CSLI Lecture Notes
Number 174

Construction grammar offers a new framework in which to consider the consistent patterns for combining words and phrases within a language. Yet what counts as a construction as a child acquires language? How do children identify constructions? How are constructions linked to the acquisition of words and word meanings?

The study of these questions has progressed to the point where this collection of recent results is both timely and coherent. This volume covers a broad range of research on construction acquisition by children, from the earliest earliest gesture and gesture-word combinations to the production of larger syntactic constructions and complex clauses. Included are studies of languages as varied as Cantonese, English, French, German, Hindi and Mandarin.

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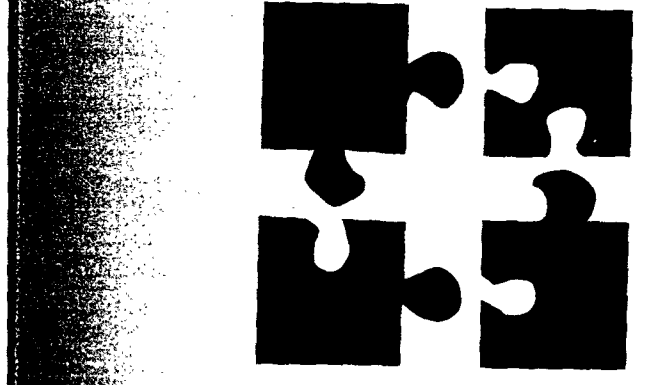

CONSTRUCTIONS *IN* ACQUISITION

edited by

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6

The Acquisition of Verb Compounding in Mandarin

JIDONG CHEN

1 Introduction

Language acquisition researchers have long been interested in how children learn the partially productive constructions[1] of a language, for example, the learning of word-formation (Clark 1993), the argument structure alternations of verbs (e.g., Bowerman 1988, Pinker 1989, Tomasello 1992). This can be seen as a more general problem of how language learners make generalizations and avoid overgeneralizations. Beyond learning verb semantics and morphosyntactic properties like word order and argument structure for individual verbs, children in the first place must discover language-specific conventions for mapping meanings onto forms, more specifically, language-specific constructions for forming new words, for example, combining verbs with other linguistic elements, such as prefixes, suffixes, particles, adjectival phrases, prepositions, and—in Mandarin—other verbs. In acquiring such combinations, the child must learn how to unpack the relevant information—to identify possible meanings, to isolate possible forms, and to map the meaning onto the possible forms, and to discover which meaning components are expressed by a verb and which by other

[1] Following Goldberg (1995), a construction, which can be a morpheme, word, phrasal combination, syntactic pattern, and so on, is defined here as a form-meaning pair such that some aspect of the meaning is not strictly predictable from its component parts or from other previously established constructions.

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elements in the construction (Bowerman 1982, Clark 1993, Pinker 1989, Tomasello 1992). This learning process is complicated by the fact that children start out not knowing what is regular in meaning-form mappings within the language, and what are conventional and what are innovative uses (Clark 1993). Given the fact that little negative evidence and formal teaching are usually unavailable in the input, it poses a basic question about how normal children eventually acquire their first language successfully.

In this chapter I discuss the learning of a very productive language-specific construction in Mandarin Chinese: verb compounding. My study focuses on two major types of Mandarin verb compounds: directional verb compounds (DVCs) and resultative verb compounds (RVCs) (Chao 1968, Li & Thompson 1981). These are the most common forms used to encode motion events and causal events in adult speech, as illustrated in (1) and (2):

(1) *Ta* ***zou-jin*** *le jiaoshi.*
He **walk-enter** PFV classroom
'He walked into the classroom.'

(2) *Ta* ***bai-duan*** *le gunzi.*
He **snap-be.broken** PFV stick
'He snapped the stick.'

Since verb compounding in adult language is very productive, it is impossible for a child to just memorize all the compounds as unanalyzed chunks. Indeed, children acquiring Mandarin have been observed to create novel verb compounds (Cheung 1992, Erbaugh 1982, 1992). This study addresses the following two research questions:

I. When and how do Mandarin-speaking children learn that verb compounding is a productive combinatorial system?

II. When and how do Mandarin-speaking children discover the constraints on Mandarin verb compounding,?

Spontaneous speech data and experimental data were examined to tackle these questions. In the following sections, I first sketch the formation and properties of Mandarin verb compounds and then present the acquisition studies on learning Mandarin verb compounding.

2 Mandarin verb compounds

Mandarin verb compounds are usually composed of two or three root verbs: V1V2(V3). There are no morphological markers to indicate the relationship between the component verbs. The ordering of these verbs is rigid and iconic, i.e., the verb encoding the end result (in resultative verb compounds) or change of location (in directional verb compounds) is always in the second or third position of a compound. There is a tight relationship between the component verbs—no lexical phrases or aspect markers are allowed to occur between them, and aspect markers always follow the last verb (cf. examples (1) and (2)).

Mandarin verb compounds instantiate a 'template' structure that has the properties of a 'construction' in the sense of Goldberg (1995): "a construction is a form-meaning pair, such that some aspect of the form or the meaning is not strictly predictable from a construction's component parts." Mandarin verb compounds—in particular, DVCs and RVCs—follow the same syntactic template, V1V2 (V3), which encodes a meaning not encoded by any one part of the template. The meanings of the parts are mapped into the syntactic template meaning compositionally. The argument structure of a verb compound is not predicable from the constituent verbs alone; rather, it reflects the combined thematic structures of V1 and V2 (Li 1990).

2.1 Composition of directional verb compounds

VCs are composed of two, or maximally three, lexical verbs, for example, *zou-chu* 'walk-exit', *pao-jin-lai* 'run-enter-come'. Verbs that appear in a DVC can be categorized into two major types according to their distributional properties (Chao 1968, Kang 1999, Li & Thompson 1981, Lu 1977, Zou 1994): an open set of verbs indicating manner (*gun* 'roll') or cause of motion (such as *reng* 'throw) or path (such as *diao* 'fall'), and a closed set of directional verbs. Manner- or cause-of-motion verbs include both intransitive verbs of self-initiated motion (e.g., *zou-jin* 'walk-enter', *fei-xia* 'fly-descend'), and transitive verbs that inherently imply that the direct object undergoes a change of location (e.g., *chui-xia-lai* 'blow-descend-come', *tui-shang-qu* 'push-ascend-go'. The directional verbs can also be divided into two types: path verbs that denote the trajectory of a movement (e.g., *shang* 'ascend' (up), *xia* 'descend' (down), etc.), and deictic verbs (*lai* 'come' and *qu* 'go'). In a DVC with three verbs (V1V2V3), the ordering of the verbs is fixed: verb of manner or cause of motion (V1), followed by a path verb

(V2), with a deictic verb at the end (V3). In a two-verb DVC (V1V2), V1 can be a manner or cause of motion verb and V2 can be either a path verb or a deictic verb (e.g., *zou-shang* 'walk-ascend', *zou-lai* 'walk-come'); V1 can also be a path verb and V2 a deictic verb (e.g., *shang-lai* 'descend-come'). Unlike the constituents of English verb-particle combinations, all the elements in a DVC (V1, V2, and V3) can be used as independent main verbs, denoting the manner or cause of a motion, the direction of the motion, and the orientation of the motion with respect to the speaker, respectively.

2.2. Composition of resultative verb compounds

RVCs are composed of two verbs, both of which may be either transitive or intransitive. V1 is an action verb indicating the cause, and V2 a verb indicating the caused change of state or caused action. V2 indicates what result the action specified by V1 has led to (McDonald 1995). The result may be a physical state like *kai* 'open', *sui* 'be in pieces'; a mental state like *dong* 'understand', *guan* 'be used to'; a quality like *cui* 'be crispy', *hong* 'be red'; or a caused action, such as *xiao* 'laugh' in *dou-**xiao*** 'amuse-laugh' (laugh by amusement), *ku* 'cry' in *ma-**ku*** 'scold-cry' (cry due to scold). Both V1 and V2 are drawn from open sets of verbs. In general, transitives and unergatives denoting activities can act as V1, while V2 is usually a stative verb, an adjective, or an action verb, as in example (2).

2.3 Productivity and semantic constraints on verb compounding

The productivity of Mandarin verb compounding shows up in several ways (Chao 1968, Li & Thompson 1981, Packard 2000, Uehara et al., 2001). First is the variety of verbs that can occur in the first (V1) and second (V2) positions of a verb compound. I noted already that verbs of different semantic classes, including both transitive and intransitive verbs, can appear in the V1 slot in both DVCs and RVCs. For example, both component verbs can be intransitive as *ku-xing* 'cry-be.awake (cry and cause someone to be awake), or transitive as *yao-shang* 'bite-hurt' (hurt someone by biting), or one transitive and the other intransitive as *ti-po* 'kick-be.broken' (break by kicking) and *pao-diu* 'run-lose' (run (so fast) as to lose someone/something). Furthermore, a same V1 can combine with different V2s, for example, *ti-kai*, 'kick-be.open', *ti-po* 'kick-be.broken', *ti-sui* 'kick-be.in.pieces', *ti-dao* 'kick-fall', and vice versa, a same V2 can combine with different V1s, for example, *si-kai* 'tear-be.open', *jian-kai* 'cut.with.scissors-be.open', *bai-kai* 'snap-be.open'.

Second, Mandarin allows not only object-oriented RVCs (similar to the English resultative construction in *He kicked the door open*, where the *re-*

sultative *open* is predicated of the object *the door*), as in example (2), but also subject-oriented RVCs where the result verb is predicated of the subject of the verb compound:

(3) *Ta$_i$ **chi$_i$-bao$_i$** le fan.*
He **eat-be.full** PFV meal
'He ate (himself) full with food.'

Third, productivity is shown by the wide range of V2s that can occur with a given V1, or of V1s with a given V2, in RVCs. Different from English resultative constructions, Mandarin allows not only "fulfillment" result but also "anti-fulfillment" (Talmy 2000, Uehara *et al.*, 2001) or even an "other event" result (ibid.). Sentences (4) illustrate such RVCs:

*(4) Wo **xi-ganjin** / **xi-zang** / **xi-po** le shoupa.*
I **wash-be.clean** / **wash-be.dirty** / **wash-be.torn** PFV handkerchief
fulfillment / anti-fulfillment / other-event
'I washed the handkerchief clean / dirty / torn.'

Xi-zang 'wash-be.dirty' and *xi-po* 'wash-be.toren" can be used in conversations for situations where someone washes a handkerchief and it turned out to be dirty or torn rather than being clean. In contrast, in English *wash* is an 'implied-fulfillment' verb that conveys a "lexicalized implicature" (Talmy, 2000): that the agent's goal in bringing about a certain result has been attained, and *wash* can only take a resultative predicate that confirms the attainment of the agent's intended goal, as in *I washed the handkerchief clean* (fulfillment). *I washed the handkerchief dirty/torn* contradicts with the implied result and lead to ungrammaticality and infelicity.

Although verb compounding is productive in Mandarin, it is a constrained process that manifest partial productivity (Gu 1992, Shen 2003, Zou 1994). Partial productivity means that a construction can be extended to additional (and even novel) verb forms, but it is not fully productive within any generally defined class of verbs, and novel extensions are acceptable only to the degree that they conform to the semantic (and morphophonological) constraints on existing clusters of strings (Goldberg 1995). This partial productivity also reflects the collective conventional preferences which mirror current perceptions of the meaning-form relations possible and available for use in coinage (Clark 1993). One general constraint

on verb compounding in Mandarin is the strict ordering of the component verbs discussed in the previous section.

Another semantic constraint is the *Unique path constraint*, to adopt Goldberg's (1991) term. She argued that there is a general constraint against specifying more than one (literal or metaphorical) path in a single clause (a resultative phrase is interpreted as a metaphorical path). For example,

(5) *Bob kicked Sue black and blue down the stairs.

Sentence (5) is ungrammatical because there are two resultative complements, *black and blue* and *down*, that specify two different types of state-change for the same entity, *Sue*. 'Double resultative' combinations like *kick black and blue down the stairs* are not allowed in Mandarin either. The *Unique Path Constraint* implies that verbs that encode a physical path lexically are not able to co-occur with resultatives in English. This rules out combinations in English like **ascend sick* 'get sick as a result of ascending'. It also applies to Mandarin RVCs: the eight path verbs (*shang* 'ascend', *xia* 'descend', *jin* 'enter', *chu* 'exit', *qi* 'rise', *hui* 'return', *guo* 'pass', *kai* 'move away') can never form grammatical compounds with state-change verbs (mostly RVCs in Mandarin). For example, it is unacceptable to say *da-po-xia* 'hit-be.broken-descend' to describe an event in which someone hits a pot and it falls and breaks[2]. Furthermore, not just any action verb can combine with any result verb. Gu (1992) observes that strings like *xia-tiao* 'frighten-jump', *xia-han* 'frighten-scream' with inherently agentive V2's cannot occur as resultative verb compounds. Certain semantic classes of verbs that involve inherent agentivity are not acceptable as the second component (V2) of conventional RVCs in Mandarin. These include the verbs of the following semantic categories: posture verbs, such as *zuo* 'sit', *dun* 'squat', *zhan* 'stand', *li* 'stand', *tang*, 'lie'; manner of motion verbs, such as *gun* 'roll', *tiao* 'jump', *beng* 'hop'; and verbs of ceasing or closing, such as *ting* 'stop', *guan* 'close', *zhi* 'stop', *bi* 'close'. It sounds odd to use *tui-zuo* 'push-sit' to describe a scene in which a man is pushed by someone and as a result he sits on the ground. Similarly, *an-dun* 'press squat' is not acceptable for a scene in which someone presses on another person, and causes him or her to squat; nor is *la-zhuan* 'pull-spin,' for an event in which someone pulls a spinning table and it spins.

[2]Unlike English monomorphemic verbs that can conflate both action and state-change (e.g., transitive *break*), the majority of Mandarin action verbs do not entail a state-change (Talmy 2000), for example, *jian* 'cut.with.scissors' only encodes the 'cutting' action; and the result of ... has to be encoded by adding a result verb such as *kai* 'be.open /apart'.

3 Acquisition of verbs and verb compounds

The productivity of DVCs and RVCs in Mandarin raises questions about acquisition. When and how do children figure out the compositional nature of verb compounds and begin to combine verbs productively? When do they discover the constructional meaning of the template as a conventional way to express change of state and change of location? How do they identify the constraints on the allowable combinations of verbs in expressing state-change and location-change? Adult productivity requires knowledge of productive patterns, that is, which verbs can be combined and which cannot, as well as an understanding of the argument structure of combinations and their meanings. This debate over argument structure alternations is relevant to the acquisition of Mandarin verb compounding: how do Mandarin-speaking children become productive with a similarly productive-but-constrained process like verb compounding?

In a study of the acquisition of complex predicates (including particle verbs and prefixed verbs) by children learning three Germanic languages (English, German and Dutch), Behrens (1998) found that the morphologically and syntactically complex nature of the separable particle verbs does not delay acquisition. Children produce particle verbs frequently and productively from age two, and verb-particle combinations are highly productive: all particles are used with a variety of verb stems, and some verb stems occur in combination with more than twenty particles. In a comparison of data from children learning English vs. Korean, Bowerman (1989; 1994) argued that learners of English also showed facility with the makeup of complex verbs: they understood how to break up complex events into an action and a change of location or state, encoding the first with a verb and the second with a particle; the two components were often interrupted by a direct object. Bowerman concluded that children show sensitivity to language-specific principles of "event packaging" even before the age of two.

Bowerman (1982, 1988) studied another construction analogous to Mandarin verb compounding, the English resultative construction. She found that that after producing mostly only acceptable combinations for about a year and a half to express the relation between a causing event and a resulting event (e.g., *eat cookie all gone, wipe table clean*), English-speaking children began to produce novel constructions like *"I pulled it unstapled"* (3;8, after pulling a stapled book apart), and *"Are you washing me blind?"* (5;6, as mother wipes corners of her eyes) (cf. *pull apart, wash clean*). Bowerman (1982) proposed that these novel combinations indicate that children have reanalyzed instances of the resultative construction: they can now disregard the specific semantic contributions of the individual lexical items and see what combinations have in common at an abstract level -- the main verbs all specify an action that causes an entity to undergo a

change of state, and the particles or other complements all specify this resulting state. Once this semantic abstraction has been made and linked to a certain syntactic pattern, children are in a position to make an indefinite number of novel combinations, some of them strange or unacceptable to adults. The mastery of subtle semantic constraints on the English resultative construction takes a long time. Bowerman (1982, 1988, p.c.) found odd utterances like *"don't cut me bald"* (cut my hair so that I am bald) and *"the doggie bited him untied"* (bit ropes so that his master became untied) from children as old as age nine.

In learning Mandarin verb compounding, children have to accomplish tasks analogous to the learning of complex predicates in English, German, and Dutch for expressing motion and cause: identifying the meaning components usually expressed by the first verb versus those expressed by the second (or third) verb, discovering the meaning, identifying subtle semantic constraints on allowable verb combinations, and establishing how the arguments of the component verbs are mapped onto the verb compounds. Although Mandarin, like English, has been categorized as a satellite-framed language (Talmy 1985), it differs from English in that its 'satellites' are verbs, and these verbs can be used freely as stand-alone main verbs. There are other syntactic differences as well. For instance, English particles can be separated from the main verb by a lexical unit such as an adverb or direct object, but the verbs of a Mandarin verb compound cannot. The first difference might facilitate Mandarin-speaking children's learning, while the second might hinder it. So how do Mandarin-speaking children in fact proceed?

4 Learning verb compounding as a combinatorial system

4.1 Data from spontaneous speech

As a first step toward answering this question, I analyzed the CHILDES Beijing Mandarin corpora (MacWhinney 2000; Tardif 1993). The CHILDES Mandarin corpora contain spontaneous data from 10 children recorded from age 1;9 to 2;2. These children show certain use of verb compounds, with an overall type/token ratio of 0.32 (89/282). DVCs are the most frequent verb compounds in their earlier uses, and they are normally composed of two directional verbs (path + deictic), for example, *chu-qu* 'exit-go' (17 tokens from 6 children), *'xia-lai* 'descend-come' (16 tokens from 5 children), *chu-lai* 'exit-come' (12 tokens from 8 children); other frequently-used compounds are *da-kai* 'hit-open' (28 tokens from 7 children) and *kai-kai* 'open-open' (22 tokens from 5 children). From age 2;0, verb compounds containing three verbs (i.e., V1V2V3) also appear; there

are 18 different V1V2V3 constructions in the Beijing Mandarin corpora. Both *lai* 'come' and *qu* 'go' were used as V3.

It seems that children between 1;10 and 2;2 have already begun to produce VCs. But a case study of one child of this age in the CHILDES Mandarin Beijing corpora reveals that this productivity is still based on adult input. This child produced 20 types of VCs (49 tokens); these represent a subset of those in the adult input (195 types and 560 tokens).

The spontaneous data reveal an early onset (by at least 1;9) in Mandarin children's use of verb compounds (both DVCs and RVCs). There is a steady increase in their production of verb compounds from 1;9 to 2;2. Children are able to cope with the formal complexity of three-verb compounds. Yet their production sticks closely to the compounds modeled in the input: in the case study of one child from age 1;10 to 2;2 in the CHILDES Mandarin Beijing corpora, the child's VCs form a subset of those used by the adult. It seems, then, that below age 2;2, children only produce VCs they have heard modeled. The limited production of verb compounds in the spontaneous data means that crucial questions remain: how productive are children in creating verb compounds? And when do they grasp their combinatorial nature? In order to elicit more focused production of verb compounds, and to create possible contexts in which children cannot simply produced modeled VCs, I conducted two elicitation studies, one to tap children's knowledge of DVCs, and the other their knowledge of RVCs.

4.2 Elicited data

Children from four age-groups (mean ages 2;6, 3;6, 4;6 and 6;1), and a group of adults (N = 10 per group) participated in both studies. The children's data were collected in two kindergartens in Guangzhou, P. R. China. Overall, in both elicitation tasks, all the verb compounds that the children produced are DVCs and RVCs[3], due to the particular design of the stimulus materials.

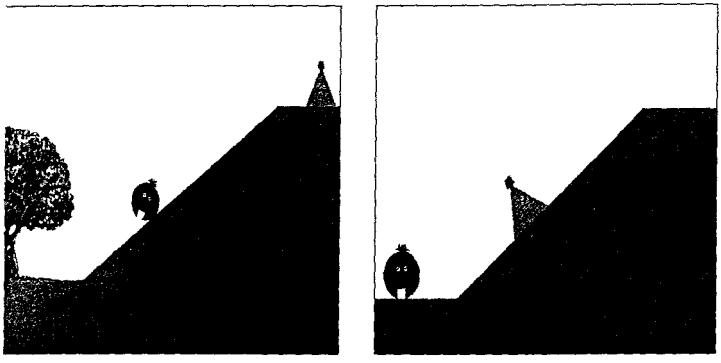
4.2.1 Elicitation 1: Directional verb compounds—Tomato Man. Each participant watched a set of 12 short *Tomato Man*[4] video clips, one by one (6 sec. each), presented on a laptop. These clips depict motion events car-

[3] Mandarin Chinese also has many parallel verb compounds (Chao 1968, Li & Thompson 1981), such as *fang-shou* 'defend-defend = defend', *ti-huan* 'replace-change = replace'. But these compounds rarely occur in young children's speech.

[4] *Tomato Man* is a set of cartoon stimuli designed by A. Özyürek, S. Kita, and S. Allen, and created by H. Baumann at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands (Allen *et al.*, 2003, Özyürek *et al.*, 2001).

ried out by two cartoon characters, the *Tomato Man* and the *Green Man.* These events can be encoded with DVCs in Mandarin, as illustrated in Figure 1 with sample descriptions from adult native speakers. The experimental procedure was conducted in a child-friendly way: children were asked to play a "story-telling" game with another experimenter, who could not see the video clip shown on the monitor. The child watched each clip twice before telling the story. Additional viewings were provided if the child could not remember what had happened. All the participants' descriptions were transcribed and the verb compounds were coded.

Figure 1. *Tomato Man* video clips: Sample still pictures



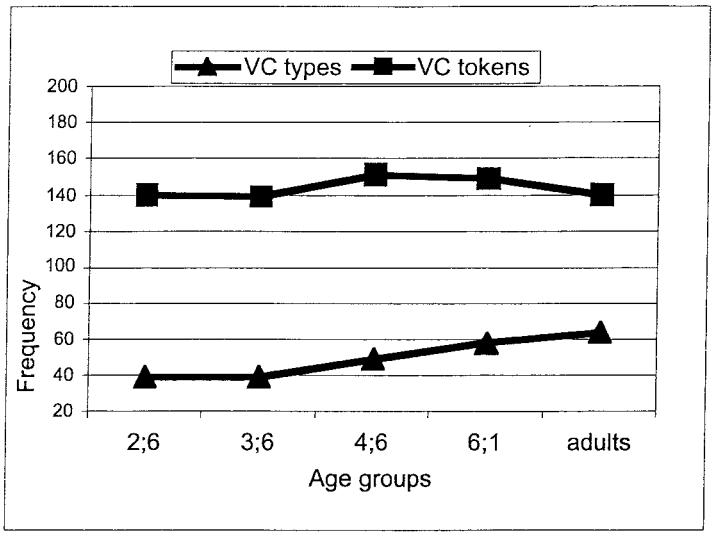
Xihongshi ***gun-xia*** *le shanpo.*
tomato **roll-descend** PFV hill
'The *Tomato man* rolled down the hill.'

Lusanjiao ***zhuan-shang*** *le shanpo.*
green.triangle **spin-ascend** PFV hill
'The green triangle spun up the hill.'

Figure 2 presents the types and tokens of DVCs produced by the participants in different age groups. There were no significant differences between the age groups in the numbers of DVC types and tokens produced, although adults produced slightly more DVC types than children. From the youngest age (2;6) on, children produced DVC tokens just as frequently as adults, and they used not only two-verb but also three-verb DVCs. They were able to capture both the manner (e.g., 'spinning' vs. 'jumping') and the direction of the motion events by using DVCs formed with a manner-of-motion verb followed by a path verb and often a deictic verb, e.g., *gun-*

shang-lai 'roll-ascend-come', *zhuan-shang-lai* 'spin-ascend-come', *gun-xia-qu* 'roll-descend-go', *tiao-shang-qu* 'jump-ascend-go'. Among their two-verb DVCs, the most frequent were combinations of a path verb with a deictic verb, such as *shang-lai* 'ascend-come', consistent with the spontaneous data. Manner-of-motion verbs were mostly combined with a path verb, as in *tiao-xia* 'jump-descend' and *gun-xia* 'roll-descend'.

Figure 2. *Tomato man*: DVC types and tokens by age



The children also produced quite a diversity of DVC types. Altogether the 40 children produced 109 distinctly different DVCs, while the ten adults produced 62. Only 20 DVCs are shared by the children and the adults. This suggests that children were not just producing a small set of highly frequent DVCs that they might hear every day. In an experimental situation with novel events, participants cannot just repeat what they have heard in frequently-encountered situations. The children had to be able to analyze the new events into their relevant components, even if they sometimes used familiar VCs for them. These results are therefore more suggestive of productivity than the spontaneous speech data presented earlier.

Further evidence for productivity comes from the fact that the children produced some innovative VCs that sound strange to adult ears: VCs with novel component words and VCs that violate the constraints on combining verbs. These innovative verb compounds offer additional evidence for children's analysis of the composite nature of verb compounds. One child of 3;5 used the onomatopoetic form *dong*, which depicts the thumping sound from jumping, as a verb:

(6) (3;5): *Ta **dong-shang-qu** le.*
He **dong-ascend-go** PFV
'He ascended the hill by donging (thumping);
he donged up the hill.'

Such a novel compound is understandable and possibly acceptable given the right context, although adults would rather prefer the conventional one *tiao-shang-qu* 'jump-ascend-go'. But other types of errors violate the constraints on verb compounding in Mandarin. For example, a child of 4;5 years, who produced DVCs with more than three verbs:

(7) (4;5): *Ta **gun-diao-xia-qu** le.*
He **roll-fall-descend-go** PFV
'He went falling down while rolling.'

(8) (4;5): *Ta **zou-diao-xia-qu** le.*
He **walk-fall-descend-go** PFV
'He went falling down while walking.'

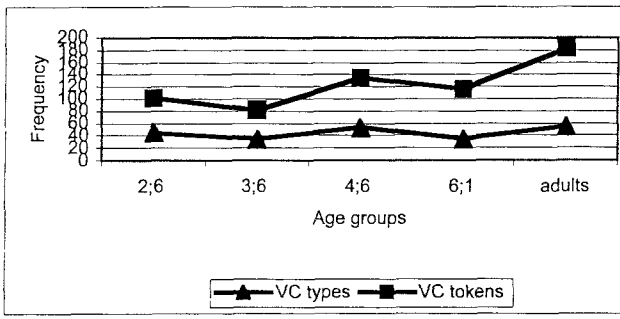
Such compounds are erroneous and never occurred in the adults' descriptions. A conventional adult use would be either *gun-xia-qu* 'roll-descend-go' or *diao-xia-qu* 'fall-descend-go' for (7), and *zou-xia-qu* 'walk-descend-go' or *diao-xia-qu* 'fall-descend-go' for (8).

To summarize, the *Tomato Man* elicitation showed that children are able to use DVCs productively to encode motion events from at least age 2;6: they produced both types and tokens of DVCs as frequently as adults, and their DVCs were not just a small set of frequently-encountered ones. Their productivity is further evidenced by innovative DVCs: children filled the V1 slot with novel words from 3;6 on. Children show, then, that they know the combinatorial nature of DVCs. But their combinations of too many verbs also suggest that they are not yet aware of some of the constraints on verb compounding.

4.2.2 Elicitation 2: Resultative verb compounds—Cut and break. A second set of video clips (28 target events + fillers) was used to collect

more focused production of RVCs[5]. The target video clips depict an actor bringing about a change of state in an object – specifically, some kind of destruction of the object's material integrity. For example, a woman breaks a bar of chocolate by hand, or a woman cuts a piece of cloth in two with scissors. In Mandarin such events are typically encoded with RVCs, such as *bai-duan* 'snap-be.broken', or *jian-po* 'cut.with.scissors-be.broken'. All the participants watched one video clip at a time on a laptop and described the events they saw. Children were asked to play a "story-telling" game with the experimenter who could not see the clips. Figure 3 presents the types and tokens of RVCs produced by each age group.

Figure 3. Cutting and breaking events: RVC types and tokens by age



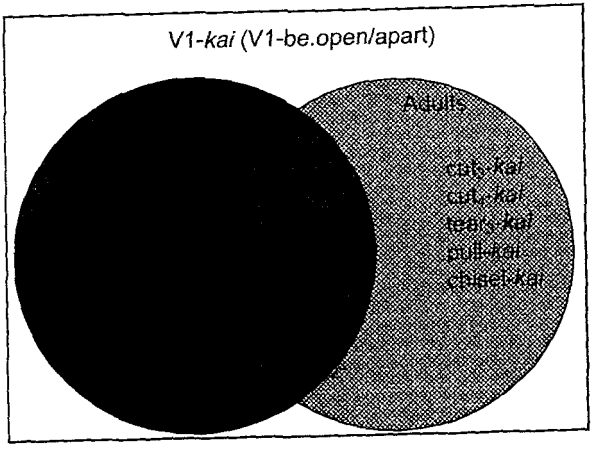
There is no significant difference between the participant groups in the number of RVC types; even the 2;6-year-olds produced as many types as the older groups. Take, for example, the RVCs that share the result verb *sui* 'be.in.pieces'. The youngest children (2;6) produced 20 tokens of RVCs with *sui* as V2; among those V1-*sui* compounds, they used 4 different action verbs: *qie-sui* 'cut-be.in.pieces', *da-sui* 'hit-be.in.pieces', *gao-sui* 'make-be.in.pieces', and *si-sui* 'tear-be.in.pieces'. But in tokens, the 2;6- and the 3;6-year-olds produced significantly fewer RVCs than adults (p

[5] This set of video stimuli was designed and filmed by Bowerman and Majid at the Max Planck Institute for Psycholinguistics (Bowerman, M. & Majid, A., 2003). For more information, refer to the MPI Annual Report 2003: http://www.mpi.nl/world/research/research.html.

<.01), while the children of 4;6 and 6;1 did not differ significantly from the adults.

As in the study eliciting DVCs, it is impossible for children to produce verb compounds based only on their knowledge of what adults typically say in the situations depicted: they have to analyze these new events and encode them with the knowledge they have acquired about their language. The RVC types produced by the children are not a subset of those of the adults: these forty children produced 95 different RVCs altogether, while the ten adults produced 55; only 21 RVCs were shared by the child and the adult groups. Take, for example, the events that are described by RVCs with the result verb *kai* 'be.open' or 'be.apart': the children and adults shared 4 RVCs, while the children combined *kai* with five additional action verbs and the adults used another five action verbs, as illustrated in Figure 4.

Figure 4. *Cutting and breaking events*[6]:RVCs produced by children and adults with V2 *kai* 'be open'



[6] Due to limited space in the chart, I use English glosses for the actual Mandarin verbs in the V1 slot of all the compounds. The numbers beside *cut* and *tear* in the chart indicate different 'cutting' and 'tearing' verbs in Mandarin.

This diversity in the verb compound types and tokens suggests that children are sensitive to the combinatorial nature of verb compounds. Further evidence comes from a comparison of children's VCs with the VCs' component verbs. I examined the data of one child from the youngest group (2;6). This child used the action verbs (V1s) and the result verbs (V2s) separately as well as in RVCs. As shown in Table 1, he combined the same action verb with different result verbs (e.g., *gao-lan* 'make-be smashed', *gao-duan* 'make-be broken'); and the same result verb with different actions verbs (e.g., *bai-lan* 'snap-be smashed', *gao-lan* 'make-be smashed'). This table shows only the verbs that were used alone and in compounds by this child.

Table 1. *Cutting* and *breaking* events – one 2;6-year-old's predicates

V1 (alone)	V2 (alone)	V1-V2
Jian (3) 'cut.with.scissors'	*huai* (6) 'be.broken.down'	*jian-huai* 'cut.with.scissors-be.broken.down'
bai 'snap'	*kai* 'open'	*bai-kai* 'snap-be.open'
	lan 'be.smashed'	*bai-lan* 'snap-be.smashed' *gao-lan* 'make-be.smashed'
	duan 'be.broken' (long objects)'	*gao-duan* (2) 'make-be.broken'

Note: Numbers in parentheses indicate tokens beyond one.

To summarize, the findings from both spontaneous speech and the elicitation studies show that Mandarin-speaking children use both DVCs and RVCs from an early age. Their early uses may be restricted to compounds that they have heard in the input, but from at least 2;6 they also use verb compounds productively: they are able to analyze them as composed of internal parts, and to link each part with a function, determining which verb expresses the manner of motion and which the path for DVCs, and which verb expresses the cause and which the result for RVCs. Evidence for these claims comes from the elicitation data: (1) the children produced a range of verb compound types that overlaps only partially with those produced by adults; (2) a child as young as 2;6 used action and result verbs alone, as well as in combinations; (3) a child of 3;5 created non-canonical verb compounds with novel V1s; (4) a child of 4;5 combined more verbs than allowed in forming verb compounds. The data also suggest that children tune into the language-specific packaging of information in their input early. In particular, they start to rely on verb compounds from an early age

and they never err in the ordering of the component verbs. In learning Mandarin verb compounding, children may start first with an item-based learning procedure, but they quickly make abstractions, analyzing verb compounds into their component parts, structured according to an overarching syntactic template of the abstraction.

In languages like Mandarin, it is often possible to draw on knowledge of compounding to coin a novel compound on the spot. A novel compound can be a coinage of a conventional one that is acceptable for a state-change event where a certain causal action leads to a certain result, e.g. some *anti-fulfillment* ones such as *ca-zang* 'wipe-dirty' and the *other-event* RVCs such as *xi-po* 'wash-be.torn', or an ungrammatical one that violates the semantic constraints on allowable concatenations of verbs such as *la-tiao* 'pull-jump'. Most of these will pass unnoticed, but some will not be acceptable to other speakers, even if they seem compatible with the situations they are used to describe. How do Mandarin-speaking children learn the subtle semantic constraints on verb compounding?

5 Learning the semantic constraints on verb compounding

Mandarin verb compounding is productive, but not everything is possible. Previous studies of Mandarin acquisition point to some combination errors by children. In her study of Mandarin-speaking children's language development in Taiwan, Erbaugh (1982, 1992) observed that children create anomalous verb compounds in addition to producing conventional ones (verb compounds become frequent from 2;10 in her data). For example, a child used *peng-fang* 'bump-put.down' (2;10) to describe an unsuccessful attempt to smash a balloon; this compound sounds odd and is problematic to understand for adults even in the relevant speech context. Cheung (1992) also noted some non-conventional RVCs in the speech of Taiwan Mandarin-speaking children, for example, *chi-po* 'eat-be.broken' (age 3;5), where *yao-po* 'bite-be.broken' should be used.

To explore children's knowledge of possible semantic constraints on verb compounding in Mandarin, I designed a further experimental study. Five groups of children (mean ages 2;6, 3;6, 4;6, 6;1 and 8;1) and a group of adults in Guangzhou, P. R. China, participated in the experiment (N=10 per group). The stimuli were a set of video stimuli consisting of 34 target events, and 8 control items. Each clip depicts an actor performing a causal action, for example, a woman blowing at a burning candle so the flame goes out. The events in the stimulus set included both location-change and state-change events. Eighteen of the events could be routinely described with a verb compound and 16 could not. Table 2 lists the conventional and strange

VCs studied in this experiment. The strange VCs included types of verbs that cannot appear as V2.

The experiment involved both a description task and a judgment task. Adults were asked to (a) describe each video clip, and (b) judge whether a target verb compound (either a conventional one or an ill-formed one) was acceptable if they had not produced it. For the acceptable ones, such as *chui-mie* 'blow-extinguish', participants should give a "yes" answer in the judgment task, whereas for odd ones, such as *la-zhan* 'pull-stand', they should give a "no" answer. A child-friendly version of this procedure was used with the children: a toy puppy was introduced to the child, and the puppy was said to be silly but eager to learn the child's language. The child was asked to describe the video clip to the puppy, and if the child did not produce the target verb compound, he or she was asked whether the puppy

Table 2. Constraints on Mandarin verb compounding – target verb compounds

Events	V2 types	Target VCs
Location change	Path	*chui-diao* 'blow-fall' *reng-chu* ' throw-exit' *ju-qi* 'lift-rise' *fang-xia* 'put-descend'
	Manner of motion	**tui-hua* 'push-slide' **ti-gun* 'kick-roll' **reng-fei* 'throw-fly' **chui-gun* 'blow-roll' **la-zhuan* 'pull-spin' **la-tan* 'pull-spring' **tui-huang* 'push-shake'
State change	Breaking	*ji-po* 'squeeze-break' *reng-sui* 'throw-smash' *chui-po* 'blow-break' *zhe-duan* ' bend-break'
	Opening	*ti-kai* 'kick-be.open' *tui-kai* 'push-be.open'
	Closing	**ti-guan* 'kick-close' **tui-guan* 'push-close' **la-guan* 'pull-close'
	Ceasing	*gai-mie* 'cover-extinguish' *chui-mie* 'blow-extinguish' **zhuang-ting* 'bump-stop' **an-ting* 'press-stop'
	Posture	**la-zhan* 'pull-stand' * *tui-tang* 'push-lie' **tui-zuo* 'push-sit' **an-dun* 'press-squat'
		ti-fan 'kick-overturn' *tui-dao* 'push-fall' *ti-dao* 'kick-fall'
	Other	*xi-zang* 'wash-dirty'
		pa-shi 'pat-wet' *tu-hong* 'paint-red'

Note: Asterisks indicate VCs that sound strange to adults.

could describe the stimulus with the target compound. In order to forestall a "yes" bias in the judgment task, I included eight relatively easy control events in the stimulus set, half requiring "no" answers and half "yes" an-

swers. For example, for a video clip depicting a man mopping the floor, the child was expected to say "no" to the puppy who said the man was sweeping the floor. Only children who gave correct responses to these control items were included in my analysis.

First let us look at participants' description of the events. Children and adults used both conventional verb compounds and single verbs in their descriptions. But children produced odd VCs that never occurred in adult descriptions, and they did so with all three types of verbs that cannot occur in a V2 slot. This overproductivity was observed across all four age groups of children. Sample errors are shown in Table 3.

In contrast, adults never constructed novel VCs like these. Rather, for the events that cannot be described with a concatenation of an action verb and a result verb, they tended to use two or more separate clauses, each with a single action verb or result verb, or other syntactic constructions.

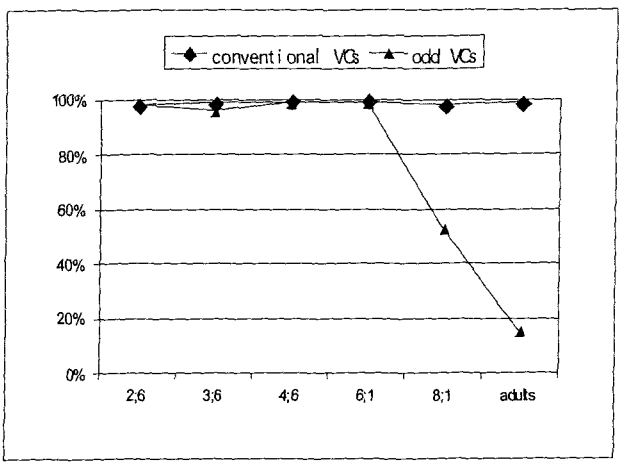
Figure 5 shows the percentage of acceptance of the target conventional VCs and the odd VCs by all age groups. Both adults and children of all ages show a very high acceptance rate of the conventional VCs (nearly 100%). But children differ dramatically from adults in that up to the age of 6;1 they tend to accept the odd VCs in general, and children as old as 8;1 still accept more than half of the odd VCs. Adults, on the other hand, overwhelmingly reject these odd VCs. This indicates that children are more lenient with verb compounding. They seem not to have even begun to acquire a feel for disallowed combinations until beyond age six, and their knowledge of the semantic constraints on verb compounding is not complete until sometime beyond age eight.

To summarize, this experiment offers further evidence for children's early sensitivity to the combinatorial nature of verb compounds. Children from age 2;6 to 6;1 produced compounds that they were unlikely to have heard in the adult input. This supports my findings from the spontaneous data that children know about the combinatorial nature of verb compounds from at least 2;6 on. Furthermore, children overgeneralize, creating verb compounds that sound strange to adults. This indicates that children do not learn the full constraints on Mandarin verb compounding until a rather ripe old age—beyond age six. This appears to be comparable to English-speaking children's late acquisition of semantic constraints on resultative verb and particle combinations (Bowerman 1982, 1988).

Table 3. Some innovative VCs listed by verb type (V2) and age

Posture verbs	(1) (3;6): *na ge ayi **tui-zuo** le shushu.* that CLF aunty **push-sit** PFV uncle 'That aunty caused uncle to sit by pushing him.' (2) (3;6): *ayi **la-zhan** le shushu.* aunty **pull-stand** PFV uncle 'Aunty made uncle stand up by pulling him.' (3) (6;2): *ayi **an-dun** le shushu.* aunty **press-squat** PFV uncle 'Aunty made uncle squat by pressing on him.'
Manner-of-motion verbs	(4) (3;6): *shushu **chui-gun** le lu qiu.* uncle **blow-roll** PFV green ball 'Uncle made the green ball roll away by blowing at it.' (5) (4;6): *shushu **la-zhuan** le zhuozi.* uncle **pull-spin** PFV table 'Uncle made the table spin by pulling on it.' (6) (4;6): *shushu **tui-hua** le ayi.* uncle push-slide PFV aunty 'Uncle pushed aunty and she slid down the slide.' (7) (6;2): *shushu **tui-huang** le ayi.* uncle push-shake PFV aunty 'Uncle pushed aunty (who sat on a swing) and she shook.'
Verbs of ceasing or closing	(8) (2;6): *ayi **la-guan** le chuanghu.* aunty **pull-close** PFV window 'Aunty closed the window by pulling on it.' (9) (2;6): *ayi **peng-ting** le che.* aunty touch-stop PFV car 'Aunty stopped the (toy) car by touching it.' (10) (2;6): *ayi **tui-ting** le chiche.* aunty push-stop PFV car 'Aunty stopped the (toy) car by pushing on it.' (11) (3;6): *shushu **tui-guan** le men.* uncle **push-close** PFV door 'Uncle closed the window by pushing on it.' (12) (3;6): *ayi **an-ting** le qiche.* aunty **press-stop** PFV car 'Aunty stopped the (toy) car by pressing it.' (13) (4;6): *ayi **fang-ting** le qiche.* aunty **put-stop** PFV car 'Aunty stopped the car by putting (a finger on) it.' (14) (6;2): *shushu **ti-guan** le men.* uncle **kick-close** PFV door 'Uncle closed the door by kicking it.'

Figure 5. Conventional vs. odd VCs: Percentage acceptance by age



6 *Discussion* and conclusion

My study shows that Mandarin-speaking children know the combinatorial nature of verb compounds by at least age 2;6. They produce multiple types of verb compounds; they use the constituent verbs separately, and they combine them flexibly. But their productivity in verb compounding extends too far: at age six, and even beyond, they are still creating compounds that adults find odd, and they generally fail to reject them in a judgment task. Such a learning pattern indicates that although young children begin language acquisition by taking over linguistic items directly from the adult language (before age 2;2 in my data), by age 2;6 at least they are able to abstract the formal syntactic template V1V2(V3) and map it onto different events (e.g., motion events and causal events, either spontaneous or caused). This suggests that children are sensitive to a Mandarin-specific way of "event packaging", in particular, its prevalent use of verb compounding to encode a whole motion or causal event, with each verb specifying only one aspect of the event. Apparently they are not misled by the fact that nothing can intervene between the component verbs of a compound into thinking that the compound is a single unit. The frequent use of the

individual constituent verbs in the input may facilitate children's discovery of the compositional nature of Mandarin verb compounds.

Children's persistent and systematic overgeneralizations in verb compounding pose questions about the learning procedures children employ in acquiring a construction. In accounting for the acquisition of argument structure alternations in English, which are similarly productive but constrained, Pinker (1989) proposed that children's productive rules are appropriately constrained from the very beginning by innate grammatical mechanisms; he explained away overgeneralizations as due to performance error or an incorrect understanding of a verb's meaning. In the case of Mandarin verb compounding, children's failure in the judgment task and their production of novel verb compounds in particular, rule out performance error as an explanation of their overgeneralizations. Rather, Mandarin children's combination errors indicate that they have analyzed the composite nature of the verb compounds and they have extracted an abstract formal template V1V2(V3) with a semantic representation of caused location-change (DVCs) or state-change (RVCs). They could also extend the abstract construction template to new verbs and new events that they had not encountered previously: they showed that they know a verb denoting a causal action maps onto the V1 slot, and a verb denoting a caused location/state-change onto the V2 (as well as V3) slot. Their overgeneralization errors (over-combining verbs and combining verbs to encode events that are not simply depicted with a concatenation of an action verb and a result verbs) reflect their analytical knowledge of verb compounding; at the same time, they failed to discern the subtle constraints on such constructions. Counter to Pinker's (1989) account, productive usage does not go hand in hand with full acquisition. Even if children have started using new verb compounds that they might have not heard in the input, they do not necessarily achieve the full adult mastery of the constructions.

Such a learning pattern offers support to the usage-base learning approach where learning is seen as a constructive process: children build their abstractions from an inventory of a highly specific, item-based schema that develop pivot-like structures in piecemeal fashion over the early childhood years. In studies of children's lexical learning, for example, learning the combinations of words (compound formation) and the combination of roots and affixes (derivational and inflectional) (Clark 1982, 1993), or the combination of verbs and particles (Bowerman 1982), children make abundant innovative combinations as shown in these studies. Clark (1982) argues that lexical innovations, rather than marking children's mastery of the word-formation paradigms, suggest that children are learning the process required in that language for creating new words. In this process certain principles are argued to be relevant in this process: Transparency of meaning, Simplicity in form, and Productivity in use. The productivity reflects the con-

ventional collective preferences for combining meanings and forms, which involve speakers' knowledge of structurally possible and available options in that language. Speakers' creation of new constructions should also be easily analyzable and so the meaning of the new combinations is understandable and predictable. To arrive at the adult preferences in coining new words, children have to attend to and track the frequencies of the forms heard in the input and build their own preferences for word coinage. The early uses of verb compounds by Mandarin children reflect adults' preferences, for example, children produce verb compounds from early ages, and they never make error in ordering the component verbs; their later productive use of verb compounds also supports this line of argument that children follow the principle of transparency in meaning (i.e., V1 indicating the causal action and V2 the resultant state-/location-change) and simplicity in form (V1V2 or V1V2V3). Their overgeneralization errors, on the other hand, reflect their incomplete knowledge of the adult preferences (the constrained productivity). The full mastery of a productive construction requires the knowledge of constraints.

I can only speculate on the possible ways that Mandarin children may eliminate their overgeneralization errors in verb compounding. One possible strategy is through "indirect negative evidence, namely" (1) the non-occurrence of ill-formed VCs (e.g., RVCs with posture verbs like *la-zhan* 'pull-stand') may lead the children to be aware of the semantic constraints on verb compounding; (2) preemption may also work to block children's ill-formed verb compounds, i.e., the ill-formed RVC like *la-zhan* 'pull-stand' will be preempted by either a conventional verb compound *la-qi-lai* 'pull-rise-come' or the *de*-resultative construction such as *la de zhan-qi-lai le* 'pull to stand-rise-come', where *de* is used to link the causal event and the result event. The detection of relevant 'indirect negative evidence' is analogous to English-speaking children's retreat from errors in morphological learning as they move from *bited* to. *bit*, or *foots* to *feet*.

This study therefore argues for a usage-based learning mechanism that considers the acquisition of verb compounding as a process in which children discover an abstract schema—a construction—for combining verbs (Goldberg *et al.*, 2004, Tomasello 1992). Productivity seems to set in at a younger age than would be predicted by Tomasello's (1992) "verb island" hypothesis, but this achievement is followed by a long period in which learners must refine their VC construction through further linguistic experience, working out which classes of verbs can participate in the construction, and exactly how many verbs may be combined. Further work will be needed to arrive at a detailed understanding of how children learn all the constraints on these constructions.

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