

The Module-Attribute Representation of Verbal Semantics: From Semantics to Argument Structure

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Abstract

In this paper, we set forth a theory of lexical knowledge. We propose two types of modules: event structure modules and role modules, as well as two sets of attributes: event-internal attributes and role-internal attributes, which are linked to the event structure module and role module, respectively. These module-attribute semantic representations have associated grammatical consequences. Our data is drawn from a comprehensive corpus-based study of Mandarin Chinese verbal semantics, and four particular case studies are presented.

1. Background

Generative theories have long assumed that lexical semantics are encoded on each and every lexical entry, and hence represent idiosyncracies of each lexical item. This assumption, however, goes back much farther than generative theories. For example, Levin [1993] pointed out that Bloomfield wrote in 1933: "The lexicon is really an appendix of the language, a list of basic irregularities" [1993: 274]. As a consequence of this assumption, lexical semantics was not intensively studied within the generative framework because it was not expected to offer any interesting generalizations.

The notable exceptions, other than the short period of intense work on the generative semantics paradigm, were studies by Jackendoff [1983] and Wierzbicka [1985]. However, as grammatical theories became more and more lexicon-driven, more in-depth theoretical and empirical studies on the lexicon were carried out, and the above assumption was no longer valid. Levin [1993] in particular sounded the call for in-depth work on a theory of lexical knowledge. She writes that a theory of lexical knowledge:

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...must provide linguistically motivated lexical entries for verbs which incorporate a representation of verb meaning and which allow the meanings of verbs to be properly associated with the syntactic expressions of their arguments (p. 1).

This goal of a theory of lexical knowledge has not yet been attained, for reasons we will discuss in Section 2 below. It is, however, a worthy goal, and is in fact, the goal of this paper - to provide a theory of lexical knowledge based on lexical semantic features that are associated with a verb and predict their associated syntactic expressions.

In what follows, we will first look at why Levin's [1993] proposed use of diathesis alternations to ferret out meaning has fallen short of its goals. We will then propose a different way of looking for relevant syntactic behavior in Section 2. We will next present two underlying assumptions of our theory of lexical knowledge in Section 3, and then present the theory in Section 4. We will give four case studies in which we apply our theory in Section 5. We will summarize our theory in Section 6.

2. Verbal Semantics

Levin (1993) assumed that:

"...the behavior of a verb, particularly with respect to the expression and interpretation of its arguments, is to a large extent, determined by its meaning. Thus, verb behavior can be used effectively to probe for linguistically relevant pertinent aspects of verb meaning" (p.1).

We agree with this assumption. But as we will discuss below, we look at different aspects of verb behavior from Levin [1993].

Levin [1993] concentrated on the range of possible syntactic alternations of a single verb (or a single verb class) and extracted semantic information from syntactic behavior. For example, she pointed out that *break* verbs (verbs such as *break*, *crack*, *rip*, *shatter*, *snap* etc.) all can appear in the middle alternation but cannot appear in the conative or body-part ascension alternation while *cut* verbs (verbs such as *cut*, *hack*, *saw*, *scratch*, *slash* etc.) can appear in all three alternations [1993: 7]. After comparing these two verb groups with two others, *touch* and *hit* (and their respective alternations), she concluded that *break* is a pure change of state verb, and that *cut* is "a verb of causing a change of state by moving something into contact with the entity that changes state" (p. 10). The syntactic differences they display, she argued, are a direct result of their semantic differences.

However, there are two reasons why we have not followed Levin in examining the relationship between a verb alternation and its associated semantics. First, although the work done by Levin [1993] in this area is impressive (having determined 50 different types of alternations and over 125 different semantic classes of verbs), the sheer number of possible permutations of alternations makes analysis difficult. In addition, when comparing verbs of very different meanings, as in the *cut* and *break* example given above, it becomes hard to determine the relevant area of semantic difference. For example, in order to attain the generalization concerning *cut* and *break*, Levin had to look at two other verbs (*touch* and *hit*) and their respective diathesis alternations, as well as look at other verbs that could fit into those alternations [cf. 1993, pp. 5-8]. If she had picked different verbs from *touch* and *hit* or different diathesis alternations from the three that she did, she might not have been able to come up with a generalization at all. These factors may have contributed to the fact that there is currently no unified theory of lexical knowledge based on verb alternations because the scope of the undertaking is so vast.

Second, our research group [e.g. Liu 1997] tried a pure-alternation based approach and found that it was not adequate for defining Mandarin verb classes. There are several possible reasons for this. The first is that diathesis alternations have not been extensively studied in Mandarin, unlike English, where as Levin notes, several important studies were done on the verbs *cut*, *hit*, *break* and *touch* prior to her own work. The second reason has to do with the vastness of the enterprise as we mentioned above. How does one decide which verbs to compare? How does one decide which alternations are relevant? The third possibility is that Mandarin differs from English in such a way as to make alternations a non-viable option for prying into a verb's relevant semantics. Liu [1997] argued that that verb alternations are not suitable for extracting semantic generalizations from syntactic behavior in Mandarin Chinese because argument placement is relatively flexible.

If we agree, then, that syntactic behavior can shed light on the relevant semantics of a verb, and that for languages like Mandarin (if not for all other languages), diathesis alternations, while originally promising, can not move us towards a unified theory of lexical knowledge, then what other type of behavior is available?

We will concentrate on delimiting the lexical semantic distinctions between near-synonym pairs that differ slightly in both syntactic behavior and in semantics. Sometimes a semantic difference is apparent at first glance as in the case of *fang4* (put) and *bai3* (set), and sometimes it is not clear and only becomes apparent after we compare the syntactic differences, as in the case of *kuaile* 'happy' and *gaoxing* 'glad'. (We will discuss both examples further in Section 5.)

However, even in cases where there is a difference in meaning, what we are looking for is the relevant differences in both syntax and semantics; that is, along what semantic lines do these two words differ, and how is this difference related to their syntactic behavior (and vice versa)?

How do we determine these syntactic and semantic differences? The answer to this question was explained in much more detail by Tsai *et al.* [1998] and Liu *et al.* [1997]. But we will give a very brief sketch here. First, we examined these near synonym pairs by first combing the Sinica Corpus for all relevant examples of the words in question. These examples were then categorized according to their syntactic functions. Third, each instance was classified according to its argument structure type. Fourth, the aspectual type associated with each verb was determined, and fifth, the sentential type for each verb was also determined. We found that near synonyms usually have several cases of complementary distribution of syntactic functions. It is often these cases of complementary distribution that allow us to formulate a hypothesis concerning the relevant nature of their semantic differences.

3. Assumptions

We share the following assumptions with some of the recent works on lexical semantic theories. The first assumption is that lexical semantic contents are mapped to the morphosyntactic level and can be used to predict grammatical behavior [e.g. Dowty 1991, Levin 1993, Goldberg 1995]. What is crucial behind this assumption is that a mapping must be rule-governed and regular by definition. Hence, the assumption entails the idea that lexical semantic generalizations are not only worth studying, but that they can also be verified by means of grammatical realizations.

The second assumption is that lexical semantics exists on the grammatical level that mediates conceptual structures with grammatical representations [e.g. Bresnan and Kanerva 1989, Zaenan 1993, Pustejovsky 1995]. In other words, lexical semantics not only can be empirically verified through grammatical predictions, but can also be justified by means of conceptual arguments.

In fact, we will take the second assumption further and make it our premise that lexical semantic representations are the grammaticalization of conceptual information. Based on the above assumptions, we propose that an adequate theory of verbal semantics must have the three following properties: direct representation, conceptual motivation, and representational clues.

First, lexical semantic information must be represented in a way that can be linked directly to grammatical structures. We assume that such a representation in verbal semantics must be based on event structure. Second, lexical semantic information must have conceptual motivation. This justifies the inclusion of such information as qualia structure in lexical semantics [Pustejovsky 1995]. Third, all lexical semantic attributes must be attested by representational clues: either collocating structure, selectional constraints, or distributional patterns. This last premise is especially important because it restricts the type of evidence that may be brought to bear on the question of whether something shares a particular attribute or not, and it limits the possibility of ad-hoc explanations. That is, it strongly focuses analyses in verbal semantics on corpus-based approaches since representational clues are best extracted from corpora.

In particular, in our work on lexical semantics, we have concentrated on exploring the semantic and syntactic differences between near synonyms in the Sinica Corpus. We have examined near synonyms in order to extract the contrasts that dictate their semantic and associated syntactic behaviors [Chief *et al.* 2000, Huang *et al.* 1999, Liu *et al.* 2000, and Tsai *et al.* 1998]. Conceptually, each group of near synonyms that we study forms a contrast set that is a constituent of a semantic field [Grandy 1992]. Our goal is to locate the linguistic relation that defines the contrast. In particular, we look for the semantic relation that can predict the difference in grammatical behaviors of the set. It is our strong hypothesis that syntactic variations, including Levin's [1993] alternations and morpho-semantic variations, can be predicted by logical implicatures of the semantic attributes encoded on the event structure of each verb.

4. Model-Attribute Representation

In the Module-Attribute Representation of Verbal Semantics (MARVS), lexical knowledge is classified into two types: structural information is represented by means of the composition of atomic modules while content information is represented by means of attributes attached to these modules.

First, the overall shape of event structure is defined by the composition of five *Event Modules*. The roles that participate in the event are represented in the *Role Modules*. The semantic attributes pertaining to the whole event are called the *Event-Internal Attributes* and are attached to the event modules. The semantic attributes pertaining to each role are termed *Role-Internal Attributes* and are attached to the appropriate role within the role

module. A sketch of the representation is given in Figure 1.¹

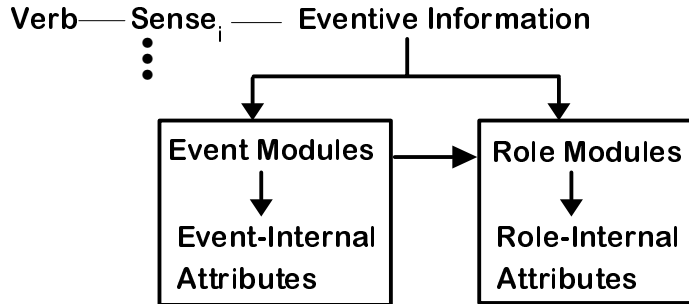


Figure 1 Module-Attribute Representation

It is important to note that the eventive information is attached to the sense of a verb. Verbs with different senses will have different eventive information.²

The second important hypothesis of this proposal is that the event representation of a verb is the sum of all attested event realizations of a particular verb. In other words, it is possible that a complex lexical event representation is never fully instantiated,

¹ In a prior version of the theory, there were only attributes: aspectual attributes, event-internal (inherent) attributes, role attributes, and role-internal attributes. The original definition is given below [Huang and Tsai 1997, Huang 1998].

- 1) Aspectual attributes: attributes pertaining to the composition of the event(s), such as Telicity, Homogeneity, etc.
- 2) Event-internal attributes: attributes referring to the semantics of the event itself, such as Control, Effect, etc.
- 3) Role attributes: attributes referring to the focussed roles of the event, such as Agent, Theme, Instrument, Manner, etc.
- 4) Role-Internal attributes: attributes referring to the internal semantics of a particular focused role (of the event), such as sentience, volition, affectedness, etc.

However, as the theory progressed, the aspectual attributes became more and more well-defined, and five basic event types were found to occur and reoccur when discussing the semantic differences among verbs. These 'atomic' event structures were then found to combine in certain ways, and as a result of their ability to combine, these aspectual attributes grew or graduated to a 'module' level.

Then the event-internal attributes were surmised to be associated with the event structure of the verb and so, were linked to this module. The close relationship between the role-internal attributes and the role attributes was also noted, and the importance of participant roles in other theories, such as Construction Grammar [Goldberg 1995], led us to postulate a role module. It was also noted that these roles may also be considered atomic roles, which then may combine to create a role module, similar to the way atomic event structures combine, when necessary, to create the event module. We feel, however, that the inventory of role modules still needs to be made more comprehensive and precise, and we will look at this in future studies.

² Ahrens *et al.* [1998] gives a working definition and criteria for distinguishing between senses of nouns.

although each component is linguistically attested. This hypothesis is motivated by our desire to maintain the theoretical elegance of one-to-one mapping between verbal sense and event representations. It is also conceptually motivated by the fact that the same verb form is often used in natural languages to refer to different aspects of an extended event. For instance, the activity of 'sitting down' and the state of 'be sitting' share the same verb form. Similarly, in Chinese at least, the activity or 'putting on' and the state of 'wearing' some piece of clothing share the same verb form. Since they have different (logical) event structures, previous theories have had to treat them as homophones. However, the conceptual tie is so salient that we feel it is counterintuitive to assign them to two different senses. We postulate that there will be conceptual/cognitive motivations to encode such complex event structures with one representation. Hence, the contrastive event realization can be understood as different (partial) realizations of the same complex event under a particular event focus, and not as two senses.

The third crucial premise in this representation is that the event modules constitute the basic frame of verbal semantics. By establishing a the two-way distinction between modules and attributes, we assume that modules refer to pre-packaged semantic information while the attached attributes give more a detailed description. The two types of modules also represent the two basic atomic terms in formal semantics: event and individuals. However, individuals are understood in the context (i.e. events) in which they participate. Figure 1 shows clearly that role modules are attached to the event modules. There is strong motivation for such a representation: first, role modules represent the participants of the event; thus, they cannot stand outside of the event representation; second, the participating roles can be partially predicted by the event types; finally, hierarchical constraints can be entailed, as will be discussed later (Section 4.3).

In what follows, we will first discuss event modules, and then the event-internal Attributes that are associated with the event modules (Section 4.1). Then, we will discuss the role modules and the role-internal attributes that are associated with these modules (Section 4.2).

4.1 Event Modules

A central issue in lexical semantics, especially verbal semantics, is the representation of events [e.g. Jackendoff 1983 and Pustejovsky 1991]. A tradition shared by philosophical and linguistic semantics, as well as the cognitive sciences, is that there are only two basic types of entities: events and individuals. Hence, a language must conceptually describe both events and individuals. Individuals are prototypically denoted by the referential properties of nominals while events are denoted by verbs. Thus, an adequate theory of verbal semantics must include a theory of event structures. Of course, all semantic

theories must also account for type-shifting and semantic coercions, such as the telic and agentive structures in Pustejovsky's [1995] nominal semantics.

In this section, we will concentrate on the basic building blocks of our verbal semantic theory. In particular, we will propose a theory in which event structures can be created from a small set of event modules and the backbone of verbal semantics can be taken to be combinations of these event modules. This account is crucially different from the autonomous view of event structure [e.g. Vendler 1967] or the attribute-value view [Jackendoff 1983]. It shares some assumptions with Smith [1991], such as the viewpoint focus interpretation of aspectual facts. However, our modules and rules of combination are different.

4.1.1 An Inventory of Event Modules

Event modules are the building blocks of linguistic event structures. They can be used in combination or alone. When used alone, they are atomic logical event structures. We list five atomic event structures below, along with their associated symbols. A brief explanation follows each event structure.

Atomic Event Structures

- (1) • Boundary (includes a Complete Event)

Boundary is an event module that can be identified by means of a temporal point and must be regarded as a whole.

- (2) / Punctuality

Punctuality is an event module that represents an single occurrence of an activity that cannot be measured based on duration.

- (3) ///// Process

Process is an event module that represents an activity that has a time course, i.e., that can be measured in terms of its temporal duration.

- (4) _____ State

State is a homogeneous event module in which the concept of temporal duration is irrelevant; i.e., it is neither punctual nor does it have a time course.

- (5) ^^^^^ Stage

Stage is an event module consisting of iterative sub-events.

In sum, we postulate that these five atomic event structures are the only building blocks necessary to capture the range of complex linguistic event structures.

4.1.2 Tests for Event Modules

Since event modules are logically and conceptually primary units, each event module has logical entailments that can be attested based on their grammatical behavior and/or their interpretation. A partial list of their verifiable entailments follows.

First, only boundaries (including stand-alone complete events) can be identified with a temporal point, such as in (6).

(6) *Complete event vs. other events*

- a. *Sheme shihou V (le)*
When V ASP
- b. *Sheme shihou kaihui (le)?*
When meeting
'When does the meeting (start)?'
- c. **Sheme shihou dasuan (le)?*
When plan

Second, since process encodes a time course, a durational phrase naturally measures the length of the time course and can distinguish between process events and boundary/complete events, as (7) and (8) show.

(7) *Process vs. Complete Event/Boundary*

- V le Duration
- V ASP Duration

- (8) a. (**yizhi si*)
always die
- b. (*yizhi pao*)
always run
'(She has been) running continuously'
- c. (**yizhi si si le san ge xiaoshi*)
always die die ASP three CL hours
'(He's) been dead for three hours.'
- d. (*yizhi pao pao le san ge xiaoshi*)
always run run ASP three CL hours
'(He has kept on) running for three hours.'

Since complete and boundary events both have a delimiting temporal point (but contain no time course), the durational phrase can only be interpreted as the distance between a reference point in time and that delimiting temporal time (i.e. the death time in (8)a&c). On the other hand, the durational phrase will be interpreted as the time course of a process ((8)b&d). The contrast in interpretation can also be demonstrated by the continuous adjunct *yizhi* 'always, keep on V-ing', which cannot co-occur with complete/boundary events (8).

(9) Stage vs. Activity

a. *ta pao-le san ge zhongtou*

s/he run-LE three CLS hour

'S/He has been running for three hours.'

b. **hua diaoxie-le san tian*

flower wither-LE three day

comp.'These flowers have been withering (on the vine) for the past three days.'

c. **shiqi miman-le san tian*

humidity permeate three day

'*The humid air has been permeating for three days.'

Third, a stage in MARVS refers to an event, which is necessarily understood as the sum of iterative sub-events. In other words, a stage as an event module means that it contains sub-events that can be distinguished conceptually, but can not be represented lexically. In contrast, an activity is holistic and can only be sub-divided with event-external measurements, such as time. Thus, although both event modules can be viewed as taking up temporal duration and can be used with the durative aspect (*zheng4*)*zai4* to refer to overlapping time, only an activity can be temporally measured (9a). This is because stage refers to equilibrium (e.g. *mi2man4* 'to permeate') or a constant and irreversible tendency towards a state (*diao1xie4* '(plants) to wither') involving dynamic or iterating sub-events. In other words, this event describes homogeneity achieved through dynamic iteration. Thus, it is predicted to exhibit some activity-like behavior and some state-like behavior, but to also differ crucially from either event types.

4.1.3 Typology of Lexical Event Representations

In this section, we present three different types of event structures that are encoded on Chinese verbs: atomic, bounded, and composite events that are made up of one or more of the five atomic event structures. Note that we propose and follow the strong hypothesis that each sense of a verb form encodes a unique eventive information representation. Hence, each meaning realization can focus on different elements of that encoded event information but cannot refer to a different event representation. This is the

One-Event-Representation-per-Sense hypothesis. Lexical event representations can be classified based on the complexity of their component event modules into three types: Nucleous, Bounded, and Composite event representation.

In this theory, event structure modules are events that cannot be further divided. Our claim is that human linguistic representation of events does not necessarily correspond to these logical and atomic events. We assume that conceptual and cognitive motivations require that certain event module combinations be perceived as a whole, and thus be mentally and linguistically represented by a single event structure with compositional modules. In other words, we are proposing a non-homomorphism between logical event structure and (human) linguistic event structure. We will focus our discussion on the linguistic event structures since they are conceptually more interesting.

4.1.3.1 Atomic Event Representation

The verbs listed below in (10) have stand-alone event modules.

(10) a. *Completion (achievement)*

- *si3* 'to die', *po4* 'to break'

b. *Punctuality*

- / *da3suan4* 'to plan to'

c. *Process*

- // // // // *zou3* 'walk', *pao3* 'run'

d. *Homogeneous State*

- _____ *kuai4le4* 'to be happy', *pi2juan4* 'to be tired'

We have not found any examples yet of the stage event module standing alone in a verb in Mandarin. However, our hypothesis is that this list of atomic events will not grow past the five listed in Section 4.1.1 for any language.

4.1.3.2 Bounded Event Representations

Bounded events have one atomic event and must be bounded at at least one end (but may be bounded at both ends). The verbs listed in (11) encode both a boundary and an associated non-instantaneous event.

(11) a. *Inchoative Process*

- // // // *xia4yu3* 'to rain', *kai1hui4* 'to convene a meeting'

b. *Bounded process*

- /llll• *gai4* 'to build'

c. *Resultative*

- /• *da3si3* 'to hit and kill'

d. *Completive Punctuality*

- *chu4fal* 'set forth', *bi4ye* 'graduate', *li2kai1* 'go away'

e. *Inchoative State (Effect State)*

- ____ *gao1xing4* 'to be glad'

f. *Inchoative Stage*

- ^^^^ *shang4sheng1* 'to rise'

g. *Bounded Stage*

- ^^^^• *diao1xie4* '(flowers) to wither'

We think we have exhausted the combinations of boundary events with the list above for Mandarin Chinese. Other languages may have other combinations.

4.1.3.3 Composite Event Representations

Composite events involve more than one atomic event (and may or may not be bounded). Two examples are given in (12). We expect this partial list of complex events to grow with further study of both Mandarin verbs and verbs in other languages.

(12) a. *Completive Resultative*

- / ____ *zuo4* 'to sit', *tang3* 'to lie [down]', *bao1wei2* 'to surround'

b. *Dual Process-State*

- /llll• ____ *chuan1* 'to wear', *dai* 'to wear'

Let us take a closer look at the verb *zuo4*. In (13a), the focus is on punctuality while in (13b), the focus is on state. In (13c), the focus is on the length/duration of state as delimited by the punctual event and a reference point. In (13d), the focus is on the manner of the state, with an implied (controllable) punctual event that could change the state.

(13) a. *zuo*

sit

'Sit [down]!, Be seated!'

- b. *ta zuo qianmian*
 s/he sit front
 'S/He is seated in the front.'
- c. *ta zuo le san ge zhongtuo*
 s/he sit ASP three CLASS hour
 'S/He has been sitting for three hours.'
- d. *haohao zuo*
 well sit
 'Sit straight!'

4.1.4 Event-internal Attributes

In our module-attribute representation, Event-internal attributes are linked to the event structure modules (when necessary). Event-internal attributes refer to the semantics of the event itself, such as [control], [effect] etc. Example (14), for example, shows that the two verbs *gaoxing* and *kuai* differ in terms of the attribute of control [see Tsai *et al.* 1998 & 1999 for more details about this relationship].

(14) [control]

*bie gaoxing/*bie kuai*
 NEG happy /NEG happy
 'Don't be happy.'

4.2 Role Modules

Role modules contain the focussed roles of an event and typically include all required (i.e., thematic) arguments but can also include optional arguments and adjuncts. The roles that we have considered are the following: Agent, Cause, Causer, Comparison, Experiencer, Goal, Instrument, Incremental Theme, Location, Locus, Manner, Range, Recipient, Source, Target, Theme, etc. We will illustrate how this module works with an optional argument. In example (15a), the focus is on an incremental theme; therefore, the measure phrase describes the resulting number of cuts. However, in (15b), there is no such focus; therefore, the measure attached to the cognate object describes the frequency of the activity

- (15)a. *ta ba shoubi gele shijidao yi shi juexin*
 s/he BA arm GE-PERF ten-plus-knife so show resolution
 'S/He made more than ten cuts on his/her arm to show his/her resolution.'

- b. *zai qindi shenshang kanle wushiliu dao*
 at love-foe body-top KAN-PERF 56 knife
 '[The person] hacked his/her rival in love affair 56 times.'

4.2.1 Role-Internal Attributes

These attributes refer to the internal semantics of a particular focused role (of the event), such as [sentience], [volition], [affectedness], [design] etc.

In (16), we give an example of the role internal attribute of [design]; when attached to the role Loc, it implies that the role can be specified based on orientation.

(16) *Role-Internal Attribute Loc [design]*

- a. *na ge taishiyi bai dongbian/zhao dong bai*
 that CLS easy-chair set east-side/towards east set
 'Put that easychair so that it faces east.'
- b. **na ge taishiyi fang dongbian/zhao dong fang*
 that CLS easy-chair put east-side/towards east put

Some readers might wonder what the difference is between role-internal attributes and the selectional restrictions placed on lexical items that previous versions of transformation theories postulated. This issue was addressed by Huang *et al.* [1999], who showed that alternative interpretations in a context can be accounted for by means of role-internal attributes but not selectional restrictions. Role-internal attributes interact with (context-induced) meaning to determine the appropriate reading while selectional restrictions are projected from a fixed lexical entry. From an informational point of view, role-internal attributes are information-bearing and declarative (i.e., directly specify knowledge about the semantics of that role). On the other hand, selectional restrictions are passive grammar-checking mechanisms.

4.3 Hierarchical Constraints

All conditions being equal, a higher-level module (i.e., event structure module) or attribute (i.e., event-internal attribute) is preferred for the sake of generality and greater explanatory power. For instance, [control] will be preferred over [volition] if both offer an equally adequate account since [control] is an event-internal attribute belonging to the whole event; on the other hand, [volition] is a role-internal attribute describing a participant of an event. If volition can be predicted by a [control] event-internal attribute (and it usually can), then there is no need to list volition again in the role-internal attribute. The [control] event-internal attribute will predict volition through the semantic relationship of implicature. However, if hypothetically a verb has the attribute [control] but has a

non-volitional subject, then there is a place in the role-internal attribute to indicate that fact, and the usual implicative relationship between [control] and [volition] will be cancelled.

In addition, when a set of near synonyms includes a covering term of a field, then the grammatical contrast is weakened to a marked/unmarked situation. That is, the covering term, as a unmarked element, can substitute for its near synonym in many cases. It simply has a wider range than its near synonym. In this case, the lack of clear-cut contrasts does not affect the legitimacy of a defining relation. Another near synonym forming a contrast set should be substituted to verify the claim. For instance, not all predicted grammatical contrasts demonstrate themselves between *ge1* 'to slice' and *qie1* 'to cut [covering term]'. But when *ge1* is contrasted with *ci4* 'to stab', the proposed contrasting relation of [effect] is clearly evident.

5. Research Methodology and Case Studies

In this section, we will show that cross-category generalizations can be captured by delimiting the lexical semantic distinctions between near-synonym pairs. We will illustrate, with four case studies, the correlation between lexical semantic specifications and event-structure attributes.

5.1 Research Methodology

Our research methodology studies on Chinese lexical semantics have produced an approach that is different from traditional approaches. First, it is corpus-based. In other words, we emphasize observations and generalizations based on qualitative and quantitative studies of actual language use. Second, we target near synonym pairs as our initial focus. In targeting near synonyms, we in effect restrict our scope to a semantic field for each study. In addition, near synonym pairs are often (minimal) contrast sets in the theory of semantic fields [Grandy 1992]. Through a comparative study on a contrast set as well as its grammatical consequences, we will be able to identify the critical semantic element(s) that distinguish contrast sets. Since contrast sets are lexical items that differ minimally semantically, the semantic elements identified should be the primary semantic elements that need to be represented in a lexical semantic theory.

Our research methodology involves three consecutive steps: 1. Make generalizations about grammatical relation contrasts based on distributional differences observed and/or extracted from corpora. 2. Deduce event structure elements that would predict the above generalizations (by examining the semantic implicatures of such elements). 3. Verify these elements by applying them to new syntactic/semantic frames.

This last step is the only one that uses linguistic intuition to generate ungrammatical sentences to test our hypothesis. During all these three steps, the following corpus-based distributional information is our primary data:

1. the syntactic functions that a verb can play,
2. the argument number and types that a verb can take,
3. the aspectual types that a verb can associate with,
4. the sentential types that a verb can occur in, and
5. the types of arguments that a verb integrates with in compounds.

How the above information can be used in argumentation will be illustrated in the following subsections.

5.2 Case Study 1: *bai3* vs. *fang4* - Event Structure Focus

Both *bai3* and *fang4* are verbs of putting, and they seem to be synonymous and exchangeable in certain contexts.

- (17) a. *bai/fang qizi*
 set/put chess-piece
 'to put down chess pieces'
- b. *bai/fang yizi*
 set/put chair
 'to put down chair(s)'

However, there are distributional differences between *bai3* and *fang4*: *bai3* can co-occur with progressive *zheng4zai4* to describe a process, but *fang4* cannot (18); *bai3* can take a resultant object, but *fang4* cannot (19); and *bai3* can be modified with an orientational adjunct, but *fang4* cannot (20).

- (18) a. *ta zhengzai bai shu*
 s/he DUR set book
 'S/He is putting down the books now.'
- b. *?ta zhengzai fang shu*
- (19) a. *mama baichu yi zuo cai*
 mother set-out one table dish
 'Mother (cooked) and set a tableful of dishes.'

- b. **mama fangchu yi zuo cai*
 mother put-out one table dish
- (20) a. *na ge taishiyi bai dongbian/chao dong bai*
 that CLS easy-chair set east-side/towards east set
 'Put that easychair so that it faces east.'
- b. **na ge taishiyi fang dongbian/chao dong fang*
 that CLS easy-chair put east-side/towards east put

The above three contrasts, attested by corpus data, point to a crucial difference between the meanings of *bai3* and *fang4*, which is that *bai3* entails that the act of putting follows a certain plan, and therefore that the orientation of the placed object can be specified while only location can be specified for *fang4*. In addition, since the plan which the putting action follows entails a resultant state to be attained, *bai3* can take a resultant object while *fang4* has no such entailment and cannot take such an object. Third, following a plan implies that *bai3* involves a process that can be broken down into constituent steps while *fang4* is a simple activity. Thus, only *bai3* can be attached with a progressive aspect referring to internal steps being carried out.

Based on the above contrasts and generalizations, we propose that the lexical semantic attribute that differentiates *bai3* and *fang4* is the role internal attribute of [design]. By [design], we mean a plan that the actor is cognizant of when s/he carries it out. This feature not only affects the interpretation of the two verbs. It also entails that only *bai3* can take an incremental theme as an object (the resultant object in (19)) as well as the aspectual and adjunct constraints described above.

One immediate implication of this account is that all idioms or compounds involving a [design] scheme can only be composed using the verb *bai3*, not *fang4*. This is confirmed by the following idioms/compounds involving setting up a scheme or taking on a certain (affected) attitude:

- (21) a. *bai jiazi*
 set-shelf
 'to put on airs'
- b. *bai SOMEBODY yi dao*
 set - SB - one - CLS
 'to set someone up once'

c. *bai ditan*

set-ground-spread

'to set up a street vending position (by spreading a piece of cloth on the ground)'

d. *bai kuo*

set-rich

'to show off one's wealth'

The above idiom/compound evidence not only offers additional support for the [design] attribute, but also strongly suggests the position where this attribute should be attached. *A priori*, the role internal aspect of [design] attribute describes the resultant location. However, since it affects the collocation of aspects, there are also motivations for arguing that it is represented at a higher level. However, an account of the above data makes it necessary for the [design] attribute to be present at the locative object. It is the lexical semantic specification of [design] on the locative object that allows the above compounds and idioms to acquire the 'affected attitude' or 'planned scheme' meaning. To account for its interaction with an aspectual specification, our analysis leads us to propose that the locative object (together with the [design] attribute) receives an Event Structure Focus. Thus, even though the attribute is Role-Internal, it is also 'visible' and can interact at the event structure level. Our account can be shown in MARVS by the following diagram (with irrelevant parts omitted). Take note that the roles are listed within angled brackets while focused roles are indicated by boldface type. Unspecified attributes simply are not represented.

Diagram 1

MARVS for *bai3* and *fang4**bai3* • ____ <Agent, Theme, **Location**>

|
[design]

fang4 • ____ <Agent, Theme, Location>

In conclusion, we want to point out that the [design] feature is not only useful for accounting for the lexical semantic differences between the members of the current pair, but it can also be applied to other pairs where the notion of a certain design is inherent in the verb. Two additional examples are *dui1* 'to pile' vs. *fang4* again and *hua4* 'to paint, to draw' vs. *tu2* 'to cover with paint, to doodle.'

5.3 Case study 2: *peng4* vs. *mo1* - Motional Path

The next pair of near synonyms *peng4* and *mo1* are verbs of touching. At first glance, they seem to differ mostly in the force used: *peng4* refers to all types of touching while *mo1* seems to be restricted to light touching with fingertips, such as caressing. However, there are additional grammatical contrasts that cannot be explained by this simple difference in degree of force.

First, it is observed that durative *-zhe* can only co-occur with *mo1*, not *peng4* (22). Similarly, only *mo1* can take a durational complement; *peng4* cannot (23).

- (22)a. *xiaohai mo-zhe bizi*
 child touch-DUR nose
 'The child is touching his/her own nose.'
- b. **xiaohai peng-zhe bizi*
 child touch-DUR nose
- (23)a. *Ta mo le bantian, (sheme ye mei mo dao)*
 s/he touch PERF half-day what YE NEG touch reach
 'S/He groped for a long time but did not touch anything.'
- b. **Ta peng le bantian, (sheme ye mei peng dao)*
 s/he touch PERF half-day what YE NEG touch reach

The two sets of contrasts suggest that *peng4* denotes an instantaneous activity, and that its motional path ends with a focus on one impact point while *mo1* denotes the activity of touching with a focus on either continuous contact or the motion towards touching. In other words, *mo1* has a time course while *peng4* does not. This generalization can be nicely captured by using two of the proposed event modules: Process for *mo1* and Punctuality for *peng4*. To account for the fact that durational phrases are interpreted as a temporal distance from the beginning point of the *mo1* activity (23a), its event structure will include a beginning boundary. Thus, *mo1* is of the Inchoative Process event type while *peng4* is of the Punctuality type.

Another important piece of semantic information that needs to be encoded is that both verbs involve a (motional) path. Following tradition in this field, path is not explicitly marked. Instead, its presence is implied by either goal or source roles (or both). In agreement with other spatio-temporal expansion of an event, we will treat path as an embedded sub-event. This will allow us to describe path and other spatio-temporal elaboration of an event by using established theories of event structures. In this particular case, *mo1* has a path that is underspecified while *peng4* has a path specification with a focus on its single endpoint. In addition to the above contrasts, this is attested to by the

fact that the goal of *peng4* is more definite and can occur as either an effective object or as the subject of a presentative sentence, as in (24a) and (24b), respectively.

- (24) a. *ta (tou) peng-le san-ge bao*
 s/he head bump-PERF three-CLS bumps
 'S/He bumped three bumps (in the head).'
- b. *chezi peng-le yi-ge da dong*
 car bump-PERF one-CLS big hole
 'There was a big hole in the car as a result of bumping (into something).'

In a formal representation, we will stipulate that the terminus of the Path of *peng4* (i.e., the Goal role) be definite (i.e. role-internal attribute). Thus, formally speaking, the pair of verbs contrast in their lexically specified event contours which are specified at both the event structure and the role-internal levels. The above account can be formally represented as follows:

Diagram 2

MARVS representation of *peng4* and *mol*

Peng4 / <Agent, Goal>
 |
 [definite]

mol •//// <Agent, Goal>

Our account suggests that the event contour will be necessary to in account for contrasts of other verbs of contact, such as *ji3* 'to squeeze' vs. *yal* 'to push down', and *an4* 'to press down' vs. *yal* 'to push down'.

5.4 Case Study 3: *gai3* vs. *bian4/ ban1* vs. *yi2* - The Causative Alternation

The third contrast involves a pair of 'change' verbs: the 'change of state' verbs *gai3* 'to revise' and *bian4* 'to transform' as well as the 'change of position' verbs *ban1* 'to move (something)' and *yi2* '(something) moves'. This contrast is commonly seen with similar verbs in other languages, where theme (i.e. the entity that changes) occurs in the objective position with one set of verbs and in the subjective position with another set of verbs. This alternation is referred to in the literature [e.g., Levin 1993] as causative alternation. Typically, the theme occurs in the subjective position for *bian4* and *yi2* and in the objective position for *gai3* and *ban1*. For instance, 85% of all occurrences of *ban1* in Sinica Corpus have an explicit theme object while 80% of the occurrences of *yi2* have a single theme subject. Illustrative examples are given below.

(25) a. *laoshi gai le san pian zuowen*
 teacher revise PERF three CLS writing
 'The teacher corrected three writing assignments.'

b. *tianqi bian le*
 weather transform PERF
 'The weather changed.'

(26) a. *ban-chu liang zhang yizi*
 move-out two CLS chair
 '[someone] moved two chairs out.'

b. *shitou yi(dong) le*
 stone move(move) PERF
 'The stone moved.'

Since causative alternation has been thoroughly studied in the literature, we will follow previous works and characterize the contrast as directly involving event-structures. In other words, the causative verb will have a unique (complex) event-contour represented as being composed of two event modules linked by a causative transition. Without such a specification, the non-causative counterpart will be a simple change of state event. Such a specification will predict all observed contrasts of the two pairs of synonyms. Since causation entails a volitional causer, the 'causative' verbs are [+control] and can occur in imperative construction (27). Since simple change of state verbs focus on the transition of changing, they are achievement verbs that do not take durational complements (28). Lastly, since causative verbs are willed by the causer, the direction of change is implied to be for the better (e.g. to correct), but simple 'change' verbs have no such implication (29).

(27)a. *kuaidian ban*
 hurry-up move
 'Move [the things] faster.'

b. *manman gai*
 slowly revise
 'Revise/correct slowly (and carefully).'

(28)a. **tianqi bian le san xiaoshi* [with the intended interpretation of
duration of activity]

weather transform PERF three hours

b. **taiyang xiang xi yi le yi ge zhongtou*
 sun toward west move PERF one CLS hour

- (29)a. *qingkuang bianhao/huai le*
 situation chang-good/bad PERF
 'The situation has improved/worsened.'
- b. *Ni zhege maobing yiding yao gai*
 you this shortcoming must want change
 'You must improve by getting rid of this shortcoming.'

The above contrasts clearly show that the lexical semantic specification of causative event-transition has many more implications than do the simple argument structure changes previously studied. For instance, the current explanation allows lexically specified direction of change-of-state, where *gai3* specifies a change of state for the better, while *bian2* has no such specification. Our study will show again how a lexical semantic attribute can be a powerful explanatory tool.³

5.5 Case Study 4: *qie1* vs. *ge1* - Manner

Last, we will look at the verbs of cutting *qie1* 'to cut' and *ge1* 'to slice' again. Huang and Tsai [1997] studied this near synonym pair and claim that the contrast is that *ge1* has the inherent attribute of [effect] and hence will take an incremental theme object while *qie1* cannot. The inherent [effect] attribute also allows prediction of the fact that cognate objects following the verbs are interpreted as results for *ge1* but as measurement for *qie1* (30 & 31).

- (30) *ta ge-le yi kuai rou*
 s/he GE-PERF 1-CLS meat
 'S/He made a slice of meat.'
- (31)a. *ta ba shoubi gele shiji-dao yi shi juexin*
 s/he BA arm GE-PERF ten-plus-knife so show resolution
 'S/He cut more than ten cuts on his/her arm to show his/her resolution.'
- vs. b. *zai qing-di shen-shang kanle wu-shi-liu dao*
 at love-foe body-top KAN-PERF 56 knife
 '[The person] hacked his/her rival in love affair 56 times.'

However, the [effect] account may not offer a complete and sufficient lexical semantic explanation. We also observe that there is a fundamental difference in manner between the two verbs. That is, *ge1* entails a careful, traceable movement that has an inherent time-duration while *qie1* denotes a movement whose manner is not specified;

³ We will not give a MARVS representation for the verbs in this section. The MARVS representation of linked events, such as causative, purposive etc., are still being developed.

thus, neither is its time-duration. When *ge1* co-occurs with a durational complement, it is more likely to interpret the duration as one single movement of *ge1*; when a durational complement co-occurs with *qie1*, it is interpreted as the cumulated time of consecutive episodes of *qie1*. The emphasis on manner may help to explain why there are far more descriptive VR compounds with *ge1* than with *qie1*. The above account is translated into a MARVS representation in Diagram 3. Note that the syntactic realization can have either a complete set or a subset of roles found in the lexical semantic representation (cf. Example 30, which only has two roles).

Diagram 3

MARVS representation of *ge1* and *qie1*

ge1 •//// • <Agent, Theme, Manner>
 |
 [effect]

qie1 •//// • <Agent, Theme>

In sum, the emphasis on manner, as an event-internal attribute of the verb *ge1*, also contributes to account for the contrast between the two near synonyms. This observation suggests that we should look into how different lexical semantic attributes can conspire to produce the same grammatical entailments. Whether they can also contradict or even cancel each other out will be another interesting topic for future studies.

5.6 Summary

First, the observed grammatical contrasts between *bai3* 'to set' and *fang4* 'to put' show that *bai3* specifies positioning with structural/spatial design' while *fang4* names simple positioning. The feature [design] inherent in the meaning of *bai3* leads to a crucial implication about the aspectual focus of its event structure; namely, *bai3* is focused on the result-state, the durative state resultant of the event of *bai3*. This, in turn, explains the corpus-based collocational patterns associated with *bai3*.

Second, the grammatical contrasts between *peng4* 'to touch, bump' and *mo1* 'to touch, caress' are found to be significant with regard to event contour. To be specific, *peng4* specifies (as a sub-event) a motional path ending with a fixed boundary. Event contour specifications may in turn account for polysemic extensions of many subclasses for verbs of contact.

Third, both "change of state" verbs (*gai3* 'to revise' vs. *bian4* 'to transform') and change of position' verbs (*ban1* 'to move (something)' vs. *yi2* '(something) moves') share

a causative event-transition attribute. The attribute explains the differences in argument structure as well as in lexical implications (i.e., 'positive or motivated change' for *gai3*; 'upward detachment' for *ban1*).

Finally, the manner distinction between *qie1* 'to cut' and *ge1* 'to slice' has a consequence for the interpretation of their object-role. The careful, traceable, and time-consuming movement inherent in *ge1* enables it to take an incremental theme as its object, and allows it to be combined in ditransitive VV compounds where the incremental theme is transferable (an alternative explanation to that of Huang and Tsai 1997).

Altogether, the four cases serve to illustrate one point: generalized event structure attributes derived from lexical meaning contrasts can be utilized to categorize and represent verbal information across natural classes, which is crucial for obtaining an explanatory account of Mandarin verbal semantics.

6. Conclusion

In this paper, we have set out the underpinnings of our new representation of lexical knowledge, known as the Module-Attribute Theory of Verbal Semantics (MARVS). This theory incorporates and supercedes the earlier versions proposed by Huang and Tsai [1997] and Huang [1998]. In this theory, the event contour (i.e., the aspectual information) is represented using the composition of five atomic event modules, which can be combined to form a complete event representation. In addition, event participants are represented using role modules. It is worth noting that the range of roles is wider than that which is traditionally covered by theories of predicate-argument structures. Crucially, our role modules represent all participant roles that semantically contribute to the event content and have grammatical consequences. In other words, the roles that are traditionally termed optional arguments or adjuncts can be represented in the role modules as long as there is evidence showing their contribution to the verbal semantics of the verb. In addition, semantic attributes can be added to the backbone of event structure (event-internal attributes) and roles (role-internal attributes) to elaborate the lexical semantic information

Based on the hierarchical inheritance relation, we postulate that some of the attributes can be predicted with logical implicatures based on the modules they attach to. In addition, role modules can be partially predicted with event modules. In other words, only the attributes that are not logically implied need to be lexically specified.

We adopt a strong hypothesis built upon the above premise of the encoding of eventive information: that each sense of a lexical verb is uniquely identified with an

eventive information representation. This follows from the premise and the lexicographic convention of treating a sense as a (prepackaged) information unit. Two theoretically significant consequences of this hypothesis are that there must be a clear-cut criterion to identify verbal senses, and second, that lexical event encoding must allow variations at the realization level. First, the simple criterion is that meanings that cannot be represented by the same event structure must belong to different senses. Second, a verbal semantic puzzle that has not been fully accounted for is that the aspectual type/event classification of a bare verb can often be changed when it co-occurs with certain complements/adjuncts. This poses a dilemma for the lexical representation of eventive information. On one hand, if a sense is not identified with a unique event structure, then this variation seems to force either complex and ambiguous event encodings on each lexical verb or contextual encoding of event information. On the other hand, if the one event structure per sense principle is adopted, then this fact seems to suggest superfluous lexical ambiguity by predicting as many senses as possible event type realizations.

Our study has shown that this dilemma is unnecessary. Human lexical conceptualization does not necessarily stop at a logical event unit (such as Vendler's activity, state, accomplishment, or achievement). In other words, lexical conceptualization can integrate the complex course of an event, possibly by including many elements of the above classifications. The whole integrated event representation will then be the lexical meaning of the verb. However, when grammatically realized, the focus can fall on part of that complex and complete event representation, and the verbal semantics can be projected to one of the typical event classes.

Two crucial assumptions of such explanation are that these focused sub-events do not contradict each other, and that the sum of the realized events can be conceptually motivated and formally represented. In other words, an activity *run* (as in 'he is running') and an accomplishment *run* (as in 'he ran two miles') belong to the same sense and share the same lexical eventive representation. Speakers focus on different aspects of the same event structure, the first one on the activity part but the second on the endpoint.

A similar approach can be taken towards the problems involving so-called optional arguments and obligatory adjuncts. We do not need to worry about the relationship between each predicate argument structure and each sense. Instead, a possible set of roles can be specified based on the complete event structure as described above. Then each realization, with a different event focus, will take a subset of the encoded roles.

In sum, MARVS differs from previous attempts to understand lexical knowledge, especially those based on the interaction of syntactic-semantic information in verbs, because it analyzes near synonym pairs. It also differs in postulating event structure

modules, which may be combined to form a complex representations and may be attached to a verb.

We have examined four sets of near synonym contrasts based on the Module-Attribute Representation of Verbal Semantics. We found that both the composition of event modules and the attested lexical semantic attributes can be generalized across the natural class they belong to. This is a crucial step towards establishing an explanatory account of Mandarin verbal semantics. Our explanations not only offer support for the MARVS theory of lexical semantic representation, but also demonstrates the explanatory power of lexical semantics in a theory of (Chinese) grammar.

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