Realization of the Chinese BA-construction in an English-Chinese Machine Translation System

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Abstract

The BA-construction refers to a special grammatical structure in Mandarin Chinese. It is an extremely important syntactic structure in Chinese, which is frequently used in daily life. The study of the BA-construction has attracted the attention of almost all linguists who are interested in this language. Yet it is a quite complex and difficult linguistic phenomenon and it is hard to analyze it satisfactorily to cope with the syntactic structure(s) of another language which does not possess this kind of construction (e.g. in machine translation). This paper discusses a few methods on how some of the English imperative sentences are realized by the Chinese BA-construction which is mandatory in transferring certain source language (SL) information into target language (TL) in an experimental machine translation (MT) system. We also introduce the basic syntactic structures of the BA-construction and explain how we formalize and control these structures to satisfy our need. Some features related to the BA-construction, such as obligatoriness versus the optionality, the semantics as well as the properties of the elements preceding and following the BA are also discussed. Finally we suggest that by constraining the variations of the formalized patterns of the BA-construction, a better MT could be reached.

1 Introduction

The BA-construction ('把'字句) is a special syntactic structure in the Chinese language. It is so frequently used in everyday conversations that its usage can not be simply ignored. In fact, the BA-construction has been greatly drawing the attention of almost all linguists who are interested in the Chinese language. The reason for this concentrates not only on the fact that it is a quite special Chinese linguistic phenomenon but also that until now no consensus has been reached among linguists on whether its grammatical category belongs to that of a verb or that of a preposition. Historically speaking, much evidence shows that it was used more as a verb than as a preposition. However, recent research tends to classify the BA-construction to the category of the prepositional phrase (PP), which characterizes the pre-posed object (usually a noun phrase – NP) of a transitive verb (Zhou and PU, 1985). In the following sections we will first introduce very briefly the different points of view held by these linguists and then we will demonstrate our choice for the study of the BA-construction in our experimental English-Chinese machine translation system, which is based on the controlled language technique. We will particularly stress the problems we face when transferring certain English imperative sentences into Chinese sentences containing the BA-construction which is mandatory in some cases, while this is optional in other cases, or can be used as one of the other alternatives (between

a normal syntactic structure (V + NP + X[1]) and the BA-construction (BA + NP + V + X).

2 The BA-Construction: a verb phrase or a prepositional phrase?

It is important to note that we do not pretend to give an overview of all kinds of points of view on the study of the BA-construction here, nor do we claim to justify all the different conceptions held in the literature in this short paper. Instead, we just try to verify how our practice with this construction can be better formulated for our specific purpose: to be well adapted to serve for an English-Chinese MT system.

Whether the word BA（把）in the BA-construction is a verb or a preposition is an open question in Chinese linguistics. Due to the difficulty of having sufficient and strong evidence to distinguish the BA-construction between a verb and a preposition, some linguists also call the BA and some other words which possess the same property, such as BEI (被) etc., a "coverb" (次动词或副动词, literally: a sub-verb) which share the properties of both a verb and a preposition. As a result of no consensus among linguists, the analysis of this construction is divided into two separate schools: that of a verb phrase (VP) and that of prepositional phrase (PP) or one that is more inclined to one of the schools than the other. The first school of linguists states that the BA-construction should be considered as a VP whose surface structure resembles a lot the serial-verb constructions (连动式) (Subj + V + (NP1+[2]) + V2 + (NP2) …), (see example 1 b). Like a serial verb construction, the first V can be represented by the word BA and form a BA-construction. In their opinion, the BA shows the characteristics of the other parallel verbs which are used in the serial-verb construction (refers to any surface string with more than one verb in a sentence). Furthermore, some features of the BA indicate that the elements following the BA make up a constituent in which the BA looks more like a verbal head taking a complement (Bender, 2002), (Hashimoto, 1971), (Ma, 1985), and (Her, 1990), for example:

1 a) 张三把李四打了一拳，王五踢了两脚。

(literal translation: Zhang San BA (V1) Li Si hit (V2) LE[3] (ASP) a punch, Wang Wu kick (V3) LE (ASP) two foot)

Zhang San gave Li Si a punch and Wang Wu two kicks.

b) 我开门进去取书。

(literal translation: I open (V1) door come (V2) in take (V3) book)

I opened the door and went in to take a book.

One of their supporting points is that unlike a prepositional phrase, the BA-construction can not be moved to the beginning of the sentence, for example:

c) *[4] 把李四, 张三打了一拳, 王五踢了两脚。

Compare this with the following example (with a prepositional phrase):

2 a) 他在北京买了一本书。

(literal translation: He in Beijing buy LE (ASP) a BEN (CLS[5]) book;)

He bought a book in Beijing.

b) 在北京，他买了一本书。

(literal translation: In Beijing, he buy LE(ASP) a BEN(CL) book)

In Beijing, he bought a book.

Furthermore, like the other verbs, the BA can be negated by MEIYOU (没有), for example (1 a):

张三没有把李四打一拳，王五踢两脚。

(literal translation: Zhang San, MEIYOU[6] , BA Li Si hit a punch, Wang Wu kick two foot)

Zhang San did not give Li Si a punch and Wang WU two kicks.

In addition, like other monosyllable verbs, the BA as a verb can be used as the attributive of a noun by adding a structural word "DE (的)" (STR[7]) between it and the noun, for example, "念的书" (read, DE, book; the book to read); "听的歌", (listen, DE, song; a song to listen to); "把的关" (BA, DE checks; the checks to do/the pass to guard)

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[1] X: a non-null variable, usually an adverb or a PP
[2] +: refers to the possibility of more than one NP.

[3] LE : Aspectual particle indicating a past action
[4] *: ungrammatical
[5] CLS: classifier
[6] MEIYOU (没有): negation = no, not or do not
[7] STR: structural word usually connects a constituent to a NP

A basic structural analysis of the first school is illustrated in Figure 1 "BA as a Verb" from the example cited from (LIN, 2004):

3) 张三把李四打了。

(literal translation: Zhang San BA Li Si hit LE)
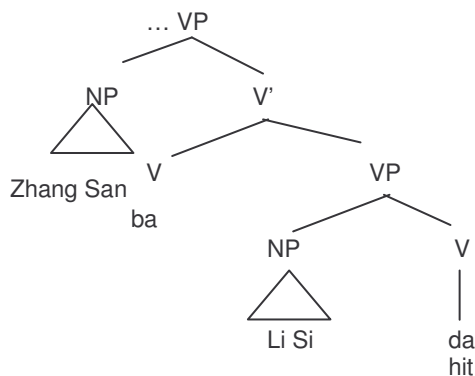*Zhang San hit Li Si.*

Figure 1 BA as a Verb

The second school of linguists claims that the BA-construction is actually a prepositional phrase with its head word followed by a NP complement which is moved in front of the transitive main verb in the sentence (See example 4 a) below). Furthermore, though the BA possesses the categorical features of a verb, it is hard to qualify the BA to function alone as the main verb or predicate in a sentence. In addition, in Mandarin Chinese the aspect attachments can be used as one of the conditions to test the verbhood of a word. The fact is that in most cases, if an aspect attachment, such as LE (了), GUO（过）(expressing past actions) and ZHE（着）(expressing continuous actions), is attached to the BA, the whole sentence will look strange and become ungrammatical (see below in b) and c)).

4 a) 他把刚才的话又重复了一遍。(literal translation: He, BA, just now, DE (STR), talks, again, speak, LE, one BIAN (CLS))
He repeated what he had said just now.
Compare the following with aspect attachments:

b) * 他把了刚才的话又重复了一遍。(LE)

c) * 他把过刚才的话又重复了一遍。
(GUO)

d) *他把着刚才的话又重复了一遍。
(ZHE)
Compare with other verb:

5 a) 他看了这本书。(LE)
(literal translation: he, look, LE, this book)
He has read the book.

b) 他看过这本书。(GUO)
(literal translation: he, look, GUO, this book)
He read the book.

c) 他看着这本书。(ZHE)
He is looking at the book.

Their point of view concerning this construction is also supported by some grammatical criteria to test the verbhood of a word. For instance, most monosyllable verbs can be duplicated as independent "AA" or "A 一 A" structures in Chinese, for example "看 (see, look)" as "看看" or "看一看"；"读 (read)" as "读读" or "读一读"; "吃 (eat)"as "吃吃" or "吃一吃"; and "走 (go or walk)" as "走走" or "走一走"; but never "把" as "*把把" or "*把一把" (some transitive verbs can be used this way without objects, but the duplicated "把把" or "把一把" as a verb must have its object following it, e.g. "把把关 (make checks; to guard a pass, etc.)" or "把一把关"). Furthermore the verb following the BA-construction is a transitive verb which in fact subcategorizes for (or still governs) the pre-posed logical object (the complement of the preposition BA) and the main verb is usually accompanied by other auxiliary constituents following or immediately preceding it. In other words, the verb can not stand alone after its object is moved in front of it (see in 6 a), 7 a) and 7 c)) in italics and in blue and the ungrammatical sentences 6 c) and 7 d)). Besides, Chinese is a thematic language, and the theme is often placed in front of the other constituents in the sentences accordingly. In many cases, we can see that the BA-construction does have an effect of emphasis on the semantic content that this structure carries (see the comparisons between 6 a) and 6 b), and between 7 a) and 7 b)). We take again the example (4), "*He repeated what he had said just now.*", and show it in (6) (HU, 1991).
Compare:

6 a)[8] 他把刚才的话又**重复**了 *一遍*。

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[8] The underlined part refers to the BA-construction; the italic refers to the auxiliary constituents; and the word in bold font refers to the verb.

(Subj + BA-structure + V + auxiliary constituent)

b) 他又重复了刚才的话。(Subj + V + Obj)

c) * 他把刚才的话又重复。

7 a) 我把信读了一遍。(Subj + BA-structure V + LE + auxiliary constituent)

(literal translation: I BA letter read one BIAN (CLS)) *I read the letter once.*

b) 我读了信。(Subj + V + Obj)

I read the letter.

c) 我 把 信 仔细地 读 了。(Subj + BA-structure + auxiliary constituent + V + LE)

(literal translation: I BA letter carefully read LE) *I have carefully read the letter.*

d) * 我把信读。

As shown in example (6 a, c) and (7 a, c, d), if we leave out the auxiliary constituents "一遍" in (6 a), and "一遍", "仔细地" and "了"in (7 a, c), both sentences (6 c and 7 d) become ungrammatical. Therefore, the syntactic structure of the second school can be analyzed as shown in Figure 2 "BA as a Preposition":
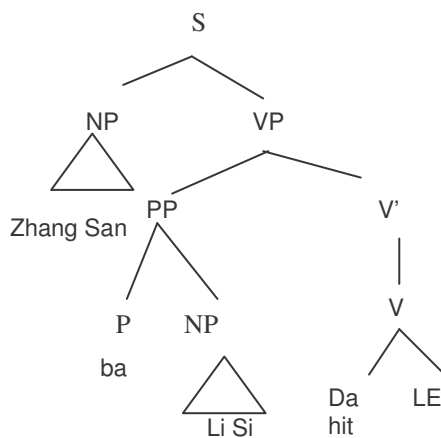

Figure 2 BA as a Preposition

Schematically, a BA-construction always has the following linear configurations:
a) NP* + BA + NP + V + X
b) NP* + BA + NP + X + V
where the sentence can have an optional (in many cases) NP* as subject, followed by BA and its NP complement, then followed by a transitive V and another constituent X (which might precede the verb as shown in (b), and usually is an adverb or a prepositional phrase).

Concerning our own view, we adopt the idea that the BA is a preposition with which the

patient object is shifted to the front of the main verb and the BA structure functions as an adjunct of the verb like many other adjuncts that are often placed between the subject and the predicate verb (HU, 1991). The reason for this choice is that considering the BA-construction as a PP is easier for the syntactic analysis and formulation than taking it as a VP in a serial verb construction.

Against this background, we will demonstrate in the following section how we formalize the BA-construction to cope with its English counterpart imperative sentences in our work and how these English sentences are finally constructed into grammatical target Chinese sentences containing the BA-structure.

3   Formalization of the BA-construction

The MT system we work with is oriented to the automatic translation of medical protocols selected from two sub-domains: echinococcosis (clinical practice) and molecular cloning (laboratory practice), where the predominant sentence type is the imperative sentence. Due to the fact that the BA-construction is mandatory in transferring some of the information conveyed in these SL sentences, we have formalized some English sentences into Chinese counterpart sentences containing the BA-construction. To do this, we compare carefully each of the sentence pairs in both languages from a parallel bilingual corpus which we have constructed for our research. In this way, we obtained enough evidence to support the formalization of this special Chinese construction for our MT system. Though the BA-construction is a very productive structure from which we can derive many varieties in Mandarin Chinese, our observation of the corpus reveals that the variations are limited but nevertheless indispensable for formulation.

As we have mentioned in the above paragraph, we have constructed a parallel bilingual corpus for an experimental MT system for the purpose of automatic translation of medical protocols which are from two different sources: one is on echinococcosis, a kind of transmissible disease shared by humans and animals, and the other is on molecular cloning. Like many other scientific documents, the medical texts we collected show a high degree of homogeneity in respect of the text structure and lexical usage, but often we find very long and structurally complicated sentences which are difficult to analyze or to be formally

represented. To narrow down the linguistic difficulty, we adopt the controlled language technique as a supporting method (CARDEY, et al. 2004), (WU, 2005). In other words, we first make the raw text materials simpler and easier for the computer to process, for example, to standardize the general structure of the text, the terminology, and to constrain the lexical usages and the sentence structures, which allows us to avoid many complex linguistic phenomena and which helps us to design practical controlled writing rules. Controlled language has been proved to be very feasible in machine translation by many systems, e.g. KANT (NYBERG & TERUKO, 1996). With the simpler and clearer input source sentences, the machine can generally produce better output target sentences.

We finally work with our already well-controlled final texts for linguistic analysis which is based on unification-based grammar. According to our observation, the English sentences which have to be transferred into Chinese sentences containing the BA-constructions are of two types, of which one is obligatory and the other is optional (with the BA-construction or no). The typical feature of these kinds of sentences is that the main verb in the sentence often indicates a kind of change or movement; therefore, in both the source and target sentence the goal or location of this change or movement is represented by a prepositional phrase, for example:

8) Insert a catheter in the cyst.

把导管插入到包囊中。

9) Store the tube on the ice.

把试管存放在冰上。

The syntactic structure of this kind of sentence in the SL can be represented as:

S → VP

VP → V NP PP

and we get two basic formulae by applying predicate-argument generation for example 8 and 9:

Insert (_, Compl1, in_Compl2)
Store (_, Compl1, on_Compl2)

"_" refers to the position of the verb which may vary accordingly.

From the aligned TL sentence, we can formulate the TL sentence as:

S → VP

VP → PP1 V PP2

in which the first PP is the BA-structure and the second PP corresponds to the PP in the SL. Therefore we get two corresponding formulae for example 8 and 9 in the TL respectively:

插入(BA_Compl1, _, 到_Compl2_中)

存放(BA_Compl1, _, 在_Compl2_上)

In fact, for example 8 the Chinese translation can leave out the second preposition "到... (中)", for the reason that it is more convenient if we lexicalize a Chinese equivalent for the English preposition "in" in the Chinese translation at the cost that it is a bit redundant in the TL sometimes, but completely grammatical and acceptable. Our principle here is that every word should have its status in the sentence. So whenever it is possible and, in particular acceptable in the TL, we assign a correspondence to the SL preposition (or other words like adverbs or NP as adjunct) in the TL. By doing so, the machine can have a better performance in most cases. It is particularly beneficial for bi-directional MT. The correspondence of a SL preposition is mostly composed of two Chinese characters in the structure of "X … Y", of which "…" is the position of the complement of the preposition in question. The second element "Y" is usually considered as a noun indicating the direction or location in Chinese. However, in our case, we consider it as a disjoint part of the first preposition "X". In other words, the "X…Y" structure is considered as one language unit in our practice. The lexicalization of a prepositional phrase in the TL is also one of our criteria to test if a sentence has to be constructed with the BA-structure or not. Most importantly this practice can reduce the workload of writing too many grammatical rules for the system, for example when a preposition has to be translated into Chinese and when it needs not to, etc.

Like most of the English imperative sentences, the Chinese counterpart sentences start with verbs. However, in some cases, the BA-construction is also employed. Generally speaking, many of the sentences can be used in both ways: to start with a verb or start with the BA-construction. They do not make big differences in general. However, semantically the sentences starting with a verb tend to be more narrative while the BA-construction is more firm and authoritative in expressing the ideas, for example:

10) Store the tube on the ice.

a. 把*试管***存放**在冰上。(BA + N + **V** + PP)[9]

b. 在冰上**存放***试管*。(PP + V + *N*)

11) Aspirate the contrast medium from the cyst.

a. 把*造影剂*从包囊中**抽出**来。

b. 从包囊中**抽出***造影剂*。

The protocols we work with are instructions of certain step-by-step procedures of either clinical practice or laboratory practice, just like product use instructions, recipes and user's manuals. The semantic contents of these sentences should be firmly expressed as kinds of orders. Though both pairs of the Chinese sentences (10 and 11) are transferring the same idea, the BA-construction is more expressive and natural in this case (example 10 a) and 11 a).

In our corpus, we have observed that some of the English imperative sentences can be transferred into two kinds of BA-construction, that of obligatory and that of optional.

Obligatoriness:

In our work, some sentences must be constructed into Chinese BA-structure, otherwise, the whole sentence sounds either ungrammatical (see in c below) or unnatural or especially unacceptable (see in b below). The grammaticality of the sentence can be tested by moving the translated SL PP to the front of the sentence in the TL (see in c)), for example:

12 a) Inject contrast medium into the cyst.

把*造影剂***注射**进包囊中[10]。

b) **注射***造影剂*进包囊中。

(unacceptable)

c) *进包囊中**注射***造影剂*。

As is shown in (c), if the whole sentence becomes ungrammatical after moving the PP in front of the sentence, we classify the sentence as obligatory to be transferred into to a TL sentence containing the BA-structure. We then constrain the syntactic structure to the first one as the legal structure while excluding the other two, thus the formulations are:

insert (_, Compl1, into_Compl2)

注射 (BA_Compl1, _, 进_Compl2_中)

The other two are excluded:

注射 (_, Compl1, 进_Compl2_中)

(unacceptable)

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[9] Note: the BA is underlined; the verb is in bold font; and the object (logical) is in italic.

[10] Red: refer the translated SL PP in TL.

*注射 (进_Compl2_中, _, Compl1)

Notice that though the first excluded formulation in the TL shares the same structure as that of the SL, they are unacceptable in the TL. The same situation applies to the following two examples:

13 a) Leave the contrast medium in the cyst as a substitute of protoscolicide agent.

作为灭杀原头蚴剂的替代品, 把*造影剂*留在包囊里。

b) *作为灭杀原头蚴剂的替代品, *留造影剂*在包囊里。(ungrammatical)

c) *作为杀原头蚴剂的替代品 , 在包囊里*留造影剂*。(strange and ungrammatical)

The final formulation is based on (a):

Leave (_, Compl1, in_Compl2, X)

留 (X, BA_Compl1, _, 在_Compl2_里)

The other two are excluded:

*留 (X, _, Compl1, 在_Compl2_里)

*留 (X, 在_Compl2_里, _, Compl1,)

14 a) Leave the inserted catheter in the cyst for 1-3 days.

把插入的导管**留**在包囊里 1 到 3 天。

Alternative:

把插入的导管在包囊里**留** 1 到 3 天。

b) **留***插入的导管*在包囊里 1 到 3 天。(unacceptable)

c) *1 到 3 天在包囊里**留***插入的导管*。(ungrammatical)

Note: for (b) a better alternative should be:

在包囊里**留** 1 到 3 天*插入的导管*。(an acceptable sentence)

The final legal formulations are:

Leave (_, Compl1, in_Compl2, T)

留(BA_Compl1, _, 在_Compl2_里, T)

The alternatives (in a) and b)) will be excluded as long as the first one (a) is a perfectly acceptable sentence. Unlike the "X" in example (13 and 14), here the "T" refers to adjuncts which refers to TIME and which usually occupies a different position in the sentence in our case.

Therefore our criterion to test the obligatoriness is to see what kind of grammatical performance a sentence will exhibit when it is used in the form shown in the above (b's and c's, especially in (c's)). If the sentence looks

84

unacceptable or is in particular ungrammatical, then it must be constructed into the TL sentence containing the BA-structure. This phenomenon is in fact closely related with the semantic contents of the verb and as well as the preposition (a goal or a location) in question (we will not discuss this aspect in this paper).

Optionality

Some sentences that we have observed can be used optionally. That is to say, we can transfer the SL sentences without employing the BA-construction, or with the BA-construction in the TL. In doing so, no significant loss of the sentence meaning will occur (except that in some cases there still exist the semantic differences where a BA-construction exhibits firmness and authority), for example:

15 a) Dissolve the nucleic acids in 50 µl of TE that contains 20 µg/ml DNase-free RNase A.

把 *核酸溶解* 在含有 20 µg/ 无 DNase RNase A 的 50 µl TE 中。

b) 在含有 20 µg/ml 无 DNase RNase A 的 50 µl TE 中**溶解***核酸*。

Final formulations:

Dissolve (_, Compl1, in_Compl2)

溶解 (BA_Compl1, _, 在_Compl2_中)

Or:

溶解 (在_Compl2_中, _, Compl1)

16 a) Store the tube on the ice for three minutes.

把试管在冰上**存放**三分钟。

(linear sequence of the literal translation: BA tube, on ice, store, three minute)

b) 在冰上**存放***试管*三分钟。

Alternative:

在冰上**存放**三分钟*试管*。

Final formulations:

Store (_, Compl1, on_Compl2, T)

存放 (BA_Compl1, _, 在_Compl2_上, T)

Or:

存放(在_Compl2_上, _, Compl1, T)

16 a) Vortex the solution gently for a few seconds.

把*溶液*轻轻**振荡**几秒钟。

(linear sequence: BA solution, gently, vortex, a few seconds)

b) 轻轻**振荡***溶液*几秒钟。

Final formulations :

Vortex (_, Compl1, Y, T)

振荡 (BA_Compl1, Y, _, T)

Or:

振荡 (Y, _, Compl1, T)

Here "Y" refers to adverbs.

However, if the transitive verb (e.g. "vortex") is used intransitively as is often the case in our corpus, the BA-construction has to be changed to the normal sentence structure (V + (X) + PP), for example:

17) Vortex gently for a few seconds.

轻轻**振荡**几秒钟。

Formulation for this becomes:

Vortex (_, Y, T)

振荡 (Y, _, T)

The reason why we allow the alternative formulations in the second case is that these sentences are actually subcategorized for by the verbs and will not be confused with other similar syntactic structures (e.g. V + NP + PP) which do not employ the BA-construction in the TL while transferring the intended information. We demonstrate this with an example:

18 a) Puncture the cyst with the needle.

用针穿刺包囊。

While the machine is searching the information concerning this sentence, two major supported sources of information (lexicon and grammar rules) will help it find the correct structure for transferring the sentence into the correct TL correspondence. Therefore, the machine will not mismatch the syntactic structure for this sentence by wrongly employing the BA-construction, for example the following translation will be excluded by both the information stored in the lexicon and grammar as a legal instruction:

b) *把包囊用针穿刺。

This is an understandable but very unnatural sentence and can be regarded as ungrammatical in the target language. Though it possesses the same structure as that of the other BA-construction, the problem of this ungrammaticality is caused by the semantic content conveyed by both the verb and the preposition. Usually a BA-construction expresses the resultative or directional effect of the verb. However, what the PP "*with the needle*" expresses is the manner of the verb, that is, how the action is done. Semantically, it is not within the semantic scope of the BA-construction (though we can find few contradictory examples)

and thus can not be translated into to the target language by incorrectly employing the BA-construction.

In our system prepositional phrases like, "*with the needle*" is subcategorized by the verb "*puncture*" and the syntactic rules for this verb. To demonstrate this, we simplify the lexical and syntactic information as shown in the formula below:

Puncture (_, Compl1, with_Compl2)

穿刺(用_Compl2, _, Compl1)

The above information tells us that the verb "*puncture*" of the source language, like the other verbs mentioned in the previous paragraphs, can have two complements, of which one has a preposition as the head of the second linear complement. The correspondence in the target language for this verb is "穿刺" which take two complements too. One corresponds to the first complement of the SL and is placed after the verb "穿刺", and the other complement corresponds to the second complement but is placed in front of the verb with a preposition as its head "用". The simplified syntactic structures for both sentences are:

SL: V_3[11] (_, A, P_B)
TL: V_3 (P_B, _, A)

4   Conclusion

In this paper we have discussed a special Chinese syntactic structure: the BA-construction which is quite controversial in the literature but nevertheless less problematic in our work. After comparing with other syntactic structures, we finally adopt the idea that the BA-construction shows more characteristics of a PP which is still governed by the verb which follows it, in particular in our work. We thus treat this structure as a PP rather than a VP. This is supported by the relatively simpler sentence structures found in our corpus. While constructing our grammar and formulating the BA-structure, we lay focus on the syntactic performance and semantic contents that the BA-construction exhibits. Based on the verb types and the semantic content of the preposition following the verb, we finally formulate two kinds of sentence types concerning the BA-construction in the target language which can well satisfy our purpose. Of course, like many

other language-specific syntactic structures, our analysis and practice can not satisfy all situations. However, as we work on a relatively narrow domain where the sentence types by themselves do not vary greatly. We can find a better solution by controlling the syntactic types to tackle the problems concerning the BA-construction and the alike.

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[11] V_3: refers to the syntactic pattern of the verb.