Building Zhong, a Chinese HPSG shared-grammar

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Proceedings of the 22nd International Conference on
Head-Driven Phrase Structure Grammar

Nanyang Technological University (NTU), Singapore

Stefan Müller (Editor)

2015

Stanford, CA: CSLI Publications

pages 96–109

Fan, Zhenzhen, Sanghoun Song & Francis Bond. 2015. Building Zhong, a Chinese HPSG shared-grammar. In Stefan Müller (ed.), *Proceedings of the 22nd International Conference on Head-Driven Phrase Structure Grammar, Nanyang Technological University (NTU), Singapore*, 96–109. Stanford, CA: CSLI Publications.
DOI: 10.21248/hpsg.2015.6.

Abstract

This paper describes some of our attempts in extending Zhong, a Chinese HPSG shared-grammar. New analyses for two Chinese specific phenomena, reduplication and the SUO-DE structure, are introduced. The analysis of reduplication uses lexical rules to capture both the syntactic and semantic properties (amplification in adjectives and diminishing in verbs). Words showing non-productive reduplication are entered in the lexicon, and the semantic relations will be captured in an external resource (the Chinese Open Wordnet). The SUO-DE structure constrains the meanings of relative clauses to a gapped-object interpretation.

1 Introduction

We are developing a Chinese HPSG shared-grammar named Zhong (Fan et al., 2015), that covers multiple varieties of Chinese. It is based on the existing work on Mandarin Chinese from the HPSG community. Our objective is to build a broad-coverage computational resource grammar that can be used for applications such as machine translation and computer aided language learning. We take a corpus-driven approach to improving its coverage through grammar rule enhancement and lexicon expansion.

Head-Driven Phrase Structure Grammar (HPSG: Pollard & Sag, 1994) is a lexicalized generative grammar theory developed by Carl Pollard and Ivan Sag at Stanford University. An HPSG-based grammar includes constraint-based grammar rules and a lexicon containing syntactic and semantic information about words, which makes it very useful as a grammar framework in natural language processing for deep linguistic analysis of human language aiming at content level understanding.

Computational linguists from different research centers worldwide have been collaborating to develop broad coverage HPSG grammars of different languages in a consortium called Deep Linguistic Processing with HPSG (DELPH-IN, http://www.delph-in.net). Broad coverage HPSGs for English (LinGO English Resource Grammar, ERG: Flickinger, 2000), German (GG: Müller & Kasper, 2000; Crysmann, 2005), Japanese (Jacy: Siegel & Bender, 2002), Korean (KRG: Kim et al., 2011), Spanish (SRG: Marimon, 2012), Norwegian (NorSource: Hellan, 2005), and several other languages have been developed and used in various applications.

In this paper we focus especially on two Chinese phenomena: reduplicated adjectives and verbs, and SUO-DE structure, and show how we implement them in our grammar.

2 Previous Works on Chinese HPSG

Since 1990s, linguistic analysis of specific Chinese phenomena in HPSG framework started to appear (Xue et al., 1994; Gao, 1994; Xue & McFetridge, 1995,?; Ng, 1997). Subsequently, two PhD theses (Gao, 2000; Li, 2001) documented the efforts towards a more comprehensive analysis of Chinese, covering major phenomena such as topic sentences, valence alternations (including BA, ZAI, and other constructions), as well as separable verbs and Chinese derivation and affixes.

More recent works accompany linguistic analysis with computational implementation, leading to several independently developed HPSG grammars on Mandarin Chinese: MCG (Zhang

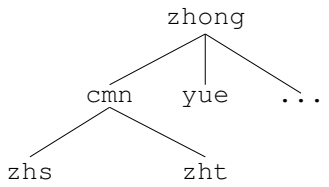
et al., 2011), ManGO (Yang, 2007), and ChinGram (Müller & Lipenkova, 2013), all adopting Minimal Recursion Semantics (MRS) (Copestake et al., 2005) as the semantic representation format. These grammars focus on a variety of linguistic phenomena in Chinese, but typically only cover the words appearing in their testsuites.

3 Zhong

There are many varieties of Chinese, historically related but now separate languages. Zhong aims to model the common parts and the linguistic diversity across these varieties in a single hierarchy, inspired by the existing works on grammar sharing, such as the LinGO Grammar Matrix system (Bender et al., 2010), CoreGram (Müller, 2013), CLIMB (Fokkens et al., 2012), SLaviCore (Avgustinova & Zhang, 2009) and SlaviCLIMB (Fokkens & Avgustinova, 2013). The different Chinese grammars in Zhong share some elements, such as basic word order, and have other elements distinct, such as lexemes and specific grammar rules (e.g., classifier constructions).

Taking the original implementation of ManGO, we restructured it as follows:

(1)



All grammars build upon the common constraints and inherit from `zhong-lextypes.tdl`, `zhong.tdl`, and `zhong-letypes.tdl`. The differences between Mandarin and Cantonese, such as NP structures, are reflected in `cmn.tdl` and `yue.tdl`, respectively. The Mandarin Chinese grammars are further divided into `zhs` and `zht` depending on whether simplified characters or traditional characters are used. Further distinction between the two are modeled in `zhs.tdl` and `zht.tdl`, respectively.

The official webpage of Zhong, with demo and test results, is http://wiki.delph-in.net/moin/ZhongTop. And the entire data set can be freely downloaded from https://github.com/delph-in/zhong.

4 Chinese-specific Phenomena

As part of the efforts to enhance the grammar's coverage, we have analysed and implemented several Chinese-specific phenomena such as VV resultative compounds, A-NOT-A questions (Wang et al., 2015), NP structure (Sio & Song, 2015), sentence end particles, interjections and fragments. Here we present how we handled another two new phenomena, reduplicated adjectives and verbs, and the SUO-DE structure.

4.1 Reduplicated Adjectives and Verbs

According to Li & Thompson (1989), reduplication is a morphological process of repeating a morpheme to form a new word, which mainly applies to verbs and adjectives in Chinese. When a monosyllabic adjective or verb is reduplicated, the character is repeated (A → AA), as shown in (2) and (3).

(2) 红红
hónghóng
red-red

"very red"

(3) 看看
kànkàn
look-look

"take a look"

When reduplication is applied to disyllabic words, the two characters are repeated differently for adjectives (AB → AABB) and verbs (AB → ABAB), as illustrated in (4) and (5).

(4) 干干净净
gāngānjìngjìng
AABB-clean

"very clean"

(5) 休息休息
xiūxixiūxi
rest-rest

"have a rest"

Syntactically, the reduplicated adjectives can not be modified by degree adverbs (e.g. 很*hen* "very", 非常 *feichang* "extremely", 特别 *tebie* "specially", 极 *ji* "extremely", 十分 *shifen* "very much", 更 *geng* "more", 最 *zui* "most", 较 *jiao* "more", 比较 *bijiao* "more", etc.), as illustrated in (6).

(6) *很　干干净净
hěn　gāngānjìngjìng
very　AABB-clean

"very clean"

Reduplicated verbs, on the other hand, do not accept aspect markers like 了 *le*, 着 *zhe*, and 过 *guo*, as shown in (7).

(7) *看看　　着
kànkàn　zhe
look-look　ASP

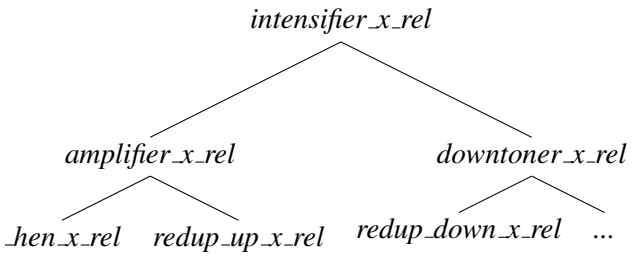
"take a look"

The meaning of the reduplicated adjectives (AA or AABB) is more vivid or intensified than its original form (A or AB) (Li & Thompson, 1989). For verbs, reduplication adds a tentative aspect (Chen et al., 1992), or signals a delimitative aspect (doing something "a little bit") (Li & Thompson, 1989).

Based on our position that sentences with similar meaning should have similar semantic representations, we model the semantic representation of reduplicated verbs or adjectives as the predicate of the original word (A or AB) and a predicate that acts as an intensifier. Depending on the semantic function of the intensifier, it can be either an **amplifier** (making the meaning more intensified) or a **downtoner** (scaling it down), following the analysis of Quirk et al. (1985, p589 onwards).

Two predicates are therefore defined, *amplifier_x_rel* and *downtoner_x_rel*, both inheriting from a common parent *intensifier_x_rel*. *redup_up_x_rel* (representing amplification using reduplication) and *redup_down_x_rel* (representing scaling-down using reduplication) inherit from *amplifier_x_rel* and *downtoner_x_rel* respectively, as illustrated in (8). Predicate for the most common intensifier, the degree adverb 很 (*hen*,"very"), is also added into this structure, but more detailed differentiation of degree scales is left to the Chinese Open Wordnet (Wang & Bond, 2013).

(8)



We use lexical rules to produce the reduplicated forms from the original form. The super type of the rules, *redup-type*, introduces the predicate *intensifier_x_rel*, as shown in (9).

(9)

$$\begin{bmatrix} \textit{redup-type} & \\ \text{CAT.HEAD} & \boxed{1} \\ \text{VAL} & \boxed{2} \\ \text{CONT} & \boxed{3}\ \text{HOOK}\begin{bmatrix}\text{LTOP} & \boxed{4}\\ \text{INDEX} & \boxed{5}\end{bmatrix} \\ \text{C-CONT} & \left\langle \begin{bmatrix} \textit{event-rel} & \\ \text{PRED} & \textit{intensifier\_x\_rel} \\ \text{LBL} & \boxed{4} \\ \text{ARG1} & \boxed{5} \end{bmatrix} \right\rangle \end{bmatrix} \rightarrow \begin{bmatrix} \text{CAT.HEAD} & \boxed{1} \\ \text{VAL} & \boxed{2} \\ \text{CONT} & \boxed{3} \end{bmatrix}$$

Two lexical rules, *redup-a-lr* and *redup-v-lr*, inherit from *redup-type*. *redup-a-lr* (10), which is for adjective reduplication (AA and AABB), requires an adjective, and defines that the predicate introduced is the amplifier *redup_up_x_rel*. It also adds the syntactic constraint that the specifier of the word is empty, preventing it from accepting degree adverbs. The rule for the reduplication of verbs (AA and ABAB), *redup-v-lr* (11), requires a verb, defines the predicate *redup_down_x_rel*, and states that the verb doesn't accept aspect markers.

(10)
$$\begin{bmatrix} \textit{redup-a-lr} \subset \textit{redup-type} \\ \text{CAT.HEAD} \quad \text{+a (adjective)} \\ \text{VAL} \quad \left[\text{SPR} \langle\rangle\right] \\ \text{C-CONT} \quad \left\langle \left[\text{PRED} \quad \textit{redup\_up\_x\_rel}\right] \right\rangle \end{bmatrix}$$

ORTHOGRAPHY: A → AA (irregular AB → AABB)

(11)
$$\begin{bmatrix} \textit{redup-v-lr} \subset \textit{redup-type} \\ \text{CAT.HEAD} \quad \text{+v (verb)} \\ \text{CONT.HOOK} \quad \left[\text{ASPECT } \textit{non-aspect}\right] \\ \text{C-CONT} \quad \left\langle \left[\text{PRED} \quad \textit{redup\_down\_x\_rel}\right] \right\rangle \end{bmatrix}$$

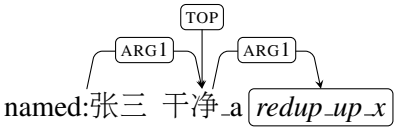
ORTHOGRAPHY: A → AA; A → A一A; (irregular AB → ABAB)

With the above definitions, for a sentence like (12), the dependency graph representing its MRS structure is provided in (13), which basically neans "Something called "张三" is *redup_up* clean".

(12) 张三　　干干净净
zhāngsān　gāngānjìngjìng
Zhangsan　AABB-clean

"Zhangsan is very clean"

(13)



If we generate from an MRS representation "Something called "张三" is *amplifier* clean", we can get two possible surface forms:

(14) a. 张三 很 干净
zhāngsān hěn gānjìng
Zhangsan very clean

"Zhangsan is very clean"

b. 张三 干干净净
zhāngsān gāngānjìngjìng
Zhangsan redup_up-clean

"Zhangsan is very clean"

The above two lexical rules handle the A → AA reduplication for both verbs and adjectives. With pre-processing using regular expressions, another variation of the reduplication pattern of monosyllabic verbs, A → A 一 (*yi* "one")A, can also be handled by (11). An example of this pattern is given below in (15).

(15) 看一看
kànyīkàn
look-one-look

"take a look/look a little"

Since AABB reduplication of AB adjectives and ABAB reduplication of AB verbs are not very productive in Chinese (i.e., there are many AB adjectives or verbs that can not be reduplicated this way), we list them as irregular derivation forms in `irregs.tab`. We have collected 92 entries for the AABB adjectives, and 74 entries for the ABAB verbs so far.

Another AB verb reduplication pattern is AB → AAB in (16), repeating the first character of some AB verbs. There is a similar pattern for some verbs with three characters. These verbs (so far 76) are also defined in `irregs.tab` to be handled in a similar manner.

(16) 说说话
shuōshuōhuà
AAB-talk

"have a talk/talk a little"

Other forms of AB verb reduplication, such as A了(*le*, "asp-marker")A, and AA看(*kàn* "see"), will be added in future work.

ABB, shown in (17) and (18), is another commonly mentioned adjective reduplication pattern. Like other reduplicated words, it can't be modified by degree adverbs. However, semantically it can't be reduced down to an A or AB predicate and a general reduplication predicate *redup_up_x_rel*. Either the AB form of the word doesn't exist, or its A form exists but the different reduplication BB adds different meaning to the same A form. These adjectives are directly added into the lexicon (103 entries) with a lexical type defined with the required syntactic constraint.

(17) 绿油油
lǜyóuyóu
green-oil-oil

"bright green"

(18) 绿茸茸
lǜróngróng
green-downy-downy

"mossy green"

The semantic connection between (17) and (18), that they are more specific but slightly different kinds of green ("bright green" and "mossy green"), will be captured in the Chinese Open Wordnet.

4.2 SUO-DE structure

In Mandarin Chinese, 所 *sǔo* is a particle used before a transitive verb to nominalize the structure "SUO+V" into a noun phrase (L ǔ , 1999). According to Lu & Ma (1985), in modern Chinese, SUO is used most commonly in the structure "(NP_1+)SUO+V+DE", either to modify a noun following it (NP_2) or to act as a noun phrase itself. These variations are listed below in (19a-d). The last variation (19e) is used directly as an noun phrase in formal text.

(19) a. "$NP_1 + SUO + V + DE + NP_2$"
b. "$SUO + V + DE + NP_2$"
c. "$NP_1 + SUO + V + DE$" as NP
d. "$SUO + V + DE$" as NP
e. "$SUO + V$" as NP

One usage of SUO, for structure (19a) "NP_1+SUO+V+DE+NP_2", is shown in example (20).

(20) 他 所 写 的 书
tā suǒ xiě de shū
he SUO write DE book

"the book he wrote"

We take the view of Deng (2009) that in structures where both SUO and DE appear (19a-d), DE plays the key role of nominalizing the phrase "(NP_1+)SUO+V+DE", so that it can either be a noun phrase itself, or be a prenominal adjunct (relative clause) to NP_2. The role of SUO in the construction is to indicate that the missing argument of the verb is its patient or direct object.

Specifically, for structures in (19a & b), the lexical entry for the relativizing DE is presented in (21). The feature SPR of DE selects a preceding verbal clause containing a gap of one missing

argument. DE heads the resulting relative clause, the missing argument of which is coreferential with the noun it modifies. The GAP value of DE's selected clause is defined to be identical to the NP in DE's MOD. DE's non-empty STOP-GAP feature ensures that it performs the gap-filling required.

DE also shares its HEAD feature with that of the selected clause. Semantically, DE does not introduce any information, so its RESTR list is empty, and its INDEX is the same as that of its selected clause.

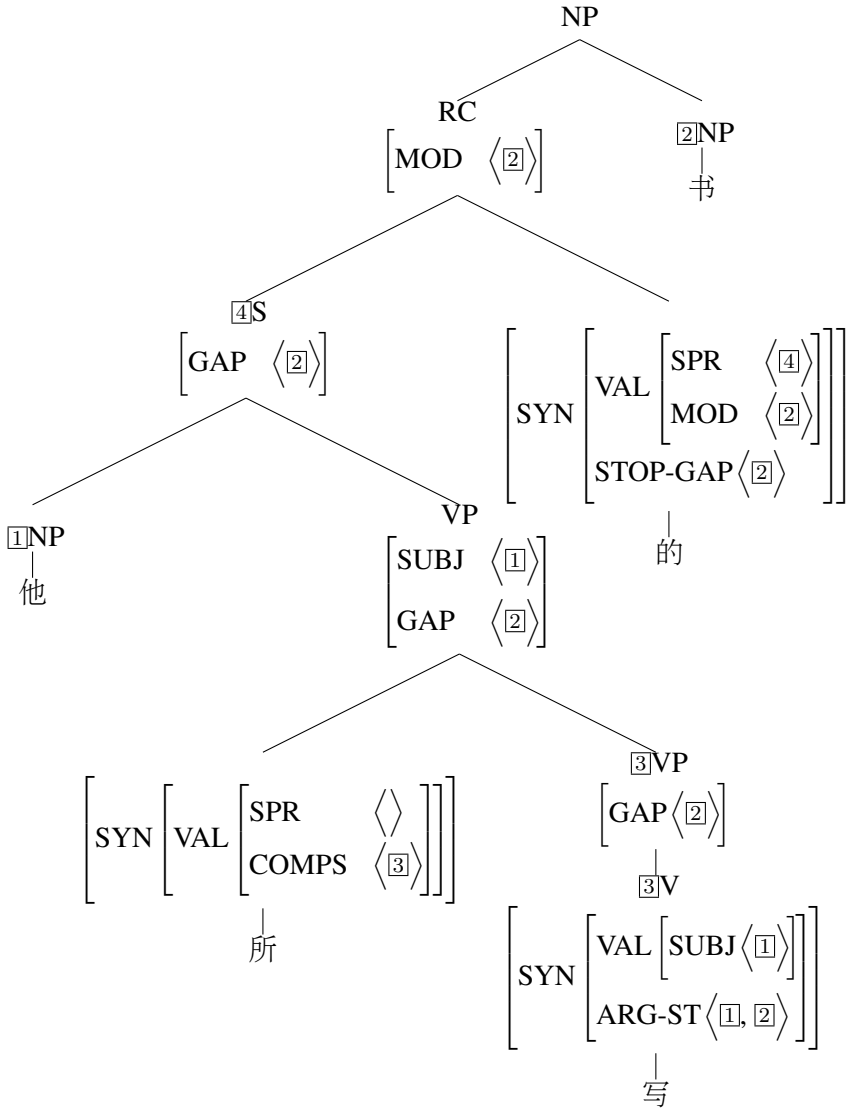
(21)
$$\left\langle \text{的}, \left[\text{SYN} \left[\text{VAL} \left[\begin{array}{ll} \text{HEAD} & \boxed{2} \\ \text{SPR} & \left\langle \text{V} \left[\begin{array}{l} \text{SYN} \left[\begin{array}{l} \text{HEAD } \boxed{2} \\ \text{GAP} \left\langle \boxed{1} \right\rangle \end{array} \right] \\ \text{SEM} \mid \text{INDEX } s \end{array} \right] \right\rangle \\ \text{COMPS} & \langle\rangle \\ \text{MOD} & \left\langle \boxed{1}\text{NP} \right\rangle \end{array} \right] \\ \text{STOP-GAP} \left\langle \boxed{1} \right\rangle \end{array} \right] \right] \\ \text{SEM} \left[\begin{array}{ll} \text{INDEX} & s \\ \text{RESTR} & \langle\rangle \end{array} \right] \end{array} \right] \right\rangle$$

The lexical entry for SUO is shown in (22). SUO selects a transitive verb which has an unrealized subject and a GAP value referring to its direct object (2nd item on ARG-ST list). As a non-head marker marking the missing object, SUO has nothing to add on semantically. It's worth noting that SUO is redundant when NP_1 is present. When NP_1 is not present, SUO helps to restrict the reading of the gap.

(22)
$$\left\langle \text{所}, \left[\text{SYN} \left[\text{VAL} \left[\begin{array}{ll} \text{HEAD} & \textit{marker} \\ \text{SPR} & \langle\rangle \\ \text{COMPS} & \left\langle \text{V} \left[\begin{array}{l} \text{SYN} \left[\begin{array}{ll} \text{HEAD} & \boxed{3} \\ \text{VAL} & \left[\begin{array}{ll} \text{SUBJ} & \left\langle \boxed{1} \right\rangle \\ \text{COMPS} & \langle\rangle \end{array} \right] \\ \text{GAP} & \left\langle \boxed{2} \right\rangle \end{array} \right] \\ \text{ARG-ST} \left\langle \boxed{1}, \boxed{2}, \ldots \right\rangle \\ \text{SEM} \mid \text{INDEX } s \end{array} \right] \right\rangle \end{array} \right] \\ \text{SEM} \left[\begin{array}{ll} \text{INDEX} & s \\ \text{RESTR} & \langle\rangle \end{array} \right] \end{array} \right] \right\rangle$$

(21) and (22) interact to produce the noun phrase structure for (20) in (23). In the tree, SUO constrains the missing argument of the verb to be the direct object. This information, contained in feature GAP, is passed up the tree, until the S or VP combines with DE to form a relative clause.

(23)



We have implemented SUO and the relativizing DE into our grammar for SUO-DE structures in (19a & b). The MRS representation for (20) is presented in (24), where the ARG2 of the predicate *_写_v_1_rel* "write" links to the predicate *_书_n_1_rel* "book". The implementation for (19c & d) is currently in progress.

(24)
$$\begin{bmatrix} \textit{mrs} \\ \text{TOP} & \boxed{0}\,h \\ \text{INDEX} & \boxed{2}\,e \\ \text{RELS} & \left\langle \begin{bmatrix} \textit{pron\_rel} \\ \text{LBL} & \boxed{9}\,h \\ \text{ARG0} & \boxed{10}\,x \end{bmatrix}, \begin{bmatrix} \textit{pronoun\_q\_rel} \\ \text{LBL} & \boxed{11}\,h \\ \text{ARG0} & \boxed{10}\,x \\ \text{RSTR} & \boxed{12}\,h \\ \text{BODY} & \boxed{13}\,h \end{bmatrix}, \begin{bmatrix} \textit{\_写\_v\_1\_rel} \\ \text{LBL} & \boxed{14}\,h \\ \text{ARG0} & \boxed{15}\,e \\ \text{ARG1} & \boxed{10}\,x \\ \text{ARG2} & \boxed{8}\,x \end{bmatrix}, \right. \\ & \left. \begin{bmatrix} \textit{\_书\_n\_1\_rel} \\ \text{LBL} & \boxed{16}\,h \\ \text{ARG0} & \boxed{8}\,x \end{bmatrix}, \begin{bmatrix} \textit{exist\_q\_rel} \\ \text{LBL} & \boxed{17}\,h \\ \text{ARG0} & \boxed{8}\,x \\ \text{RSTR} & \boxed{18}\,h \\ \text{BODY} & \boxed{19}\,h \end{bmatrix} \right\rangle \\ \text{HCONS} & \left\langle \begin{bmatrix} \textit{qeq} \\ \text{HARG} & \boxed{0}\,h \\ \text{LARG} & \boxed{16}\,h \end{bmatrix}, \begin{bmatrix} \textit{qeq} \\ \text{HARG} & \boxed{12}\,h \\ \text{LARG} & \boxed{9}\,h \end{bmatrix}, \begin{bmatrix} \textit{qeq} \\ \text{HARG} & \boxed{18}\,h \\ \text{LARG} & \boxed{16}\,h \end{bmatrix} \right\rangle \\ \text{ICONS} & \left\langle \begin{bmatrix} \textit{focus-or-topic} \\ \text{IARG1} & \boxed{15}\,e \\ \text{IARG2} & \boxed{8}\,x \end{bmatrix} \right\rangle \end{bmatrix}$$

5 Conclusion

We have extended our grammar of Chinese with new analyses for reduplication and the SUO-DE structure. The analysis of reduplication uses lexical rules to capture both the syntactic and semantic properties (amplification in adjectives and diminishing in verbs). Words showing non-productive reduplication are entered in the lexicon, and the semantic relations will be captured in an external resource (the Chinese Open Wordnet). Classifier reduplication is left until we have a fuller analysis of classifiers. The SUO-DE structure constrains the meanings of relative clauses to a gapped-object interpretation.

Treebanking using the current version of Zhong has revealed many gaps, especially in dealing with longer sentences found in real text, where different phenomena tend to interact to make constraint specification challenging . We plan to focus our subsequent efforts on phenomena that would help parse such longer sentences. Some of the tasks on the immediate agenda are: relative clauses, variations of nominalisation, serial verb constructions, conjunctions, other forms of VV compounds, etc. Lexical acquisition for Mandarin Chinese using traditional characters, `zht`, and Cantonese, `yue`, will also be performed to expand their lexical coverage.

Acknowledgments

We would like to thank the reviewers, the participants of the Linguistic Analysis Design (LAD) sessions at the DELPH-IN 2015 summit, attendees of the HPSG 2015 conference as well as all others who have given their useful input.

This research was supported in part by the MOE Tier 2 grant *That's what you meant: a Rich Representation for Manipulation of Meaning* (MOE ARC41/13).

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