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The acquisition of lexical and grammatical aspect in Chinese*

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ABSTRACT

This study reports three experiments on how children learning Mandarin Chinese comprehend and use aspect markers. These experiments examine the role of lexical aspect in children's acquisition of grammatical aspect. Results provide converging evidence for children's early sensitivity to (1) the association between atelic verbs and the imperfective aspect markers *zai*, *-zhe*, and *-ne*, and (2) the association between telic verbs and the perfective aspect marker *-le*. Children did not show a sensitivity in their use or understanding of aspect markers to the difference between stative and activity verbs or between semelfactive and activity verbs. These results are consistent with Slobin's (1985) basic child grammar hypothesis that the contrast between process and result is important in children's early acquisition of temporal morphology. In contrast, they are inconsistent with Bickerton's (1981, 1984) language bioprogram hypothesis that the distinctions between state and process and between punctual and nonpunctual are preprogrammed into language learners. We suggest new ways of looking at the results in the light of recent probabilistic hypotheses that emphasize the role of input, prototypes and connectionist representations.

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Theories of aspect differ in how they capture the aspectual systems of language, but most of them recognize two kinds of aspect, one 'grammatical' and the other 'lexical' (under various labels). Grammatical aspect marks a verb for a particular viewpoint toward the described situation (Smith 1991), such as perfective or imperfective. Lexical aspect involves the inherent temporal meaning of a verb, for example, whether it characterizes a situation as having a temporal boundary or a result. In the past 40 years, theorists have tried to understand the functions of both grammatical and lexical aspect, and they have become increasingly interested in the interaction between the two (Comrie 1976, Smith 1991, Vendler 1957).

Studies of child language have long documented how properties of lexical aspect can affect children's acquisition of tense-aspect morphology (Aksu 1978, Aksu-Koç 1988, Antinucci & Miller 1976, Bloom, Lifter & Hafitz 1980, Bronckart & Sinclair 1973, and, more recently, Cziko 1989, Cziko & Koda 1987, Li 1990, Shirai 1991, 1993, in press, Shirai & Andersen 1995). These studies have served an important role in the development of theories of language acquisition. In particular, evidence from children's acquisition of tense and aspect has been incorporated into two influential hypotheses: the language bioprogram hypothesis (Bickerton 1981, 1984) and the basic child grammar hypothesis (Slobin 1985). In this paper, we will evaluate these hypotheses by examining the role of lexical aspect in the acquisition of grammatical aspect by children learning Mandarin Chinese.

The paper is organized as follows. First, we briefly discuss the aspectual system of Chinese. Second, we present an overview of the language bioprogram and basic child grammar hypotheses and their relevance to our study. Third, we present three experiments on young children's comprehension, production and imitation of aspect markers in Chinese. Finally, we evaluate our results with respect to different theoretical perspectives and propose a plausible explanation of the acquisition of aspect.

GRAMMATICAL AND LEXICAL ASPECT IN CHINESE

Grammatical aspect in Chinese has been discussed intensively in the linguistic literature (see Chao 1968, Li & Thompson 1981, Yang 1995). Several aspect markers have been studied in detail, including the progressive marker *zai*, the durative marker *-zhe*, the perfective marker *-le*, and the experiential marker *-guo*. Lexical aspect, in contrast, has received much less attention.

Markers of grammatical aspect: 'zai', '-zhe', '-ne', and '-le'

The morpheme *zai* has had a long historical development, appearing first as a verb, then as a preposition, and only recently as an aspect marker (for discussion, see Li 1988, 1993*a*). As a preposition, *zai* can occur both preverbally and postverbally, while as an aspect marker it can occur only preverbally (Li 1990, 1993*a*, Zhu 1981). Its main function as an aspect marker is to indicate that an action or event is ongoing. Hence, it is a progressive aspect marker. The morpheme *-zhe* indicates that a situation should be viewed as enduring or continuing (i.e., durative), often as a background event in a discourse (cf. the function of *be + (verb)-ing* in a sentence such as 'while she *was reading* a book she heard a noise in the kitchen'). As a durative marker, *-zhe* is used most naturally with verbs that specify a state. The progressive marker *zai*, in contrast, cannot be used with stative verbs. According to Comrie (1976), progressive and durative aspect together make up the category of *imperfective aspect*, which presents the internal structure of a situation without explicit reference to the situation's beginning or end.

Another progressive marker, *-ne*, was not traditionally treated as an aspect marker; its aspectual function has been recognized only recently (Liu 1985, Ma 1987). This neglect might be partly due to the existence of pragmatic constraints on its use in spoken language. Liu (1985) suggested that *-ne* is used to mark progressive aspect only in answers to questions in colloquial dialogues. However, Ma (1987) argued that *-ne* is actually the main device for denoting ongoing actions in spoken language. In this study, we treat *zai, -zhe* and *-ne* all as imperfective aspect markers, although we recognize the restrictions on their use (e.g., that *zai* cannot be used with stative verbs and that *-ne* occurs only colloquially).

In contrast to *zai, -zhe* and *-ne*, the aspect marker *-le* is perfective: it presents a situation in its entirety, as an event bounded at the beginning and the end, and without reference to its internal structure.[1] Because it emphasizes the entirety and particularly the end of the situation, *-le* has often been characterized as a marker of completion (Chao 1968). But *-le* by itself does not necessarily indicate a completed event or action

[1] Our discussion of the aspect marker *-le* is relevant primarily to the verb-final *-le*. Linguists disagree on whether the verb-final *-le* and the sentence-final particle *-le* express the same aspectual meaning (for discussion, see Li 1990).

(Li & Thompson 1981); rather, the meaning of completion often comes from the meaning of the verb with which *-le* occurs. When the verb encodes a situation with a clear temporal boundary, *-le* indicates that the situation comes to its natural end, i.e., it is completed, as illustrated in sentence (1). But when the verb encodes a situation with no clear temporal boundary, *-le* simply signals the termination of a situation, as in (2). In sum, *-le* presents the described situation as a whole. Variation in its interpretation in specific contexts provides a good example of how grammatical aspect interacts with the lexical aspect of verbs to determine the final aspectual interpretation of a sentence.

(1) *Qiche zhuang-dao -le fangzi.*
car hit-break -LE house
The car broke (i.e., knocked down) the house.

(2) *Xiaoyazi you -le yong.*
duckling swim -LE stroke
The duckling swam.

Categories of lexical aspect

The best-known categorization of lexical aspect is probably Vendler's (1957) classification of English verbs into four categories with respect to the so-called 'time schemata': *activities, accomplishments, achievements* and *states*. According to Vendler, activity verbs encode situations as consisting of successive phases over time with no inherent endpoint, for example, 'walk', 'run', and 'swim'. Accomplishment verbs also characterize situations as having successive phases, but they differ from activity verbs in that they encode an inherent endpoint, for example, 'paint a picture', 'build a house' and 'run a mile'. Achievement verbs encode situations as punctual and instantaneous, as in 'recognize a friend', 'reach the summit', and 'cross the border'. Finally, state verbs like 'know' and 'love' encode situations as involving indefinite duration and no inherent endpoint. Unlike activity and accomplishment verbs, they denote situations as homogeneous, with no successive phases.

Few studies have examined lexical aspect in Chinese. In an early study, Teng (1974) divided Chinese verbs into actions, states, and processes within Chafe's (1970) semantic framework. In a more recent analysis, Tai (1984) examined lexical aspect in Chinese using Vendler's categorization scheme. According to Tai, Chinese has roughly the same types of verbs as English. But one striking difference between the two, he noted, is that Chinese often uses resultative compounds to describe events that English specifies with accomplishment and achievement

verbs. Unlike English accomplishment verbs, however, Chinese resultative compounds cannot be marked with the progressive marker. For example, *xue* (study) in sentence (3) is an activity verb, so it is compatible with the progressive marker *zai*; but *xue-hui* (study-know) in sentence (4) is a resultative compound, and so it cannot be combined with *zai*.

(3) *Yuehan zai xue Zhongwen.*
John ZAI study Chinese
John is studying Chinese.

(4) **Yuehan zai xue-hui Zhongwen.*
John ZAI study-know Chinese
John is learning Chinese.

The incompatibility of resultative compounds with *zai* probably reflects the compound's increasing emphasis on result rather than action in its historical development (Li 1987). Because of this incompatibility, Tai has argued that Chinese lacks accomplishment verbs. But this position has been challenged recently (e.g., Li 1990, Yang 1995). For example, Li (1990) has suggested that Chinese has many accomplishment verbs similar to those of English, such as *hua yi-fu huar* (draw a picture), *gai yi-suo fangzi* (build a house), and *pao yi-bai mi* (run 100 metres). In this study, we retain the category of accomplishment verbs for Chinese, but we agree with Tai that resultative compounds lack a progressive meaning, so we treat them as a subclass of achievement verbs.

In an expansion of Vendler's system, Smith (1991) added the category of semelfactive verbs; English examples include 'cough', 'tap' and 'knock'. She argued that although semelfactives are similar to achievements in being punctual, they differ from achievements in their behaviour with progressive markers. When semelfactive verbs are marked for progressive, they are interpreted as specifying a repeated event (e.g., coughing or knocking several times). According to Smith, achievement verbs are, in general, compatible with progressive in English, but not in Chinese. Moreover, in English the use of achievements with progressive indicates preliminary, detachable stages of the event rather than a repeated event (e.g., 'John is reaching the summit' means that John is at a stage just prior to having reached the summit, not that he arrives at the summit several times). Chinese also has semelfactive verbs (e.g., *tiao* (jump) and *ti* (kick)), and, consistent with Smith's analysis, they indicate repeated events when they are combined with the progressive marker *zai*. In contrast, achievements in Chinese cannot be combined with *zai* at all.

Still another lexical-aspectual verb class in Chinese is discussed by Li (1990): mixed telic-stative verbs. These verbs can indicate either the process of a telic action or the state resulting from that process, depending on their aspect marker. In English, separate lexical items are usually needed to express such a pair of meanings. For example, with the progressive marker *zai* the verb *chuan* corresponds to English 'put on', while with the durative *-zhe* or the perfective *-le*, it corresponds to 'wear', as shown in sentences (5) to (7). Mixed telic-stative verbs demonstrate clearly the interaction between lexical and grammatical aspect.

(5) *Ta zai chuan yi-jian xin yifu.*
he ZAI put-on one-CL new garment (CL = classifier)
He is putting on a new garment.

(6) *Ta chuan -zhe yi-jian xin yifu.*
he wear ZHE one-CL new garment
He is wearing a new garment.

(7) *Ta chuan -le yi-jian xin yifu.*
he wear LE one-CL new garment
He is wearing (as a resulting of having put on) a new garment.

Integrating the analyses of Vendler, Tai, Smith and Li, we arrive at six different categories of lexical aspect in Chinese: activities, accomplishments, achievements (including resultative compounds), states, semelfactives and mixed telic-stative verbs.

Associations between lexical and grammatical aspect

As our previous discussion showed, lexical and grammatical aspect can interact. On the one hand the interpretation of a grammatical aspect marker such as *-le* often depends on the lexical aspect of the verb it marks. On the other hand the interpretation of the lexical aspect of a verb – in particular the mixed telic-statives – depends on the co-occurring grammatical aspectual marker.

Despite these interactions there are natural associations between lexical and grammatical aspect in Chinese: in particular, between the perfective marker *-le* and accomplishment/achievement verbs, between the progressive marker *zai* and activity verbs, and between the durative marker *-zhe* and stative verbs. In fact, as noted, *zai* is ungrammatical with statives and with resultative compounds (a subtype of achievement verbs). Comrie (1976) referred to such associations as natural combinations. According to Comrie, perfective aspect combines naturally with punctual verbs because perfective aspect presents a

situation as a whole without regard to its internal structure and punctual verbs present a situation as a single point lacking internal structure. In contrast, imperfective aspect is not compatible with punctual verbs (unless, like semelfactives, they can be construed iteratively), because imperfective aspect presents a situation as having an internal structure while a punctual verb presents it as a point lacking internal structure. Activity verbs lend themselves naturally to the internal perspective of imperfective aspect because they encode the successive phases of an event over time. In this study, we are interested in whether children learning Chinese are sensitive to these natural associations.

THE LANGUAGE BIOPROGRAM AND BASIC CHILD GRAMMAR

In this section, we briefly review two theoretical proposals about the acquisition of tense and aspect: the language bioprogram hypothesis and the basic child grammar hypothesis. According to the language bioprogram hypothesis, put forward by Bickerton (1981, 1984), certain semantic distinctions are biologically programmed and emerge early in human language acquisition. For tense and aspect, two such distinctions are state versus process and punctual versus nonpunctual. Because the distinctions are by hypothesis innate, states will be marked differently from processes early on in language development, and punctual situations will be marked differently from nonpunctual situations, probably by the use of different tense-aspect markers.

Bickerton supported his claims in part with evidence from creole grammars, arguing that in the absence of relevant input (the pidgins from which creoles arise do not have tense-aspect markers), first-generation creole speakers invent tense-aspect systems to mark the bioprogrammed distinctions. Drawing in addition on child language studies by Antinucci & Miller (1976), Bronckart & Sinclair (1973) and Brown (1973), he argued that children first use the tense-aspect markers of their language to mark the distinctions between state and process and between punctual and nonpunctual. For example, Brown (1973) had observed that children learning English do not overgeneralize the progressive marker *-ing* to stative verbs. According to Bickerton, this is because they are sensitive to the bioprogrammed distinction between state and process.

The basic child grammar hypothesis advanced by Slobin (1985) is similar in many respects to Bickerton's language bioprogram hypothesis. According to Slobin, children come to the language acquisition task with a prestructured 'semantic space' containing a universal, uniform set of prelinguistic semantic notions. These notions,

which are not biased toward any particular language, are 'privileged' for mapping on to grammatical forms in the process of language acquisition. That is, in the form-meaning mapping process they strongly attract the mapping of grammatical forms of the input language. Two notions, according to Slobin, define a basic semantic contrast in children's early acquisition of tense and aspect: the 'temporal perspectives' *process* and *result. Result* is particularly salient to children, proposed Slobin, and provides an early mapping point for grammatical morphemes associated with content words referring to actions. In particular, whenever a language has an acoustically salient past tense or perfective marker on the verb, its first use by children seems to be to comment on an immediately completed event that results in a visible change of state. These state changes encompass both end results such as breaking, opening and spilling, and changes of location (i.e., events with locative endpoints) such as dropping, falling and going to school. Slobin pointed to evidence from studies of tense and aspect acquisition in a number of languages, including Chinese (Erbaugh 1978, 1982), English (Bloom *et al.* 1980, Brown 1973), French (Bronckart & Sinclair 1973), Italian (Antinucci & Miller 1976), and Turkish (Aksu 1978, Aksu-Koç 1988).

Both the language bioprogram hypothesis and the basic child grammar hypothesis attempt to explain the acquisition of tense and aspect by appealing to innate or prelinguistically determined semantic distinctions. However, the two hypotheses differ in the specific semantic distinctions they invoke: the state-process and the punctual-nonpunctual distinctions for the language bioprogram, and the process-result distinction for basic child grammar. The two approaches also differ somewhat on whether the semantic distinctions are considered to be biologically built in: this claim is fundamental to the language bioprogram hypothesis, whereas it is left more open in the basic child grammar hypothesis.

In a test of the language bioprogram hypothesis, Cziko & Koda (1987) found that Japanese children never overgeneralize progressive markers to stative verbs, which supports one of the bioprogram distinctions. But they also found that these children make no punctual-nonpunctual distinction in their use of tense-aspect markers, which is inconsistent with the language bioprogram hypothesis. In a subsequent exchange, Cziko (1989) and Bickerton (1989) debated which semantic components are at stake in the punctual-nonpunctual distinction. To resolve the controversy, Shirai (1991) suggested that Bickerton might be confusing punctuality with telicity (i.e., all the verbs in Bickerton's category of punctual verbs are also telic, equivalent to Vendler's

accomplishments or achievements), so it might be telicity rather than punctuality to which children are sensitive in the supposed punctual-nonpunctual distinction. Shirai (1994) also questioned the bioprogram explanation for why English-speaking children do not overgeneralize *-ing* to stative verbs, and showed that they do in fact occasionally make this error.

Evidence for or against the basic child grammar claims about the acquisition of tense and aspect has mostly revolved around whether children at first restrict the use of given tense-aspect markers to a subset of the verbs for which they are appropriate in adult speech (Bloom *et al.* 1980, Rispoli & Bloom 1985, Smith & Weist 1987, Weist, Wysocka, Witkowska-Stadnik, Buczowska & Konieczna 1984). For example, Bloom and her colleagues proposed that aspect precedes tense in child language, since the initial use of tense markers by the English-speaking children they studied was always redundant with lexical aspect (e.g., *-ed* always occurred with completive or resultative verbs). Weist and his colleagues argued against this proposal, which they termed the 'defective tense hypothesis'. In a series of experimental and longitudinal studies, they showed that Polish children do not use tense markers redundantly with the perfective and imperfective forms of verbs, and are able to understand and produce the basic contrast between perfective and imperfective aspect as young as 2;6 (Weist 1983, Weist, Wysocka & Lyytinen 1991). More recent studies suggest that, although there may well be associations between lexical aspect and particular tense-aspect markers, just as Bloom *et al.* (1980) proposed, the associations are probabilistic rather than absolute (Li 1990, in press, Shirai 1991, 1993, Shirai & Andersen 1995); we will return to these studies in the General Discussion.

Previous crosslinguistic studies have provided important information about how children acquire tense and aspect in other languages. However, few studies have systematically examined the acquisition of aspect in Chinese,[2] a language with properties that are interesting in light of current theorizing about the acquisition of aspectual systems. In particular, Chinese provides a set of semantic distinctions in the lexical aspect of verbs that we can use to explore further the language

[2] To our knowledge, the only one so far who has examined the acquisition of aspect markers in Mandarin Chinese is Erbaugh (1978, 1982). In a longitudinal study of four Chinese-speaking children between 2 and 3 years old, Erbaugh found that the perfective marker *-le* emerged first and was used to signal a change of state. The imperfective markers *zai* and *-zhe* emerged later than *-le*.

bioprogram and the basic child grammar hypotheses. For example, 'process' in the distinctions between process and state (language bioprogram) and between process and result (basic child grammar) is encoded by activity verbs in Chinese, while 'state' and 'result' are encoded by stative and accomplishment/achievement verbs, respectively.[3] If the process-state or process-result distinctions are bioprogrammed or otherwise prelinguistically salient, and serve as semantic templates that strongly attract grammatical morphemes, Chinese-speaking children should show early sensitivity to the differences between activity and stative verbs, or between activity and accomplishment/achievement verbs; that is, they should mark verbs from these classes differently.

Evidence for such sensitivity would be compatible with hypotheses about prelinguistically salient aspectual distinctions, but not conclusive, since differential marking patterns could also be learned on the basis of the distribution of aspect markers in the input. So it is also important to examine how children handle distinctions that are marked in Chinese differently from the way they are marked in other languages. For example, English does not normally permit the use of the progressive marker with stative verbs (there are occasional exceptions, cf. Smith 1983). Chinese agrees in not allowing the progressive with stative verbs, but – unlike English – it also does not allow it with achievement verbs, e.g., *da-po* (hit-break) or with posture verbs, e.g., *zuo* (sit) and *zhan* (stand). If children's obedience to supposedly prelinguistic aspectual distinctions is actually caused by their sensitivity to patterns in the input, they should be just as sensitive to language-specific constraints as to the distinctions of the language bioprogram or basic child grammar.

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[3] An anonymous reviewer has reminded us that the term 'process' is not used in exactly the same way in the language bioprogram and basic child grammar hypotheses, with neither hypothesis explicitly adopting Vendler's classification. In the bioprogram, the 'process' side of the state-process contrast remains somewhat vague, but it seems to have to do with the presence of action or dynamicity in the meaning of a predicate, whereas in basic child grammar, 'process' is defined as a temporal perspective (nonpunctual, noncompletive, and ongoing) that contrasts with 'result' (punctual, completive); both perspectives are superordinate to language-specific categories such as imperfective versus perfective or progressive versus nonprogressive. While recognizing that the notion of 'process' is not identical in the two hypotheses, we would argue that 'activity' verbs are good representatives of what is meant by the term in both hypotheses. This means that by comparing activity verbs with stative verbs in children's acquisition of aspect markers we can test the bioprogram's process-state distinction, and by comparing activity verbs with accomplishment and achievement verbs we can test the basic child grammar's process-result distinction.

In what follows, we report three experiments that examined children's comprehension and use of grammatical and lexical aspect in Chinese. Our first experiment explores children's comprehension of the aspect markers *zai, -le* and *-zhe* with verbs from different lexical aspectual classes.

EXPERIMENT 1: COMPREHENSION

METHOD

Participants

A total of 135 children from several kindergartens of Peking University and Qinghua University took part in the experiment. They were divided into three age groups of 45 children each: 4-year-olds (mean age 4;2, range 3;11–4;4), 5-year-olds (mean age 5;1, range 4;10–5;4) and 6-year-olds (mean age 6;0, range 5;10–6;4). Half the children were boys and half girls. Although no attempt was made to test the children's general linguistic and cognitive abilities, all participants appeared to fall within normal limits.

Materials

Our materials and procedure were adapted from a sentence-picture matching task devised by Weist (1983) and Weist *et al.* (1991) to test the comprehension of aspectual distinctions in children learning Polish and English. In our study, aspectual distinctions were represented by pairs of contrasting picture stories, with each story made up of two pictures. Both stories of a pair could be described by the same verb; the difference between them corresponded to the contrast between two aspect markers, one perfective (*-le*) and the other imperfective (*zai* or *-zhe*). The paired stories were bordered with different colours, one red and one green, and some details of the pictures were also correspondingly either red or green. One was called the 'red story' and the other the 'green story', which allowed the two pictures of each story to be referred to as a unit.[4]

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[4] These pairs of two-picture stories have two methodological advantages over pairs of single pictures. First, aspect often has to do with the contour of a situation over time, and the stages of a situation over time can be suggested more clearly in successive frames than in a single picture. Second, pilot testing revealed a methodological problem with the use of single pictures. When one picture shows an imperfective situation (i.e., an ongoing or enduring situation, such as people skating) and the other shows a perfective situation (i.e., the aftermath of a just-

In the overall design of the experiment there were three sentences associated with each story pair (the verb plus *-le, zai* or *-zhe*). The complete set of sentences is listed in Appendix A. But individual children heard only two sentences with each pair: the perfective sentence with *-le* and, as its imperfective counterpart, a sentence with either *zai* or *-zhe*. Across all children, each story was presented with *-le/zai* versus *-le/-zhe* an equal number of times. Which of the two sentences – perfective or imperfective – was designated as the target varied systematically, so that for each story the target sentence contained *-le, zai* and *-zhe* an equal number of times and for each child there was an equal number of *-le, zai* and *-zhe* target sentences (with the exception that only *-le* and *-zhe* appeared in sentences with stative verbs since *zai* cannot be combined with stative verbs).

For each of the six lexical-aspectual verb classes, except for achievement verbs, there were three stories, each with a different verb. We did not test achievement verbs because they cannot be combined with the progressive marker *zai* or the durative marker *-zhe*. We divided accomplishment verbs into two subcategories: resultative verbs that encode the end result of an event (e.g., *gai yi-suo fangzi* (build a house) [note that these are *not* resultative compounds, which we have classified as achievements]), and locative verbs that encode the endpoint of a change of location (e.g. *qu xuexiao* (go to school)). The purpose of this distinction was to allow us to assess whether children treat these alike; recall that Slobin's 'result' temporal perspective encompasses both change of state and change of location verbs, but most of his examples involve resultative verbs, which might well be considered more prototypical of the result perspective.

Each child was thus presented with a total of 18 pairs of stories, three for each of six verb types: activity, semelfactive, stative, mixed

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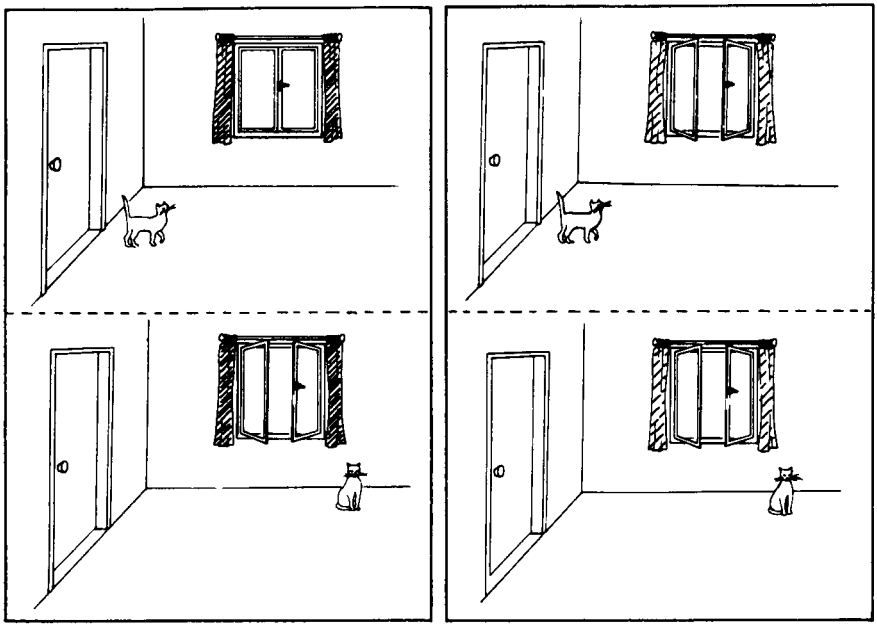
completed event, such as people leaving the ice), children who ignore the aspect markers or who do not understand them will tend to choose the imperfective picture because it best represents the meaning of the verb itself, e.g., skate. To solve this problem, the pictures in our study were combined into stories in such a way that one picture – which optimally represented the situation named by the verb – was shared by *both* stories. In the imperfective story this picture was combined with another picture showing an earlier phase of the same situation, and in the perfective story it was combined with another picture showing the event just ending. (Hints were built into both stories to indicate the passage of time; e.g., in the story shown in Fig. 1, a bystander cat has just entered a room in the first picture and has moved to the centre of the room in the second picture.) This arrangement encouraged children to compare stories rather than individual pictures and eliminated their bias for choosing imperfective pictures.



(1a) (1b)

Fig. 1. Sample pair of picture stories used in Experiment 1 to test the understanding of the contrast between perfective and imperfective aspect. Story (1a) is picked out by the perfective sentence *Wu-li -de chuanghu kai -LE* (The window in the room opened), whereas story (1b) is described by the imperfective sentence *Wu-li -de chuanghu kai-ZHE* (The window in the room is open). In one story the curtains are red, and in the other story they are green.

telic-stative, accomplishment/resultative, and accomplishment/locative. Fig. 1 presents a sample story pair, which illustrates the stative verb *kai* (open).

Procedure

Children were tested individually. For each story pair, the two stories were laid out side by side on a table in front of the child. The experimenter briefly explained the stories without using the target verb, pointing out that one was the red story and the other was the green story. Then the test procedure was administered. For example, the child was told: 'In these two differently coloured stories, one story tells that *Wu-li -de chuanghu kai -LE* (the window in the room opened), and the other tells that *Wu-li -de chuanghu kai -ZHE* (the window in the room

is open). Now, tell me which story shows *Wu-li -de chuanghu kai -LE* (or *Wu-li -de chuanghu kai -ZHE*)?' (These instructions are of course translated in part from the Chinese original.) The child could point to the pictures as in Weist (1983) and Weist *et al.* (1991), but he or she was also asked to say whether the sentence described the red story or the green story. This procedure was designed to forestall responses based purely on the child's assessment of individual pictures.

Before the start of testing with the 18 story pairs, the child was asked to label the colour of two identical toys, one green and one red, and those who could not do this were replaced by children who could. Children were also given two warm-up sets of stories and sentences to practise on, and the practice was repeated until they clearly understood the procedure. Each experimental session lasted about 30 minutes.

Data analysis

A child's response was counted as correct if it picked out the picture story described by the test sentence and incorrect if it picked out the other story. When children gave no verbal response (e.g., they only pointed), or changed their answer, their responses were counted as missing. Children who had more than three missing responses were replaced.

Our analysis will focus on the contrasts between (1) the progressive marker *zai* and the perfective marker *-le*, and (2) the durative marker *-zhe* and the perfective marker *-le*. We exclude from the analysis target sentences that combined *-zhe* with verbs other than stative and mixed telic-stative, because these combinations are generally used to signal background information, and so are incomplete on their own. We did not test the combination of *zai* with stative verbs since the combination is ungrammatical. The contrasts we are interested in, then, are between *zai* and *-le* for all verb types except statives, and between *-zhe* and *-le* for statives. Only one category of verbs, the mixed telic-stative verbs, was tested with all three aspect markers, *zai, -zhe* and *-le*.

Responses to the three stories for each verb type were pooled and a loglinear analysis was performed on the raw frequencies of correct responses for each verb type. Loglinear analysis has become an increasingly important tool for developmental researchers because of its usefulness in analysing complex frequency data (Gilbert 1981, Green 1988, Kennedy 1992, Knoke & Burke 1980).[5] Loglinear analysis

[5] Some readers may wonder why we did not conduct analyses of variance (ANOVA) on these data. The reason is that complex multi-factor frequency data often violate basic requirements of distribution and variance for ANOVA.

TABLE 1. *Percentage correct in children's comprehension of aspect markers with each verb type across age groups*

	4-year-olds			5-year-olds			6-year-olds		
	zai	*-le*	*-zhe*	*zai*	*-le*	*-zhe*	*zai*	*-le*	*-zhe*
Activity	77	38	*	78	49	*	96	51	*
Semelfactive	70	51	*	77	52	*	84	67	*
Accomp./Res.	53	68	*	61	80	*	70	82	*
Accomp./Loc.	62	56	*	65	75	*	76	78	*
Mixed Tel.-Sta.	56	78	89	66	80	91	68	96	89
Stative	**	44	78	**	51	87	**	58	87

* Incomplete sentences ** Ungrammatical combinations

fits data to various candidate models that incorporate the effects of one variable (denoted below with {X}), two variables ({X}{Y}), or three variables ({X}{Y}{Z}). For example, the model that incorporates the effect of age is designated {A}, whereas the model that incorporates the individual effects of age and aspect marker is designated {A}{M}, with each variable name in separate brackets. A model that incorporates the *interaction* effects as well as the individual effects is designated {XY}, with all variable names enclosed in one bracket, e.g., {AM}, for the interaction between age and aspect marker. Because the models are hierarchically organized, models with higher-order effects, e.g., interactions between age, aspect marker and verb type, presuppose the inclusion of the corresponding lower-order effects, e.g., individual effects of age, aspect marker and verb type, plus three two-way interactions.

RESULTS AND DISCUSSION

Table 1 shows the percentage of correct responses broken down by age, obtained by dividing the number of correct responses by the total number of responses for each verb type.

Table 2 presents the results of the loglinear analysis performed on the raw frequency data from which the percentages of Table 1 were calculated. This table shows all the possible models and their fit to the data. In a loglinear analysis we select the best-fitting model that is at the same time the most parsimonious in terms of how many effects are involved. Each model's fit to the data is indicated by a p value in Table 2. A p value above 0.05 indicates an adequate fit to the data, while a p

TABLE 2. *Loglinear models fitted to the comprehension data in Experiment 1*

Model	Effect name*	*df*	L^2	*p*
(1)	{M}	36	43.68	0.18
(2)	{A}	36	48.81	0.08
(3)	{V}	33	51.49	0.02
(4)	{M} {A}	34	34.33	0.45
(5)	{V} {A}	31	42.14	0.09
(6)	{V} {M}	31	39.19	0.15
(7)	{V} {M} {A}	29	29.84	0.42
(8)	{MA}	30	32.93	0.33
(9)	{VA}	21	41.09	0.01
(10)	{VM}	21	12.33	0.93
(11)	{MA} {V}	25	28.44	0.29
(12)	{VA} {M}	19	28.79	0.07
(13)	{VM} {A}	19	2.97	1.00
(14)	{VA} {MA}	15	28.01	0.02
(15)	{VM} {MA}	15	1.57	1.00
(16)	{VM} {VA}	9	1.92	0.99
(17)	{VM} {MA} {VA}	5	1.12	0.95
(18)	{VMA}	0	0.00	1.00

* A = Age, M = Aspect marker, V = Verb type

value below 0.05 indicates an insufficient fit.[6] All models except (3), (9) and (14) are above this significance level. To determine which of the acceptable models best accounts for the data, we evaluated pairwise all combinations of models that differed in only one effect. Through a forward-selection method (i.e., starting with the simpler models and moving on to the more complex ones),[7] we identified (13) as the best-fitting and most parsimonious model. This model shows that the effect of age and the interaction between the aspect markers (grammatical aspect) and verb types (lexical aspect) are the most important relationships in the data.

[6] Special attention should be paid here to the interpretation of *p* values. In loglinear analysis, a *p* value above 0.05 indicates that the model fits the data adequately. Thus, the smaller the L^2 is relative to the *df* and the closer the *p* value is to 1.00, the better the model fits the data. This interpretation differs from the customary one for a *p* value, according to which values of 0.05 *or less* are taken to indicate a significant effect; see Knoke & Burke (1980).

[7] Another technique in loglinear analysis is the backward-elimination method, in which the selection of a best model proceeds from the more complex to the simpler one.

The interaction effect revealed in the loglinear analysis shows that the children understood given aspect markers better with some verb types than with others. In particular, children of all ages comprehended progressive *zai* better with activity and semelfactive verbs than with resultative and locative verbs, and perfective *-le* better with resultative and locative verbs than with activity or semelfactive verbs (see Table 1). Notice that activity and semelfactive verbs are both atelic (process but no endpoint), while resultative and locative verbs are both telic (process with endpoint). Within the category of atelic verbs there was no difference between activity verbs (nonpunctual) and semelfactive verbs (punctual), and within the category of telic verbs there was no difference between resultative verbs (end result) and locative verbs (endpoint). The property of lexical aspect that seems to be critical for these young learners is, then, telicity rather than punctuality. For the stative verbs, children understood *-zhe* much better than *-le*, whereas for the mixed telic-stative verbs, they understood both *-zhe* and *-le* very well (both above 80%).

The significant main effect of age in model (13) indicates that there was a developmental effect: not surprisingly, the comprehension of aspect markers increased steadily with age. The differences between different verb types were more pronounced for younger than for older children, but the pattern of interaction between aspect markers and verb types was similar across age groups, with *zai* associated with atelic verbs and *-le* with telic verbs. In contrast to *zai* and *-le*, the comprehension of *-zhe* showed no clear development across the age range studied. Even the youngest children, the 4-year-olds, responded correctly to *-zhe* 78% of the time with stative verbs, and 89% of the time with mixed telic-stative verbs.

Experiment 1 shows that grammatical and lexical aspect interact to determine the pattern of children's correct responses, suggesting that the inherent lexical meaning of verbs plays a significant role in children's comprehension of aspect markers in Chinese. The associations between *zai* and atelic verbs, and between *-le* and telic verbs, are consistent with previous findings in other languages (e.g., Aksu 1978, Antinucci & Miller 1976, Bloom *et al.* 1981, Stephany 1981, Weist *et al.* 1984). But our study is more comprehensive than previous studies in that (a) it looks at children's comprehension of aspect markers with all major types of verbs, in contrast to, for example, Weist (1983), who examined Polish children's comprehension of aspect markers with only result verb phrases; and (b) it provides a balanced picture of the acquisition of both the perfective and imperfective markers. According to Weist (1983) and Weist *et al.*

(1984, 1991), perfective aspect is the most marked perspective in Polish, while imperfective aspect is the most marked perspective in English. In Chinese, perfective aspect and imperfective aspect do not differ in markedness, so our results are not influenced by the effects of linguistic markedness.

The finding that children understand the progressive marker *zai* better with atelic verbs (activity and semelfactive) and the perfective marker *-le* better with telic verbs (both resultative and locative endpoint) is consistent with the predictions of basic child grammar. Recall that Slobin (1985) argued that children are prelinguistically attuned to the distinction between process and result. Processes include both activity verbs and iteratively-construable semelfactive verbs. Results encompass for Slobin both changes of state (our resultative verbs) and changes of location (our locative endpoint verbs). We found no significant difference in the comprehension of *-le* with telic verbs of the two kinds, so for children changes of state are apparently no more central to this category than changes of location.

In contrast, predictions of the language bioprogram hypothesis were not borne out. In particular, children's comprehension of *zai* and *-le* did not differ as a function of the punctuality of the verb: *zai* was not understood better with activity verbs (nonpunctual) than with semelfactive verbs (punctual) nor, conversely, was *-le* understood better with semelfactive verbs (punctual) than with activity verbs (nonpunctual). Similarly, there was no evidence for the bioprogram 'state-process' distinction, since children understood the perfective marker *-le* poorly with both activity and stative verbs, and they understood imperfective markers equally well with both activity verbs (which take *zai*) and stative verbs (which take *-zhe*).

EXPERIMENT 2: PRODUCTION

Experiment 1 was a comprehension study that assessed children's understanding of grammatical aspect when aspect markers were combined with verbs that differ in lexical aspect. Experiment 2 was a production study that investigated how children use aspect markers with verbs of different kinds.

METHOD

Participants

Children for this experiment came from the same kindergartens as in Experiment 1, and some children participated in both experiments

(with at least a 48-hour interval between them). There was a total of 99 children across four age levels: 3-year-olds (mean age 3;2, range 2;9–3;6), 4-year-olds (mean age 4;1, range 3;8–4;4), 5-year-olds (mean age 5;1, range 4;11–5;4), and 6-year-olds (mean age 6;1, range 5;11–6;4). Each age group had 25 children, except for the 3-year-old group which had 24 (one 3-year-old's data were missing due to apparatus breakdown). Half the children were boys and half girls.

Materials

Children were asked to describe 18 situations enacted with toys. There were three situations for each of six lexical-aspectual categories – the same categories as in Experiment 1 except for the addition of achievements and the omission of mixed telic-statives, since it was too difficult to elicit the use of a mixed-telic-stative verb in both its senses (e.g., both 'wear' and 'put on' for *chuan*). Sample enactments included: for activities, a doll canoeing; for semelfactives, a doll knocking once on the back of a turtle (single punctual event), and a rabbit jumping around (iterated event); for achievements, a car knocking down a bridge; for accomplishments (these were again split into two subcategories), a doll catching a fish with a hook (resultative), and a penguin climbing to the top of a staircase (locative); and for (postural) states, a monkey standing on a table.

Procedure

The children were brought individually to a room where the toys were laid out on the floor, and told that they were going to play games with the experimenters. There were two experimenters. One acted out the situations one at a time and, after each enactment, asked the child to describe what had happened with the toys for the benefit of the other experimenter, who was blindfolded (for a similar procedure, see Hickmann & Liang 1990). The child was told to look carefully at the situations that were about to be shown and to make sure that the blindfolded experimenter could understand from the descriptions what had happened.[8] Children were given a few practice trials to make sure

[8] The instruction given to the child was *gaosu shushu/ayi, X zenme la?* (tell uncle/auntie X how question marker; = tell the uncle/auntie [i.e., the blindfolded experimenter] how X [the manipulated toy] is'). This instruction contains no aspect marker, and was chosen because, as Bronckart & Sinclair (1973) and Weist *et al.* (1984) have noted, children's use of tense-aspect markers in experimental situations can be influenced by biased elicitations.

that they understood the procedure. The whole testing session lasted about 20 minutes, and was audio-taped for later analysis.

Data coding and analysis

Children's descriptions of the enacted situations were all transcribed, coded, and entered into the computer by the first author according to the format of the Child Language Data Exchange System (CHILDES database, MacWhinney 1995, MacWhinney & Snow 1985, 1990). The transcriptions were double-checked by James Liang of the Sinological Institute, Leiden University. The CLAN program designed for CHILDES data was used for the computational analysis (including lexical search and frequency counts).

Although the enactment situations were designed to elicit verbs belonging to particular lexical-aspectual categories, it was impossible to ensure that the children would use the target kinds of verbs, since they were free to focus on any part of the situation. Thus, it makes little sense to count how many instances of a given aspect marker occurred in response to each category of situation (as has been done in some studies, e.g., Bronckart & Sinclair 1973). Instead, we classified the verbs in children's descriptions irrespective of the type of situation they were used to describe. There were five such classes: (1) *activity* verbs that encode an action with no endpoint or end result, e.g., *hua-chuan* (row-boat), *youyong* (swim); (2) *semelfactive* verbs that encode a punctual but not resultative situation, e.g., *tiao* (jump), *zhayan* (blink); (3) *achievement* verbs that encode the end result of a punctual situation, e.g., *zhuang-dao* (hit-break); *diao* (drop); these were mostly resultative compounds; (4) *accomplishment* verbs that encode a durative process with a locative endpoint, e.g., *pao xiao fangzi-li* (run into the little room), *shang louti* (go upstairs); and (5) *stative* verbs that encode the posture of the actor in a situation, e.g., *zuo zai yizi-shang* (sit in the chair), *zhan zai zuozi-shang* (stand on the table).

Eighty-five percent of all the sentences in the children's speech contained an aspect marker, either *zai, -ne, -zhe* or *-le*. Of the remaining 15%, half had stative verbs that did not require an aspect marker because a prepositional phrase occurred postverbally.[9] We will report only on those sentences in which the verb was accompanied by an imperfective marker, either *zai* or *-ne*, or the perfective marker *-le*. The

[9] In Chinese, if a stative verb is immediately followed by a prepositional phrase (PP) – usually a locative phrase with the preposition *zai* – then the V+ PP structure has the effect of indicating the duration of the state, without requiring the use of aspect markers. See Li (1990, 1993*a*) for details.

TABLE 3. *Percentage represented by* -ne, zai *and* -le *of the total number of aspect markers used with each verb type across age groups*

	3-year-olds			4-year-olds			5-year-olds			6-year-olds		
	-ne	*zai*	*-le*	*-ne*	*zai*	*-le*	*-ne*	*zai*	*-le*	*-ne*	*zai*	*-le*
Activity	48	20	32	58	18	24	42	33	25	61	31	8
Semelfactive	55	20	25	52	24	24	40	37	23	56	36	8
Achievement	0	0	100	0	1	99	0	1	99	0	1	99
Accomp./Loc.	9	0	91	5	0	95	0	5	95	0	8	92
Stative	47	9	44	55	5	40	49	22	29	75	10	15

marker *-zhe* was excluded from the analysis because it occurred very infrequently in the children's speech. A total of 1007 sentences was included in the analysis: 213 sentences from the 3-year-olds, 254 sentences from the 4-year-olds, 254 sentences from the 5-year-olds, and 286 sentences from the 6-year-olds.[10]

RESULTS AND DISCUSSION

Table 3 presents the percentages represented by *zai, -ne* and *-le* of the total number of aspect markers used with each verb type, broken down by age group. As in Experiment 1, a loglinear analysis was applied to the raw frequency data from which these percentages were calculated.

Table 4 presents all the possible models and their fit to the data. In Experiment 1, many simple models fit the data well, but in this experiment, models simpler than (14) did not fit the data adequately; only models (14), (17), and (18) were adequate. This indicates that the relationships among the variables are more complex than in Experiment 1.

Although there was no obvious best model in terms of both fit and

[10] There is no grammatical category of tense in Chinese. As in other languages that lack inflectional morphology, such as Thai or Vietnamese, verbs in Chinese are not marked for event time differences. The imperfective aspect markers *zai* and *-ne* can be used to mark events in either the present or the past. In our experiment, then, children could use *zai* and *-ne* to refer to enactment situations that were either ongoing at the time they described them (e.g., a doll was canoeing or a rabbit was jumping) or completed (e.g., a doll had been canoeing or a rabbit had been jumping earlier).

TABLE 4. *Loglinear models fitted to the production data in Experiment 2*

Model	Effect name*	*df*	L^2	*p*
(1)	{M}	57	1010.00	0.00
(2)	{A}	56	1256.92	0.00
(3)	{V}	55	1024.46	0.00
(4)	{M} {A}	54	999.20	0.00
(5)	{V} {M}	53	766.75	0.00
(6)	{V} {A}	52	1013.66	0.00
(7)	{V} {M} {A}	50	755.95	0.00
(8)	{MA}	48	975.78	0.00
(9)	{VM}	45	76.78	0.00
(10)	{VA}	40	1002.55	0.00
(11)	{MA} {V}	44	732.52	0.00
(12)	{VM} {A}	42	65.98	0.01
(13)	{VA} {M}	38	744.83	0.00
(14)	{VM} {MA}	36	42.56	0.21
(15)	{VA} {MA}	32	721.41	0.00
(16)	{VM} {VA}	30	54.87	0.00
(17)	{VM} {MA} {VA}	24	15.21	0.91
(18)	{VMA}	0	0.00	1.00

* A = Age, M = Aspect marker, V = Verb type

parsimony, we again used the forward-selection method to discover – by systematic pairwise comparisons of all models that differed in only one effect – the significant effects that account for most of the structure in the data. These were the three main effects – verb type, aspect marker, and age – and the two-way interaction effects of verb type by aspect marker, and aspect marker by age. The interaction between verb type and aspect marker was the most important effect: models that included this interaction provided a significantly better fit to the data than models that did not. As in Experiment 1, the strong effect of verb type by aspect marker emphasizes the importance of the interaction between lexical aspect and grammatical aspect in children's acquisition of Chinese. In Experiment 1 we observed an association in children's comprehension between the progressive marker *zai* and atelic verbs (activities and semelfactives), and between the perfective marker *-le* and telic verbs (accomplishments, including resultative and locative). In this experiment we found that both the imperfective markers *zai* and *-ne* occurred almost exclusively with atelic verbs (activities and semelfactives) while the perfective marker *-le* occurred

predominantly with telic verbs (accomplishments and achievements). This pattern held for all age groups, and became more pronounced with age; the 5-year-olds did not produce a higher proportion of *-ne* with activities and semelfactives than did the 3- or 4-year-olds, but they produced a higher proportion of *zai* with these verbs than did the 3- or 4-year-olds.

To establish the difference between pairs of verb types more clearly, we conducted several separate chi-square analyses. For each age group, we contrasted activity verbs with semelfactive verbs and activity verbs with stative verbs in the frequency of use of aspect markers in 2 x 3 (verb x aspect marker) contingency tables. The only significant differences were between activity and stative verbs in the 4-year-olds (χ^2 (2) = 5.97, $p = 0.05$) and 6-year-olds (χ^2 (2) = 6.58, $p < 0.05$). There is, then, no difference between activity and semelfactive verbs in this experiment, as was also true in Experiment 1; nor is there a clear difference between activity and stative verbs.

To summarize, the results provided converging evidence for the patterns observed in Experiment 1. Children's productive speech is characterized at an early stage by a strong interaction between lexical and grammatical aspect. In particular, the results provide further support for the basic child grammar hypothesis that the distinction between process and result is important in children's early acquisition of tense-aspect markers. From at least age 3, children almost always combine achievement verbs with *-le*, and not *zai* or *-ne*, which indicates that they must have integrated the meaning of result into their knowledge of these verbs.[11] In contrast, the data from Experiment 2 are not consistent with predictions of the language bioprogram hypothesis. First, in no age group did children use aspect markers differently with activity (nonpunctual) and semelfactive (punctual) verbs. Second, in all age groups children used aspect markers differently with achievement verbs (punctual and resultative) and semelfactive verbs (punctual but non-resultative) – in other words, punctual verbs did not hang together as a category. Third, the pattern with respect to activity versus stative verbs went, if anything, counter to the language bioprogram hypothesis, with its emphasis on built-in or unlearned distinctions: the youngest children (3-year-olds) did not mark verbs belonging to these two categories differently while the oldest (6-year-olds) did.

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[11] The result versus process distinction is also crucial to children's acquisition of certain syntactic devices in Chinese, as revealed by a qualitative analysis of the data from Experiment 2 (see Li 1990, 1993*a*).

EXPERIMENT 3: IMITATION

Experiment 3 was an elicited imitation task. Following Slobin & Welsh (1973), we assume that when young children are asked to imitate a sentence that is too long for them to reproduce by rote memory, they filter its meaning, as they understand it, through their own productive system. This means that elements in the model that are ungrammatical or unusual within the child's system will tend to be modified. (For systematic applications of the elicited imitation technique, see Kuczaj & Maratsos 1975, and Budwig 1991.) Applying this reasoning to the problem at hand, we can predict that if Chinese children understand the use of aspect markers, they should have more difficulty imitating ungrammatical than grammatical combinations of aspect markers with verbs. In particular, when faced with an ungrammatical combination of verb and aspect marker they will tend to omit the marker or change either the marker or the verb so that the combination becomes grammatical.

In this experiment, we used elicited imitation to see whether children are sensitive to two combinations of aspect marker and verb that are ungrammatical in Chinese: (1) progressive *zai* with achievement verbs, and (2) progressive *zai* with stative verbs.

METHOD

Participants

A total of 72 children participated in this experiment immediately after completing Experiment 2: 22 3-year-olds (mean age 3;2), 25 4-year-olds (mean age 4;1), and 25 5-year-olds (mean age 5;1).

Materials

Eight model sentences were constructed. All the sentences were about the same length (9 to 10 syllables, 6 to 8 words). The sentences were intended to exceed children's short-term memory capacity so that they could not be simply parroted back. Since no work has assessed 3- to 5-year-old Chinese children's short-term memory span for syllables and words, we settled on 9 to 10 syllables on the basis of pilot testing. A pre-test showed that our sentences were too easy for 6-year-olds, so children of this age were not tested further.

In the production task of Experiment 2, children almost never used the progressive marker *zai* with achievement verbs (resultative compounds) – rather, they used it almost exclusively with activity and semelfactive verbs, which are non-resultative. This finding was interpreted as showing that children are sensitive to the meaning of result

inherent in achievement verbs. The 5-year-olds in that experiment did produce some ungrammatical combinations of *zai* with a stative verb, but this was rare. The present experiment created an artificial environment in which both achievement verbs (resultative compounds) and stative verbs were combined ungrammatically with *zai* in the sentences modelled for imitation.[12] Achievement verbs and stative verbs were also combined grammatically with the perfective marker to provide a baseline for comparison. Two instances of each verb type were combined with *zai* and another two with *-le* for a total of eight test sentences, all of which were administered to each child. The four resultative verb compounds were *qie-kai* (cut-open), *da-hao* (build-ready), *zuo-hao* (make-ready), and *shuai-po* (throw-break). The four stative verbs were *xihuan* (like), *mingbai* (understand), *you* (have), and *zhidao* (know). Two examples are shown in sentences (8) and (9); see Appendix B for the complete set of sentences.

(8) *Xiaopengyou da-hao -le neixie jimu.* (achievement verb + *-le*; grammatical)
child build-ready -LE those blocks
The child built (i.e., stacked up) the blocks.

(9) *Mama zai zuo-hao yi-guo mifan.* (*zai* + achievement verb; ungrammatical)
mother ZAI make-ready one-pot rice
Mother is making a pot of rice ready.

Procedure

After completing Experiment 2 children were asked to continue with another game called 'teaching the puppet to speak'. The experimenter held out two puppets and asked the child which one he or she liked better. The child then took the preferred puppet and the experimenter kept the other. Next, the experimenter explained that the puppets could not speak and that she and the child would play a game to teach them how to speak. The child should follow the experimenter and teach his or her own puppet in exactly the same way as the experimenter would do. Then the experimenter read the model sentences one by one for her puppet, and the child imitated each one for his or her puppet. The order of presentation of the model sentences was pseudorandomly arranged separately for each child such that no more than two ungrammatical

[12] A third type of verb was also tested in this experiment: simple resultatives such as *diao* (fall), which belong to the category of achievement verbs. Since these were all intransitive and are not directly comparable to the other two types of verb used in this experiment, they are not reported here; see Li (1990) for details.

TABLE 5. *Percentage successful imitations of the model sentences (verb type by aspect marker by age group)*

	3-year-olds		4-year-olds		5-year-olds	
	*zai**	*-le*	*zai**	*-le*	*zai**	*-le*
Achievement	23	57	40	72	64	82
Stative	46	43	78	70	88	72

* Ungrammatical combinations of the aspect marker with the verb

sentences occurred consecutively. Before testing began, the child practised with three warm-up sentences until the task was clear. The whole session was audio-taped.

Data coding and analysis

The data were transcribed and coded in the same way as in Experiment 2. An imitation was counted as successful if the child retained the main verb and the aspect marker of the model sentence, irrespective of other changes; otherwise it was counted as erroneous. The errors were either omissions or substitutions of the aspect marker or the verb, and they occurred most typically when the combination was ungrammatical.

RESULTS AND DISCUSSION

Table 5 presents the successful imitations as percentages of the total number of imitations in each age group for each combination of aspect marker with verb type (there were 22 3-year-olds and so a total of 44 imitations for each combination; there were 25 children in both the 4- and 5-year-old groups and so 50 imitations for each combination). Table 5 shows that children's successful imitations increased steadily with age.

Because the data shown in Table 5 have a much simpler structure than the data of the previous experiments, we used chi-square analyses rather than loglinear analyses. A 2 x 2 chi-square analysis was conducted for each age group, treating aspect marker (*zai* vs. *-le*) and verb type (achievement vs. stative) as the variables. For the 3- and 4-year-olds, success in imitating sentences with *zai* versus *-le* differed significantly as a function of whether the verb encoded a result (achievement verbs) or a state (stative verbs): age 3: χ^2 (1) = 3.95, $p < 0.05$; age 4: χ^2 (1) = 3.71, $p = 0.05$. For the 5-year-olds, however, the difference did not reach significance: χ^2 (1) = 1.90, n.s. This may be

due to the increased short-term memory span of the 5-year-olds: of the ungrammatical combinations with *zai,* they could successfully imitate over 60% of those with achievement verbs and over 80% of those with stative verbs.

The ungrammatical combination of *zai* with achievement verbs (resultative compounds) presented a particular imitation difficulty, especially for the younger children. Note that resultative compounds consist of two components, the first indicating the action and the second the result, e.g., *qie-kai* (cut-open). In adult speech, the meaning of result is dominant in these constructions: it eclipses the meaning of action to such an extent that the compound cannot be marked with *zai* (Li 1987, Tai 1984). Children's difficulty in imitating the ungrammatical combination of *zai* with these verbs shows their sensitivity to the salience of the meaning of result and its clash with the progressive meaning of *zai.* This finding is consistent with the finding in Experiment 1 that children understood *-le* better than *zai* with resultative accomplishment verbs, and in Experiment 2 that they used *-le* and almost no *zai* with achievement and locative accomplishment verbs. Taken together, these findings indicate that Chinese children are indeed sensitive to the distinction between process and result, as proposed in the basic child grammar hypothesis.

If the process-state distinction were just as salient to learners as the process-result distinction, children should be just as resistant to imitating combinations of *zai* with stative verbs as combinations of *zai* with achievement verbs; recall that both are ungrammatical. But these combinations did not present a particular difficulty to children; even the 3-year-olds imitated the ungrammatical stative combinations just as well as the grammatical ones, and the 4- and 5-year-olds imitated them even better. Children were not, then, sensitive to grammaticality *per se* in this experiment, but to particular combinations of aspect marker and lexical aspectual category. This result constitutes a further challenge to Bickerton's proposal that the process-state distinction is bio-programmed, and so to his explanation for why English-speaking children do not over-generalize progressive *-ing* to stative verbs.

GENERAL DISCUSSION

This study has examined children's comprehension and use of grammatical and lexical aspect in the acquisition of Mandarin Chinese. In Experiment 1, children showed that they understood progressive *zai* better with activity and semelfactive verbs than with accomplishment verbs, and perfective *-le* better with accomplishment verbs than with

activity and semelfactive verbs. There was no difference in their comprehension of either *zai* or *-le* with activity versus semelfactive or stative verbs. In Experiment 2, children produced imperfective aspect markers (*zai* and *-ne*) mostly with activity and semelfactive verbs and rarely with accomplishment or achievement verbs, and they produced the perfective marker *-le* more frequently with accomplishment and achievement verbs than with activity and semelfactive verbs. There was no significant difference in their use of either perfective or imperfective markers with activity as opposed to with semelfactive or stative verbs. In Experiment 3, children imitated the combination of achievement verbs (resultative compounds) with the perfective marker *-le* (grammatical) better than with the progressive marker *zai* (ungrammatical), but their imitation of stative verbs with *-le* (grammatical) and *zai* (ungrammatical) did not differ. In sum, there was a consistent association of imperfective markers with atelic verbs and the perfective marker with telic verbs. Stative and semelfactive verbs patterned in general like activity verbs.

What are the implications of these results for the language bioprogram and basic child grammar hypotheses? According to the language bioprogram hypothesis (Bickerton 1981, 1984), children are innately sensitive to the distinction between process and state and between punctual and nonpunctual verb meanings. Our results are inconsistent with this claim. In general, children did not distinguish between activity and stative verbs in their use of aspect markers. They did treat achievement verbs differently from activity and stative verbs, which might at first glance be taken as evidence for the punctual-nonpunctual distinction (Bickerton indeed used such evidence to support the innateness of the distinction). But the achievement verbs in our studies were not only punctual but also resultative, so to identify which meaning component is responsible for the difference between activity verbs and achievement verbs, we must look at verbs that are punctual but not resultative, such as semelfactive verbs. In our studies children did not distinguish semelfactive verbs from activity verbs, but did distinguish them from achievement verbs. This is strong evidence that the difference between achievement verbs and activity verbs in our experiments comes not from the punctual but from the resultative meaning of the achievement verbs.

According to the basic child language hypothesis, children orient from the beginning to a major temporal contrast between process and result (Slobin 1985). This contrast is claimed to belong to a starting set of basic semantic notions that are independent of experience with any particular language, and that serve as initial magnets for the

grammatical morphemes of the input language. Our findings are consistent with the claim that children are highly sensitive to this contrast: in all three experiments children treated activity verbs differently from resultative verbs. But must we concur with Slobin that the cleavage between process and result is critically salient for the child before language learning even begins?

In the last few years, proposals that children organize their grammars according to semantic or syntactic contrasts that are especially salient ahead of time have come increasingly under fire from researchers who stress young children's extraordinary skills at detecting patterns in the linguistic input (e.g., Behrens 1993, Bowerman 1985, 1989, 1996, Choi & Bowerman 1991, Snow 1977) and at extracting correlations and prototypes from these patterns (Li 1990, Shirai 1994, Shirai & Andersen 1995, Stephany 1981). In a very recent rethinking, even Slobin himself (1997, and in press) has raised serious problems for his earlier proposal that there is a universal set of semantic notions that are 'privileged' for mapping to grammatical morphemes. He now suggests that the grammatical morphemes found in a language at any particular time, and the meanings they express, are best seen as the outcome of continuous diachronic processes of grammaticization – processes shaped not by a priori templates for either grammatical forms or for their possible meanings, but by various kinds of communication pressures. Learning the meanings of grammatical morphemes is, according to Slobin's reformulation, no different in kind from learning the meanings of content words: both belong to the general domain of concept formation. In line with these reanalyses of the problem of how children map between form and meaning, we believe that it is possible to account for children's early sensitivity to the process-result distinction by appealing to learners' analysis of the distribution of aspect markers in the speech they hear, perhaps as operationalized through connectionist principles (Li, in press, Li & MacWhinney 1996, Rumelhart & McClelland 1986).

An early appeal to patterns in the input to explain children's use of tense-aspect markers was made by Brown (1973). Brown observed (1973: 334) that English-speaking children first use past tense forms with a small set of verbs, including 'fell', 'dropped', 'slipped', 'crashed' and 'broke', 'which name events of such brief duration that the event is almost certain to have ended before one can speak' (i.e., punctual and resultative events). He pointed out that these verbs, in contrast to others, may have always or almost always been modelled in the past form in the mothers' speech. In a more elaborate argument Brown also weighed alternative explanations for the absence of

overgeneralizations of *-ing* to stative verbs in his data. On the one hand, children might have an innate ability to subcategorize verbs as naming processes versus states. But Brown doubted this because, among other things, the English dividing line between processes and states is not universal. As an alternative he suggested that children might simply learn which verbs are '*ing*able' on a verb-by-verb basis from their mother's speech. In this case they would apply *-ing* earlier and more often to verbs that occur frequently with *-ing* in the input than to those that rarely or never do. A comparison of the use of progressives by Brown's subject Eve and her mother was consistent with this hypothesis (Brown 1973: 326–8, see also Kuczaj 1977). In a further analysis of Brown's data, along with data from Sachs (1983), Shirai (1994) showed that children do in fact occasionally overgeneralize *-ing* to stative verbs. Interestingly, a child who often did so had a mother who often used the progressive with stative verbs, lending further support to the hypothesis that children's usage is heavily influenced by patterns in the input.

As we noted earlier, there is mounting evidence that children's associations between tense-aspect markers and categories of lexical aspect are probabilistic rather than absolute; for example, past tense markers may be used most often for resultative events, but they are also occasionally used for activities in the past. Probabilistic associations are problematic for theories that attribute children's biases to the powerful force of prelinguistic semantic distinctions, but they are compatible with the view that children's biases reflect patterns of association in the linguistic input. Systematic evidence for a relationship between children's and parents' marking of temporality comes from a study of the acquisition of tense, aspect and modality in Modern Greek (Stephany 1981). Stephany found that in the speech of Greek mothers there is an association between past/perfective markers and resultative verbs, and between present/imperfective markers and nonresultative verbs, and that this association is in fact stronger in the mothers' child-directed speech than in their adult-directed speech. Greek children's use of tense and aspect markers strongly reflects the distribution of these markers in the mothers' child-directed speech.

To explain the probabilistic nature of associations, Shirai (1994) and Shirai & Andersen (1995) invoked the notion of prototypes. According to prototype theory (Rosch 1975, Rosch & Mervis 1975), members of a semantic category share similarity with each other probabilistically, and membership in a category is graded: members that share many features with other members are seen as more central to their category (i.e., more prototypical) than members that share fewer features. In many domains of language acquisition, children are known to acquire

prototypical members of a category earlier than less prototypical members (Bowerman 1978). In line with this, Shirai (1994) proposed that children might at first associate progressive aspect markers with the prototypical meaning 'action in progress', and so use *-ing* initially only with prototypical action verbs such as 'walk'. Only later, if ever, would they extend *-ing* to verbs that are nonprototypical for the progressive, such as statives. In a similar argument, Shirai & Andersen (1995) proposed that the strong initial association between past/perfective markers and accomplishment and resultative verbs in children's language is due to children's detection of the prototypical meaning for past/perfective markers: 'completion in the immediate past of a punctual event'. They suggest that a prototype account can reconcile the debate over the 'defective tense hypothesis', since it combines recognition that there is a strong semantic tendency in children's use of past/perfective markers with the acknowledgment that the association is imperfect.

Although the prototype hypothesis appears promising for explaining the acquisition of tense and aspect, the process by which a prototype is formed and modified has not been clear. The prototype hypothesis also lacks a mechanism for specifying which verbs fit the prototype for a particular tense-aspect marker and which do not. A connectionist approach may help by providing a mechanistic explanation of how children form probabilistic patterns in analysing the linguistic input. Li (1993*b*) and Li & MacWhinney (1996) proposed that semantic categories such as the verb classes associated with the use of the English reversative prefix *un-* (Bowerman 1982, Whorf 1956) emerge out of a network of semantic features. In the acquisition of a category, the feature-to-category relationship can vary in: (a) how many features are relevant to category membership, (b) how strongly each feature is activated in the representation of the category, and (c) how features overlap with each other across category members. In this perspective, the formation of a semantic category is supported by multiple features connected in a network. A prototype can be viewed as the product of strong connections between particular features or groups of features and particular lexical items or morphemes, such as reversative *un-* or – in our case – aspect markers. The semantic category is organized as a distributed network in which individual lexical items – verbs in the case of both *un-* and aspect markers – differ in the number of features they share and in the strength of their activation in the pattern. Recent empirical evidence suggests that some of these properties of category formation – for example, semantic feature correlations – also play an important role in word recognition by adults (McRae, de Sa & Seidenberg 1997).

In an attempt to explain tense-aspect acquisition from a connectionist perspective, Li (in press) has proposed that semantic features such as 'endpoint', 'result', and 'punctual' can interact collaboratively through summed activation to support the formation of a past/perfective aspectual category that licenses the use of past (e.g., English *-ed*) or perfective (e.g., Chinese *-le*) forms. These features collaborate in the sense that a given verb can be represented with multiple features, and the features themselves often co-occur in the situations to which the verb applies. For example, 'spill' may be viewed as indicating both a punctual and a resultative meaning; 'close' may involve both a change of state and a completive meaning; and 'build a house' implies both an end point and an end result. A feature may also vary in the strength with which it is represented in different verbs. For example, the feature 'punctual' may be represented more strongly in 'jump' than in 'fall': in a natural setting a single jump occurs instantaneously, whereas falling need not (e.g., we could still say that a leaf fell from a tree even if it drifted down slowly). With varying degrees of connections from semantic features to verb forms, verbs can form clusters or categories that differ overall in lexical aspect

Connectionist models differ in how they view 'features': it is still unclear, for example, whether features should be specified ahead of time (i.e., hardwired) for a learner, or whether the learner can extract the necessary features from the input through an inductive process, for example, by analysing lexical co-occurrence and contextual constraints (Burgess & Lund 1997, Landauer & Dumais 1997). In either case, it is not necessary to assume that particular features have a privileged status in guiding the meaning-form mapping process. Children can pick up on patterns in the input through a process of correlating the features of situations with lexical items, or – more relevant to the problem at hand – by correlating sets of features that turn up repeatedly across lexical items (e.g., the recurrent resultative and punctual meanings of achievement verbs) with particular grammatical markers (e.g., English past tense *-ed* or Chinese perfective *-le*). This process can be described as a statistical (probabilistic) procedure in which the child implicitly tallies and registers the frequencies of co-occurrence of semantic features, lexical items, and morphological devices. Children may initially restrict particular tense-aspect forms to particular kinds of verbs because they pick up first only on the most frequent associations in the input.

To conclude, it is possible to account for the strong opposition between process and result that we found in our Chinese data, and that has turned up repeatedly in studies of other languages, without

assuming that children are guided in the form-meaning mapping process by semantic distinctions that are 'privileged' before language-learning even begins. A plausible alternative, we have suggested, is offered by models that emphasize children's ability to detect patterns in the linguistic input, possibly through the formation of prototypes by connectionist networks. Although our understanding of how children approach the input in search of regularities is still limited, it has become increasingly clear that learners' capacity for pattern extraction is robust against 'noisy' data (i.e., partial correlations in the input), and it works remarkably fast.

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APPENDIX A

Test sentences for Experiment 1

Each pair of sentences below corresponds to one pair of picture stories used in the comprehension experiment. The sentences in the left column have an imperfective marker (*zai* or *-zhe*), and those in the right column have a perfective marker (*-le*). For the mixed telic-stative verbs, there are two imperfective sentences (with *zai* and *-zhe*) and one perfective sentence (with *-le*). See text for details. Each sentence is followed first by a literal annotation and then an English gloss. CL stands for classifiers in Chinese. The aspect markers are shown in capital letters. For convenience we use only the present tense to translate the imperfective sentences, but these sentences can be used equally well to describe the same events in the past since there are no tense markers in Chinese.

1. ACTIVITY VERBS

(1) *Shushu ZAI pao-bu.*
uncle ZAI run-pace
Uncle is running.

Shushu pao-LE bu.
uncle run-LE pace
Uncle ran.

(2) *Shushu he ayi ZAI hua-bing.*
uncle and auntie ZAI skate-ice
Uncle and Auntie are skating.

Shushu he ayi hua-LE bing.
uncle and auntie skate-LE ice
Uncle and Auntie skated.

(3) *Shushu ZAI you-yong.*
uncle ZAI swim-strokes
Uncle is swimming.

Shushu you-LE yong.
uncle swim-LE strokes
Uncle swam.

2. ACCOMPLISHMENT (RESULTATIVE) VERBS

(1) *Xiaopengyou ZAI gai yi-zuo fangzi.*
child ZAI build one-CL house
The child is building a house.

Xiaopengyou gai-LE yi-zuo fangzi.
child build-LE one-CL house
The child built a house.

(2) *Shushu ZAI gua yi-zhang huar.*
uncle ZAI hang one-CL painting
Uncle is hanging a painting.

Shushu gua-LE yi-zhang huar.
uncle hang-LE one-CL painting
Uncle hung a painting.

(3) *Xiaopengyou ZAI hua yi-zhi huar.*
child ZAI draw one-CL flower
The child is drawing a flower.

Xiaopengyou hua-LE yi-zhi huar.
child draw-LE one-CL flower
The child drew a flower.

3. ACCOMPLISHMENT (LOCATIVE) VERBS

(1) *Liang-ge xiaopengyou ZAI qu xuexiao.*
two-CL child ZAI go school
The two children are going to school.

Liang-ge xiaopengyou qu-LE xuexiao.
two-CL child go-LE school
The two children went to school.

(2) *Shushu ZAI shang lou.*
uncle ZAI go upstairs
Uncle is going upstairs.

Shushu shang-LE lou.
uncle go-LE upstairs
Uncle went upstairs.

(3) *Shushu ZAI pao yi bai mi.*
uncle ZAI run one hundred metre
Uncle is running one hundred metres.

Shushu pao-LE yi bai mi.
uncle run-LE one hundred metre
Uncle ran one hundred metres.

4. SEMELFACTIVE VERBS

(1) *Da qingwa ZAI tiao ne.*
big frog ZAI jump NE
The big frog is jumping.

Da qingwa tiao-LE.
big frog jump-LE
The big frog jumped.

(2) *Shushu ZAI ti na-tou zhu.*
uncle ZAI kick that-CL pig
Uncle is kicking that pig.

Shushu ti-LE na-tou zhu.
uncle kick-LE that-CL pig
Uncle kicked that pig.

(3) *Houzi ZAI fan-gentou.*
monkey ZAI turn-somersault
The monkey is turning somersaults.

Houzi fan-LE ge gentou.
monkey turn-LE CL somersault
The monkey turned a somersault.

5. MIXED TELIC-STATIVE VERBS

(1) *Ayi ZAI ti yi tong shui.*
auntie ZAI carry a bucket water
Auntie is picking up a bucket of water.

Ayi ti-LE yi tong shui.
auntie carry-LE a bucket water
Auntie carried a bucket of water.

Ayi ti-ZHE yi tong shui.
auntie carry-ZHE a bucket water
Auntie is carrying a bucket of water.

(2) *Shushu ZAI na baozhi.*
uncle ZAI pick newspaper
Uncle is picking up a newspaper.

Shushu na-LE baozhi.
uncle pick-LE newspaper
Uncle held a newspaper.

Shushu na-ZHE baozhi.
uncle pick-ZHE newspaper
Uncle is holding a newspaper.

(3) *Xiaopengyou ZAI chuan yi-jian hua yifu.*
child ZAI wear one-CL flower garment
The child is putting on a flowered garment.

Xiaopengyou chuan-LE yi-jian hua yifu.
child wear-LE one-CL flower garment
The child wore a flowered garment.

Xiaopengyou chuan-ZHE yi-jian hua yifu.
child wear-ZHE one-CL flower garment
The child is wearing a flowered garment

6. STATIVE VERBS

(1) *Wu-li -de deng liang-ZHE.*
room-in -'s light shine-ZHE
The light in the room is on.

Wu-li -de deng liang-LE.
room-in -'s light shine-LE
The light in the room went on.

(2) *He-bian -de shu wan-ZHE.*
river-side -'s tree crooked-ZHE
The tree by the river is crooked.

He-bian -de shu wan-LE.
river-side -'s tree crooked-LE
The tree by the river got crooked.

(3) *Wu-li -de chuanghu kai-ZHE.*
room-in -'s window open-ZHE
The window in the room is open.

Wu-li -de chuanghu kai-LE.
room-in -'s window open-LE
The window in the room opened.

APPENDIX B

Model sentences for Experiment 3

1. ACHIEVEMENT VERBS (RESULTATIVE COMPOUNDS)

(a) Grammatical sentences

(1) *Shushu qie-kai -LE na-ge da xigua.*
uncle cut-open -LE that-CL big watermelon
Uncle cut open that big watermelon.

(2) *Xiaopengyou da-hao -LE neixie jimu.*
child build-ready -LE those block
The child built (i.e., stacked up) those blocks.

(b) Ungrammatical sentences

(3) **Mama ZAI zuo-hao yi-guo mifan.*
mother ZAI make-ready one-pot rice
Mother is making a pot of rice ready.

(4) **Shushu ZAI shuai-po neixie beizi.*
uncle ZAI throw-broken those cup
Uncle is breaking those cups by throwing them.

2. STATIVE VERBS

(a) Grammatical sentences

(1) *Jiejie you -LE yi-jian xin yifu.*
sister have -LE one-CL new dress
The sister has a new dress.

(2) *Shushu mingbai -LE ayi -de hua.*
uncle understand -LE auntie -'s words
Uncle understood what auntie said.

(b) Ungrammatical sentences

(3) **Ayi ZAI xihuan ting-hua -de haizi.*
auntie ZAI like hear-word -'s child
Auntie is liking obedient children.

(4) **Xiaopengyou ZAI zhidao zhe-ge gushi.*
child ZAI know this-CL story
The child is knowing this story.