose a frequency based account, i.e. AOR arise because of a categorical frequency constraint. I also show that this constraint must apply under Construction Morphology (CM) (Booij 2010).

CM adopts the notion 'constructional idioms', which are morphological or syntactic schemas with both lexically specified positions and open slots that are represented by variables (Goldberg 1995, 2006, Jackendoff 1997, 2002, Booij 2010, among others). For example, [[*da*]$_A$ [*x*]$_N$]$_N$ is a constructional idiom in which the adjective is lexically specified whereas the nominal element is represented by a variable. CM adopts 'unification', a mechanism under which a variable of a construction is replaced with another construction. For example, the variable of [[*da*]$_A$ [*x*]$_N$]$_N$ 'big x' can be replaced with [[*bai*]$_A$ [x]$_N$]$_N$ 'white x', but not vice versa. That is, an [A N] construction with a SIZE adjective ([[SIZE]$_A$ N]) can subsume one with a COLOR adjective ([[COLOR]$_A$ N]), but not vice versa. See Table 1, in which Chinese [A N]'s with different types of adjectives are arranged in a decreasing order of their categorical frequencies from the Chinese National Corpus.

Table 6 Categorical frequencies of Chinese [A N]'s with different types of adjectives

[A N]	%
$[QUALITY]_A$-N	35
$[SIZE]_A$-N	27
$[COLOR]_A$-N	21
$[SHAPE]_A$-N	17

My categorical frequency constraint states that:

(20) Constructional idiom C_1 can be incorporated into constructional idiom C_2 iff the categorical frequency of C_1 is lower than that of C_2.

This constraint also accounts for cases like *bai da-guar* 'a white unlined long gown', in which a COLOR adjective precedes a SIZE adjective. According to Aronoff 1976, the type frequency of a word formation process can be measured by the number of words it has produced. Accordingly, the categorical frequency of [A N] is the number of variables that occupy the open slot. For example, the categorical frequency of $[[SIZE]_A$-N] is the number of all variables of constructional idioms where the adjectival modifiers denote the property 'SIZE'. For *da-guar*, after combining with guar 'gown', the construction has a conventional meaning (*da guar*, 'an unlined long gown'). In terms of the notion 'constructional idiom', both the components of *da-guar* are lexically specified, so it cannot be used to form new words. Therefore, for *da-guar*, its type frequency as well as categorical frequency is 1, i.e. the lowest frequency, so no other [A N] construction can be incorporated into it.

4.3 Summary

In this chapter, I examine the second prediction of the Parsability Hypothesis, which suggests that affix order is based on their productivity. More productive affixes are further away from the bases than less productive ones. However, this approach

cannot account for the order of adjectival modifiers in Chinese [A [A N]]. The adjectival modifier with higher productivity does not mean that it would tend to be located outside those with lower productivity. As an alternative, I propose a categorical frequency based account of the order of adjectival modifiers in Chinese [A [A N]. Adjectives with lower categorical frequency tend to be closer to the noun heads than those with higher categorical frequency. This approach predicts not only a nearly identical order of adjectival modifiers in line with the order based on AOR, but also those cases where AOR do not apply.

Chapter 5 Concluding remarks

With the notion ‘constructional idiom’, it is clear that both derivational affixes and the constituents of compounds are pieces of morphological structures. As a word formation means, derivational affixation and compounding do not differ in accessibility of rules in grammar (Booij 2005: 129). Constraints on productivity of word formation are supposed to be able to apply to both compounding and derivational affixation.

This thesis shows that Hay and Baayen’s modeling approach to morphological productivity cannot provide an adequate account of the whole picture of word formation process. The calculation result shows that there is no statistically significant correlation between productivity and relative frequency ratio in Chinese [A N]. Parsability based on relative frequency cannot explain why a particular [A N] is more productive than the other. As for the order issue, the parsability does not seem to work well for Chinese [A N] either. Contrary to the prediction, more productive adjectival modifiers do not precede less productive ones. The statistical result shows that the order of adjectival modifiers has nothing to do with their productivity.

Instead, I argue that language-specific selectional restrictions, the Blocking Principle and semantic transparency are jointly shown to override the effect of the parsability in shaping productivity. Additionally, I propose a categorical frequency account of the ordering of adjectival modifiers. It predicts that less frequent adjectival modifiers tend to be closer to the noun head than those more frequent ones. The present study shows that constraints on productivity consist of a heterogeneous set of grammatical rules that cannot be simply ascribed to the parsability based on relative frequency. As pointed out by Plag (2002:305), “[e]ach morphological category comes

from its own particular phonological, morphological and semantic restrictions, so that no account can work which completely abstracts away from these inherent."

There are several remaining problems for future research. A fundamental question in psycholinguistics is whether morphologically complex words are accessed by decomposition or retrieved by the whole. For Chinese compounds, some researchers argue that compounds are completely decomposed (e.g. Hoosain 1992, Zhang and Peng 1992), while others such as Packard (2000) who remarked that all Chinese morphological complex words are listed in the lexicon. More linguists seem to agree with the dual-route race model such as Dai (1992), Sproat and Shih (1996), who suggest that decomposition route and the-whole route should coexist. Hay and Baayen take the same position to explain morphological productivity. The present study seems to argue against the dual-route race model. If Chinese [A N] were accessed by dual-route race model, productivity should be influenced by the parsability. The statistical result shows, however, that parsability plays a minor role in predicting either productivity or adjectival ordering in Chinese [A N]. Nevertheless, corpus-based investigations suggest the correlation but not the cause-and-effect. It is still an open question whether morphologically complex words are accessed by the whole word or by decomposition. Additionally, those [A N]'s with bimorphemic adjectives are not discussed in this thesis. Z.Xu 2012 suggests that some morphologically bimorphemic adjectives like *hao-hua* (luxurious splendid) 'luxurious' tend to be analyzed as semantically monomorphemic ones. It seems to indicate that semantic transparency is the key in understanding compound production. In comparison, many experimental studies have shown that the frequency effect plays an important role in compound production (e.g. Bien, Levelt and Baayen 2005, Baayen, Kuperman and Bertram 2010). To show whether and how these factors may contribute to Chinese compound

production, more well-designed and factor-controlled experimental works need to be carried out. I will leave these tasks for future research.

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Appendix

[AN]	V(C,N)	V(1,C,N)	N(C)	P	semantic category	gloss
[*ai* N]	31	3	107	0.028	dimension	low
[*huang* N]	83	25	927	0.027	color	yellow
[*lü* N]	47	15	593	0.0253	color	green
[*ku* N]	46	11	463	0.0238	Physical property	Bitter
[*jiu* N]	64	16	684	0.0234	Age	Old
[*bai* N]	192	60	2587	0.0232	color	White
[*chou* N]	13	2	88	0.0227	physical property	Smelly
[*xian* N]	14	3	151	0.0199	value	Idle
[*xiang* N]	40	11	591	0.0186	physical property	Fragrant
[*ruan* N]	28	6	330	0.0182	physical property	Soft
[*tian* N]	10	2	116	0.0172	physical property	Sweet
[*kuang* N]	13	3	180	0.0167	value	Crazy
[*hei* N]	108	33	1972	0.0167	color	Black
[*ruo* N]	13	4	242	0.0165	value	Weak
[*liang* N]	17	3	214	0.014	physical property	Cool
[*yuan* N]	27	5	363	0.0138	dimension	Round
[*kuai* N]	19	3	221	0.0136	value	Fast
[*jin* N]	19	3	236	0.0127	dimension	Close
[*hong* N]	114	28	2265	0.0124	color	Red
[*ji* N]	18	2	177	0.0113	value	Urgent
[*nong* N]	14	2	183	0.0109	physical property	Dense
[*guai* N]	20	3	302	0.0099	value	Odd
[*ying* N]	24	2	215	0.0093	physical property	Hard
[*duan* N]	43	5	575	0.0087	dimension	Short
[*bao* N]	19	2	248	0.0081	dimension	Thin
[*shen* N]	25	5	702	0.0071	dimension	Deep
[*fei* N]	18	2	292	0.0068	dimension	Fat
[*qing* N]	27	3	442	0.0068	physical property	Light
[*qian* N]	7	1	149	0.0067	dimension	Shallow
[*dan* N]	5	1	154	0.0065	physical property	Tasteless
[*mei* N]	24	3	472	0.0064	value	Beautiful
[*cu* N]	14	1	163	0.0061	dimension	Thick
[*lan* N]	18	2	350	0.0057	color	Blue
[*xiao* N]	338	57	11019	0.0052	dimension	Small
[*gui* N]	11	4	798	0.005	value	Expensive
[*di* N]	34	4	855	0.0047	dimension	Low
[*da* N]	384	58	12529	0.0046	dimension	Big
[*xin* N]	116	21	4714	0.0045	Age	New
[*gao* N]	101	15	3643	0.0041	dimension	high
[*yuan* N]	24	3	751	0.004	dimension	Remote

[*chang* N]	86	7	1841	0.0038	dimension	Long
[*qiang* N]	18	1	267	0.0037	value	Strong
[*zhong* N]	52	6	2003	0.003	physical property	Heavy
[*lao* N]	192	17	6220	0.0027	age	Aged
[*hao* N]	38	5	1888	0.0026	value	Good
[*xian*N]	12	1	404	0.0025	value	Fresh
[*huai* N]	15	1	460	0.0022	value	Bad
[*xi* N]	29	3	3567	0.0008	dimension	Thin
[*shu* N]	3	0	98	0	physical property	Familiar
[*zang* N]	5	0	30	0	value	Dirty
[*xian* N]	5	0	50	0	physical property	Salty
[*nan* N]	6	0	394	0	value	Difficult
[*qiong* N]	8	0	217	0	value	Poor
[*chou* N]	9	0	75	0	value	Ugly
[*xian* N]	13	0	95	0	value	Dangerous
[*leng* N]	22	0	576	0	physical property	Cold

[A N]: Chinese adjectives-noun compounds where A as modifier and N as head

V(C,N): The number of types of [A N]

V (1,C,N): The number of hapax legomena of [A N]

N(C): The number of tokens of [A N]

P : The potential productivity of [A N]