A Resolution for Polysemy:
the case of Mandarin verb *ZOU* (　)

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Abstract

In this paper, we propose a procedural schema as a model of cognitive processing of word senses, which can be viewed as a derivational resolution of polysemy. Previous researches, such as Frame -Based Lexicon by Fillmore [4] and Lexical Semantics by Cruse [2], are all concerned with word senses, but what is still missing is a holistic resolution of polysemy. Therefore, in this paper, we focus on the cognitive process from word form to word senses, based on corpus-based procedural resolution. In this way, we hope to provide an overall discussion and a computerizable way of solving multiplicity of semantic usages of a single word form. A case study of the Mandarin verb *ZOU* (　) is presented and used as an illustration.

1   Introduction

Since 'two or more semantic elements may be expressed in a single monomorphemic lexical item' (Bybee [1]), to understand the meaning of a word in a particular utterance, we need to resort to 'cognitive structures, knowledge of which is presupposed for the concepts encoded by the words' (Fillmore [4]). According to Fillmore [4], we know word senses are not related to each other directly, but only by way of their links to common background frames and indications of the participant roles associated with such frames (i.e., Frame elements). However, when we turn to semantic multiplicity of a single word form in Mandarin, such as *ZOU* (　), the highlighted core elements of frames may not be enough to help us distinguish the different meanings of the single monomorphemic lexical item. The problem can be the spelled out as follows:

a) Different senses of a single lexical item may have similar participant roles in the general terms and similar patterns of expressing these elements. Therefore, if we only depend on the information of core frame elements, how could we tell the different senses and in what way we can tell the non-prototypical senses from the prototypical one? Since the process of sense selection is under the force of many interacting factors (Bybee [1]), a reliable source of clues is collocational patterns that reveal lexical as well as grammatical associations of words. To fully utilize corpus data, we will look at Colloconstruction (a term adopted from Stefanowitsch and Gries' idea with some modification), i.e., clause-internal, morpho-syntactic patterning characteristic of each sense, to further distinguish semantic polysemy.

b) With the postulation of Colloconstruction, we may still encounter ambiguous cases where two different senses may share similar frame elements and similar Colloconstrucions. Thus, next in our cognitive resolution, we propose 'Contextual Dependence' as another disambiguation factor which depends on discourse-level patterning across sentences, and we will have a detailed discussion in the following sections.

2   Cognitive resolution

The resolution model proposed here intends to simulate human cognitive process of detecting word senses. As Cruse [2] describes, a lexical form may well be associated with an unlimited number of possible senses, but **these are not all of equal status** (bold is added by us)…every lexical form has at least one relatively well-utilized sense. Our resolution is based on Cruse's observation and the assumption made by cognitive linguists that each word has at least one cognitively most salient meaning, the prototypical sense. First, a single word form within a clause comes into our cognitive system, and then according to the salient frame -evoked elements, we might easily get one sense from the word form (as shown by the arrowed line 'a' in Figure 1 below.). In most cases, readers tend to start with the predominant sense with the highest frequency count (we will discuss this in the following sections). However, some words may have two different senses that share similar participant roles and surface patterns, and then we need an efficient mechanism to detect the different sense while probing into the underlining frame. In these cases, we need to go through the next step—identifying Colloconstruction (as shown in the following) to get more information to help delimit the different senses. Colloconstruction provides information regarding morpho-syntactic patterns within a particular construction which consists of frequently co-occurring le xemes. Still, in some cases, Colloconstructions are not distinct enough to disambiguate. There might be another sense which requires similar core elements in a similar Colloconstruction as the more prototypical sense does. Then, we have to go into the next step - finding 'Contextual Dependence', i.e., discourse-pragmatic variables commonly associated with a given sense.   The resolution formula is schematically

represented in Figure 1 below. Assuming that the most prototypical and thus more frequently used sense is easier to detect, the process starts with checking the highlighted frame elements and the high frequently use for identifying the prototypical sense. As shown in Figure 1, the path with the arrowed line 'a' represents this shortest route – frame element checking.   The paths with the arrowed lines 'b' and 'c' represent the additional efforts required for identifying less prototypical senses.
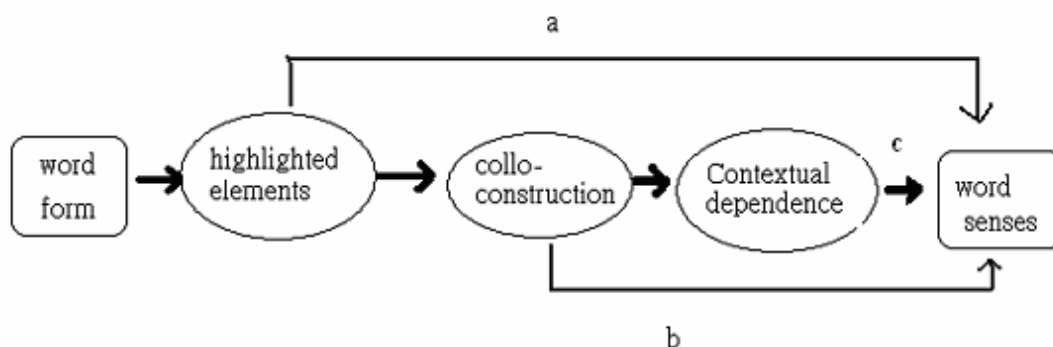

Fig. 1. Cognitive resolution

3   The different senses of Mandarin verb ZOU( ):

In this paper, we use the Mandarin verb ZOU(   ) to test and illustrate our cognitive resolution. First, we will distinguish the different senses of the verb by frame conceptions (adopting the frame definitions in FrameNet II with little modifications), as shown in Table 1.

Table 1. The four main senses of Mandarin verb ZOU(   )'[1]

Sense	Frame	Frame Elements	Frequency (Total: 200)
Sense1: walk/go	Self_motion	Area, goal, path, source, self-mover, duration	135 (67.5%)
Sense2: move	Motion	Area, goal, path, source, theme	10 (5%)
Sense3: visit	Arriving	Area, goal, self-mover	9 (4.5%)
Sense4: leave	Path_shape	Path, path_shape, road, self_mover, duration	46 (23%)

As we can see in Table 1, all the senses are in different frames with some shared core frame elements. In what way, then, can we identity these different senses by their frame elements? Besides, how do we distinguish the different senses when they are composed of the same pattern with the same instantiated frame elements? In order to provide an overall analysis of semantic polysemy, we propose fluid routes for cognitive resolution.

4   Frame-based sense distinction

As we mentioned above, the predominant sense goes through fewer steps since it is cognitively more accessible. Take the verb ZOU( ) in Chinese as an example. Among the four possible senses, sense 1 occurs most frequently (as shown in Table 1) and denotes a specific sensory motor action that is assumed to be cognitively salient and prototypical. Sense 2 can be viewed as extended from sense 1 in that the human action of moving by walking is broadened to denote the moving of entities in general. While sense 1 and sense 2 are both motional and they share a number of core frame elements, the two meanings can be easily distinguished in terms of the semantic attributes of participate roles. That is, sense 1 is associated with human or animate self-mover, and sense 2 is associated with inanimate moving entities or 'theme', as exemplified in the examples (1) and (2) below.

(1) Sense 1
Self-mover [animate] <*< Distance

ta1 ye3 bu4 zhi dao4 jiu4jing4 zou3 le duo1yuan3, zhong1yu2 zai 4yi1ge4 huang1pi4 de da4shan1 xia4mian4, fa1xian4 le yi1ge4 shan1dong4
He also not know actually walk LE how far, finally at one-CL desolate DE great mountain under, find LE one-CL cave

'He also did not know how far he walked actually, and finally under the desolate great mountain, he found a cave.'

(2) Sense 2
Mover [inanimate] <*< Distance

da4yue1 130 fen1zhong1, huo3che1 zou3 le yue1 200 gong1li3, wo3men dao4 le tong3yi1 qian2 dong1de2 de di4san1da4 du1shi4 de2le41si1deng1

about 130 minutes, train walk LE about 200 kilometers, we come LE unify before east German DE third big city Deluxe
'About 130 minutes, the train walked about 200 kilometers; we came to the third metropolis, Deluxe, of ex- east German.'

Figure 2 below is meant to capture the details of the sense derivational process of the word form ZOU( ), and we will see that sense 1 and sense 2 are distinguished in the first step. Semantic information of their frame elements is utilized to process these two senses in cognition.
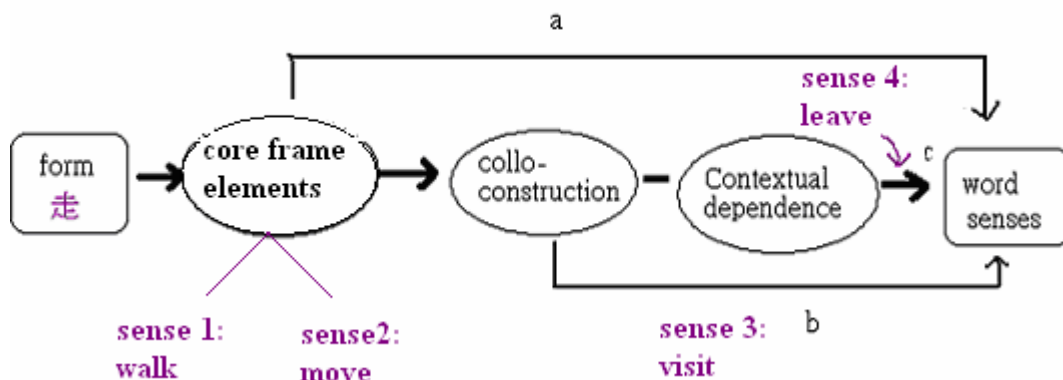

Fig. 2. The cognitive resolution of Mandarin verb ZOU( )

5   Colloconstruction

Colloconstruction refers to a combination of lexical and grammatical collocations. It is used to identify the specific morpho-syntactic sequences of lexical items. Colloconstruction may help detect crucial collocational elements and constructional features when the word form is semantically compatible with the construction. When semantic information of participant roles is insufficient, word senses can only be detected with a careful examination of lexical and grammatical collocations. For example, sense 1 and sense 3 of ZOU( ) can only be distinguished when colloconstructions are taken into consideration. Consider the following uses of sense 3:

(3) Self-mover <*< path

min2zhong4 yu4 jian4 nan2ren2 shan1qu1 de sen1lin2 sheng1tai4xi4, zhi3 xiao1 zou3 yi1tang4 nan2hui2 gong1lu4 ji2ke3

people want see Nan-Ren mountain area DE forest ecosystem, only just walk once south highway all right
'If people want to take a look around the forest ecosystem of the Nan-Ren mountain area, they may have a visit of the south highway'

(4) Self-mover <*< goal

tai2wan1 ben3dao3 de xiao3peng2you3 lai2 shuo1, yao4 kan4kan4 kong3long2 biao1ben3, zhi3 yao4 zou3 yi1tang4 ke1bo2guan3 jiu4 ke3yi3 le

Taiwan insular DE kids come say, want see dinosaur specimen, only have to walk once science museum all right LE
'For insular kids in Taiwan, if they want to see the dinosaur specimen, they may visit of the science museum all right'

(5) (CNI/self-mover) <goal<*

zai4 xiao3ren2guo2 nei4 zou3 yi1zao1, fang3fu2 zi4ji3 bian4 shi4 tong2hua4 zhong1 de ju4ren2

ge2lie4fu2
in Lilliputian inside walk once, like oneself is nursery tale inside DE giant Grief.
'Visiting in Lilliputian, one may imagine themselves as is being the giant Grief in the nursery tale'

In these utterances, the delimiting phrases *yitang* (　　) or *yizao*(　　) combined with a Location are crucial indicators of the 'visiting' sense of ZOU(　). In other words, the word form ZOU(　) and the phrases *yitang* (　　) or *yizao*(　　) co-construct a specific sequence commonly associated with the sense of 'visiting'. Exactly, in what way can Colloconstruction help? The answer is: when frame-based semantic roles fail to disambiguate. Let's consider the following utterances which contain the uses of sense 1:

(6) Self-mover <*< path

jie1zhe shi4 xun4lian4 ta1men zou3lu4. zou3 xie2po1, zou3 tai2jie1; zou3 ping2lu4, ye3 zou3 bu4ping2 de lu4
then is train them walk. walk slope, walk step, walk even, also walk not even DE road
'Then, train them walk, walk slope, walk step, walk even road, and also walk uneven road'

(7) Self-mover <*< goal

wo3 dui4 ta1 xiao4yi1xiao4 zou3kai1 le, yang3tou2 yi1kan4, cai2 zhi1dao4 zou3dao4 yi1pai2 song1shu4 xia4
I to her simile walk away. Faced upward a look, just know walk to a line pine tree under
'I gave a smile to her and walked away. Then, I faced upward taking a look and found that I had walked under a line of pine trees.'

(8) (CNI/self-mover) < goal < *

wang3 ying1guo2 hua1yuan2 de xi1nan2 bian1 zou3, shi4 yi1ge jiu4 shi4qu1
　　　　　　)
toward British garden DE southwest side walk, is an old downtown

'Walk toward the southwest side of the British garden, there is an old downtown
　　'

As we can see, the examples (6)-(8) above contain uses of sense 1 and the core frame elements (Self-mover, Area, and Goal) are similar to those of sense 3 (examples in (3)-(4)). To detect the differences between these two senses, we need to pay attention to their collocational features. Here, the colloconstruction [ZOU(　) +*yitang* (　　) /*yizao*(　　)] help to identify the occurrence of sense 3. Therefore, as we proposed above, Colloconstructions might be the anchor for the derivational senses. In this case, the adjunct *yitang* (　　), *yizao*(　　) help to anchor sense 3 in a commonly recognized construction, taking the following NP as a destination (Goal) and then the sense 'visit' is derived. This resolution conforms to the perspective of Emergent Grammar, as Firth [5] contended that usage patterns of lexical forms can best be examined by looking at 'the company' they keep. However, given the dynamic nature of word usage, collocational associations alone may not be flexible enough to distinguish subtle differences of the senses of a word. Therefore, we need to take another step, looking into contextual dependence to obtain the overall resolution for polysemy.

6   Contextual dependence
The word form ZOU(　) has another sense —sense 4 'leave'—as shown in examples (9)-(11). Initially, we take the first step and test whether sense 4 can be derived only by utilizing information of core frame elements. Let's consider the following utterances:
(9)   Self-mover<* (sense 4: leave)

yu2shi4 da4huo3er2 bian4 fen1tou2 zou3le, dai4zhe man3qiang1 de xing4fen4
hence a group of people separately walk away LE, bring full De excitement
'Hence, the group of people walk away separately filled with excitement.'

(10)   Self-mover<* (sense 4: leave)

yi1bu4 mo2tuo1che1, mei2you3 tui3 de qi2shi4, yuan3yang2le…zou3le…
one-CL motorcycle, no leg DE knight, far wary LE…walk LE
' A motorcycle, carrying a knight without legs, moved far away … leave …'

(11) Self-mover<* (sense 1: walk)

wo3 zai4 man3 jie1 shui3bing1 han4 jun1guan1 men zhong1jian1 zou3zhe, ting1 ta1men yong4 shou22xi1 de cu1hua4 hu4xiang1 xiao4nao4zhe, yi1zhi2 lai2dao4 ma3tou2 bian1
I in full street soldiers and military officerses centre walk ZHE, hear them use familiar obscene language each other laugh ZHE, make hullabaloo ZHE, until arrive at wharf side.
' I walk in the street full with the soldiers and the military officerses, hearing them use the familiar obscene language, laugh to each other, make hullabaloo, and has been arriving at the wharf.'

Relying solely on core elements, it would be difficult to tell the differences between instances of sense 4 ' leave' (as in examples (9), (10)) and the use of sense 1 ' walk' (as in example (11)), because they show the same highlighted elements and the same associated constructions. At first glance, in terms of Colloconsruction, we may find an anchor for sense 4 - the verb-final '   ', which has quite distinct distributions with clauses containing either ' walk' or ' leave', as we can see in the statistics in Table 2:

Table 2. Collocate frequencies for the ZOU LE(   ) construction as the meaning of ' walk' and ' leave'[1].

Sense	' leave'	' walk'
Co-occur with verbal LE ( )	28/42 (57.14%)	7/53 (13.2%)
without verbal LE( )	14/42 (42.86%)	46/53 (86.8%)

Although, as shown in Table 2, the possible anchor '   ' indeed has a higher frequency of occurrence in clauses compatible with the sense of ' leave', we still have to explain how people distinguish the two senses in the fewer cases where both senses have the same Colloconstruction - co-occurring with '   ' to form a colloconstruction - [walk +   + duration] or [leave +   + duration] (such as examples (12)-(13)). Moreover, how can we deal with utterances with a bare '   ' and no other constructional anchors can be found (such as example (14))?

(12) sense 1: walk

(CNI/self-mover) <*< duration

yi1lu4 gen1zong1 er2jin4, you3shi2 cha4lu4shang4 liang3bian1 dou1you3 jiao3yin4, zhi3dei3 ren4yi4 xuan3 yi1tiao2lu4. zou3le hao3ban4tian1, shan1dong4zhong1 cha4lu4 bu4zhi1 fan2ji3,
all road follow and enter, sometimes branch road above two sides have footprints, only can choose one road. walk LE good half-day, cave inside branch road not know how much
' All the way we follow the footprints and walk into the caves, sometimes both sides of branch road all left the footprints and we just can choose one road arbitrarily. We walked a long time, we met uncountable branch roads on our way ,'

(13) sense 4: leave
(CNI/self-mover) <*< duration

wo3 fan1shen1 zuo4le qi3lai2, zheng1leyi1zheng1, qing1xing3le xu3duo1, wen4dao4: "zou3leduo1jiu3?" "bu4zhi1dao4, wo3 xia4wu3 kai1shi3 pei2ta1, hou4lai2 kan4shu1 kan4 de2 kun4le. jiu4 shui4zhao2 le, qi3lai2 jiu4 mei2kan4dao4ta1le
I turn body sit LE up, stun LE one stun, wide awoke LE many, ask: "walk LE how long?"
"don' t know, I afternoon start accompany him, then read books read DE feel asleep, then sleep LE, get up then not see him LE.
' I turned over and sat to get up, and was being stunned a while, and when I wide awoke, I asked:" How long did he leave?" "I don't know, I started to accompany him in the afternoon, and then read the book and I felt asleep, and then imperceptibly I fall asleep; when I got up, I did not see him.'

(14) sense 4: leave

lin2zhao1liang2 san1xia4liang3xia4 jiu4 ba3 mian4 chi1wan2, jiu4 gen1 ta1men yi1wo1feng1 zou3le.

lin2zhao1liang2 immediately then BA noodles eat over, then with them an onrushing crowd people leave LE

'Zhao-Liang Lin finished the noodles immediately, and then left with them blindly.'

Comparing examples (12) and (13) above, sense 1 and sense 4 are almost identical in surface structure as they share the following:

Shared core frame elements: path, self_mover, duration

Shared syntactic pattern: (CNI/self-mover) <*< duration

Shared colloconstruction: [* +   + duration]   (* represents the verb)

To distinguish the two senses, additional information from the larger context is needed. Each sense is believed to display certain features of Contextual Dependence. Here, Contextual Dependence refers to both foregrounded and backgrounded factors that are contextually linked with a given sense. In other words, we derive the sense 'leave' or the sense 'walk' from contextually bounded elements across clause boundaries. We make inferences on the basis of identifiable sense relations. For example, in example (12), the preceding sequence provides a valuable clue – the mention of *jiao yin* (   ) 'footprint', which helps infer to the sense of 'walk'. A semantic link is established since the definition of 'walk' is 'the act of traveling by foot' (from WordNet)[2]. The clear mention of 'footprint' thus motivates a contextually appropriate reading of ZOU(   ). In examples (13) and (14), the sense of 'leaving' is motivated by contextual sequences referring to 'appearing/disappearing', 'seeing/not seeing' or 'finishing/departure'. For example, *mei kan dao ta le* (   ) '(he) is no longer seen', and *mian chi wan* (   ) 'finished eating the noodles', both are related to the concept of disappearance. The semantic distance or proximity of contextual variables can be obtained if an independently motivated hierarchy of semantic categories is available. In practice, a valuable resource would be databases such as SUMO. The contextually salient features can be readily identified if a close link in the SUMO hierarchy can be established. In our proposed resolution, discourse-level factors may be utilized with a clear measure of their semantic relations. According to Hopper and Thompson [6], 'users of a language are constantly required to design their utterances in accord with their own communicative goals and with their perception of their listeners' needs.' We also believe that communicative goals will often be realized with semantically coherent sequences.

7   Conclusion

In the previous sections, we present a preliminary model of the cognitive process for detecting word senses. Given the principle of economy and mechanisms in prototype theory, we assume that not all the senses of a word have equal weights and require exactly the same procedure for sense derivation. Therefore, three modules are called upon in a sequence when needed. The first module focuses on frame-based information regarding participating frame elements and their expressions. The second module identifies colloconstructions that go beyond the expression of core arguments and look for detailed lexical as well as grammatical association patterns. The last module deals with contextually dependent cues that are semantically or ontologically related to the target word.

In sum, the proposed resolution schema could be viewed as the cognitive procedure drawn upon when multiple senses are present in a single word form, as illustrated with the case of Mandarin verb ZOU(   ). For further research, an automatic procedure may be established that makes use of frame-based semantic analysis and ontological hierarchy such as Sumo. A comprehensive investigation of Mandarin lexical semantics is under way (Liu [7][8]) and a bilingual ontological wordnet (Sinica BOW) is also available (Huang et al [9]). With useful tools, the cognitive procedure may offer a workable model to develop a computer system dealing with polysemy resolution. This model aims to integrate lexical semantics, corpus-based morphosyntax, and discourse analysis to provide a procedural and holistic solution. We also hope that this resolution can be applied in languages besides Mandarin.

Notes

1.   The data used in Table 1 and Table 2 in this paper is from the Sinica Corpus (http://www.sinica.edu.tw/SinicaCorpus/). And the numbers are based on the randomly 200 utterances found in the corpus. The total occurrences of ZOU(   ) in Sinica Corpus is over 2000. The examples cited in this paper are also from Sinica Corpus.

2.   The definition is adopted from WordNet 2.0

References

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On-line Resources

FrameNet II: http://www.icsi.berkeley.edu/~framenet/

Sinica BOW: http://BOW.sinica.edu.tw/

SUMO: http://ontology.teknowledge.com/

WordNet: http://www.cogsci.princeton.edu