Grammatical aspect in early child Mandarin: Evidence from a preferential looking experiment

Xiaolu Yang[1], Rushen Shi[2], and Kailin Xu[1]

[1]Tsinghua University, Beijing, China

[2]Université du Québec à Montréal, Montreal, Canada

Yang, X., Shi, R., & Xu, K. (2018). Grammatical aspect in early child Mandarin: Evidence from a preferential looking experiment. *Journal of Psycholinguistic Research*, *47*(6), 1301-1320.

1. Introduction

Aspect, together with tense, crucially contributes to the establishment of temporal reference in natural languages. Every situation takes places at a certain time and lasts for a certain period of time. It is impossible for us humans to experience situations in an atemporal perspective. Sentences describing human experiences should thus all be temporally interpreted. As one of the prominent components in construction of temporal relations, aspect, which typically refers to different ways of viewing the internal temporal structure of situations, has been extensively studied in linguistic theories in the past four decades (e.g. Comrie, 1976; Dahl, 1985; Klein, 1994; Rothstein, 2004; Smith, 1991; Tenny, 1994; Verkuyl, 1993; among others; see also the recent review by Tonhauser, 2015 and references cited there). There are two types of aspect. Grammatical aspect (also known as the viewpoint aspect, Smith, 1991) concerns how the speaker views the event. It refers to the perfective and imperfective distinctions and is encoded in inflectional morphemes in many languages. In English, grammatical aspect is realized in the bound inflectional morphemes *–ed* and*–ing*, which also encodes tense. But in Mandarin Chinese, it is encoded in a range of aspect markers such as *le*, *zhe*, *guo*, *zai*. Lexical aspect (referred to as situation aspect, Smith, 1991) is largely associated with the inherent meanings of lexical verbs or verb constellations that describe whether a particular situation is telic or atelic, i.e. whether it is a stative, acitivity, accomplishment or achievement in Vendler's sense (1967). Given the complexity and subtlety of aspect, learning about the aspectual system in a particular language is no easy task to children. Take grammatical aspect, for instance. English-speaking children need to learn about aspectual forms and understand that they are bound, functional morphemes different

from verbs. In other words, they should be able to segment them apart from lexical verbs. They should also learn about the meanings associated with these morphemes: the past/perfective *–ed* encodes an event that is completed whereas the present/progressive *–ing* describes an event that is still in progress. The ability to differentiate the meaning contrast between the aspectual morphemes such as *–ed* and *–ing* is extremely important in both production and comprehension, without which it is unlikely for children to successfully and appropriately describe or understand what is going on. In this study, we investigate the status of this ability in 30-month-old Mandarin-speaking children. Specifically, we focus on young children's ability to detect the aspectual distinctions involving two aspect markers *le* and *zhe* adopting the intermodal preferential looking paradigm.

A substantial amount of research has been conducted to investigate the use of past/perfective morphemes and present/progressive morphemes by children of different ages learning different languages (e.g. Bloom, Lifter, and Hafitz, 1980; Brown, 1973; Bronckar and Sinclair, 1973; Antinucci and Miller, 1976; Stephany, 1981; Shirai, 1991, 1993; Li, 1990; Liu, 2009; Chen and Shirai, 2010; Stoll, 1998; Behrens, 1993; Green and Roeper, 2007; Tomasello, 1992; Shirai and Andersen, 1995; Clark, 1996). Aspect/tense morphemes have been found to appear quite early in children's speech, well before age two. In a survey of fourteen grammatical morphemes in English-speaking children's speech, Brown (1973) reported that the present/progressive morpheme *–ing* was one of the morphemes used early and the past/perfective morpheme *–ed* emerged later in their use. Compared with lexical means such as temporal adverbials (e.g. *yesterday*, *today* in English), grammatical markers of tense/aspect appear much earlier. Children start to use tense/aspect markers from 1;8 to 2;0

cross-linguistically, whereas children learning different languages start to use temporal adverbials much later: from 2;2 in Mandarin Chinese, 2;6 in French, Polish, and French, and 3;0 in Italian (Weist, 1986). One phenomenon widely attested in many languages is that children tend to under-generalize these morphemes: they apply these morphemes only to a limited number of contexts. Specifically, the past/perfective morpheme (e.g. *–ed* in English) is mostly attached to telic verbs while the present/progressive morpheme (e.g. *–ing* in English) applies predominantly to atelic verbs (e.g. Antinucci and Miller, 1976; Bloom et al., 1980; Brown, 1973; Bronckart and Sinclair, 1973; Clark, 1996; Tomasello, 1992; Shirai and Andersen, 1995; Olsen and Weinberg, 1999). This is different from the adult use of these morphemes. In adult English, -*ing* can occur both on atelic verbs like *play*, *ride*, *eat*, and telic verbs like *break*, *fall*. Yet, in early speech of English-speaking children, verbs like *playing*, *riding*, *pushing*, *eating* are quite common, while verbs like *break*, *fall* are seldom used in the form of V-*ing* such as *breaking*, *falling* and the past/perfective forms of these verbs like *broke* and *fell* are preferred (Bloom et al., 1980; Tomasello, 1992). Clark (1996) studied speech of children between 19 months to 36 months and found that 90% of the present/imperfective morpheme *–ing* occurred on atelic predicates and 60% of the past/perfective morpheme *–ed* appeared on telic predicates. Comprehension studies also suggest the semantic bias or the telicity effect (Li and Bowerman, 1998; Stoll, 1998; Wagner, 2001), though there is also evidence that English-speaking children have an equally good understanding of both the regular combination (i.e. the perfective marker-telic predicate combinations and the progressive marker-atelic predicate combination) and the irregular combination (i.e. the perfective marker-atelic predicate combination and the progressive

marker-telic predicate combination) by age three (Weist, Atanassova, Wysocka, and Pawlak, 1999). Several accounts have been proposed to explain the telicity effect. The aspect hypothesis (e.g. Li and Shirai, 2000; Shirai and Anderson, 1995; also referred to as the aspect-before-tense hypothesis, Bloom et al., 1980; the aspect first hypothesis, Wagner, 2001; see also Shirai, 2009 for a review and references cited there) assumes that there is a lack of the tense category in early grammar and children take tense/aspect markers as telicity or aspect markers. Shirai and Andersen (1995) argue for the existence of a prototypical category conflating tense with aspect. As a result, the misanalysis leads to the undergeneralization in early use of tense/aspect markers. A different account, the learnability account, holds that both categories of tense and aspect are present in child grammar, but the restrictions of tense/aspect markers to a particular verb classes are due to learnability reasons (Olsen and Weinberg, 1999). There are languages that impose use restrictions on some aspect markers (e.g. the Korean aspect marker *–e* only appears with telic intransitives and the Mandarin imperfective aspect marker *zhe* can only co-occur with verbs of activity). Children will ultimately learn whether their language is one that is more restrictive in the use of aspect markers such as Korean or Mandarin Chinese or one that is not so restrictive such as English, but before they succeed in this, they might adopt the more restricted option from which they can retreat later when they find it incompatible with the input data. Thus, the semantic bias results from learnability requirements such as the subset principle (Berwick, 1985) and does not reflect a defect in tense.

The discussion of when children start to use aspect markers and what they encode in early child language also bears to the debate on the initial status of language acquisition. Is

children's knowledge (and understanding) of aspect (and tense) crucially different from that of adults? An answer to this question concerns not only the status of aspect (and tense) but also the status of the abstract category of verbs in early child grammar. If verbs do not form a general category in children's grammar, it would be impossible for children to understand the real function of tense/aspect morphemes. Superficially, acquisition facts of aspect seem to challenge the continuity view of language acquisition that children's grammar consists of the same set of grammatical categories as adults' grammar (Crain and Pietrosky, 2002; Pinker, 1984). Children's early underextensions of the past/perfective and present/progressive morphemes as introduced above show that they do not use aspect markers in the same way as adults as the latter apply these markers more generally to a wider group of verb classes. Another feature of early use of tense/aspect markers also indicates a discrepancy between early child use and mature adult use. It has been found that in some cases, children learning different languages omit tense/aspect morphemes in the obligatory contexts (see Brown, 1973; Platzack, 1992; Wexler, 1994; Haegeman, 1995; Hamann and Plunkett, 1998; among others). This is referred to as the root infinitive stage where young children use bare verbs without any tense/aspect marker and has captured wide attention within the generative camp (Hoekstra and Hyams, 1995; Hyams, 1996; Wexler, 1994, 1999; Rizzi, 1993/1994; see also Guasti, 2002 and references cited there). Generative acquisitionists are more concerned about whether the grammatical category of tense is present in child grammar and try to argue for its availability in early grammar. More recently, Hyams (2007) has discovered a parallel between finite and non-finite clauses concerning the telicity effect: just like children restricting past/perfective morphology to telic predicates and present/imperfective

morphology to atelic predicates in finite clauses, nonfinite clauses that contain telic predicates are largely associated with a past/perfective interpretation and nonfinite clauses with atelic predicates have a present/progressive interpretation. Based on this parallel, Hyams argues against a strictly morphological account or learnability account of the telicity effect and suggests instead that tense is present in early child grammar and is influenced by the event structure in finite clauses. Valian (2006) experimented with two-to-four-year-old English-speaking children's comprehension of the contrast between *is/was* and *will/did* and found that even two-year-olds could distinguish between tense and aspect independently in comprehension, suggesting a syntactic representation of both the abstract tense and aspect as well as the syntactic verb category in children's early grammar. Getting back to the category of aspect, a number of studies have provided evidence for abstract representations of aspect in children's early grammars and for the continuity view of aspect in child grammar. It has been found that by age two children could segment the aspect morphemes from lexical verbs, indicating they are treating these morphemes as an independent category. In Hohenstein and Akhtar's (2007) study, when given novel verbs such as *meeking*, two-year-old children could segment *-ing* from *meek*. Interestingly, these children were aware of the difference between *-ing* as a phonological unit of nouns like *pudding* and the functional morpheme *-ing* attached to verbs like *meeking*. Deploying the intermodal preferential looking paradigm, Wagner, Swensen, and Naigles (2009) examined children's productive comprehension of the past/perfective morpheme *-ed* and the present/imperfective morpheme *-ing* using the intermodal preferential looking paradigm. The results suggested that 30-month-old English-speaking children were able to understand the aspectual contrast between *-ed* and

-ing when they were in combination with familiar verbs such as *pick*, *wash*, *drink*, and *draw*. Specifically, presented with the two dynamic scenes describing the completed event and on-going event side by side on a screen, they looked longer at the completed event when hearing the verb with the *-ed* sentence and looked longer at the on-going event when hearing the verb with the *-ing* morpheme. Furthermore, their understanding went beyond familiar verbs: 30-month-olds demonstrated a productive comprehension of the two morphemes as they could successfully generalize them to unknown verbs and unknown events. These findings all indicate young children's sensitivity to the aspect morphemes as a different category from lexical verbs and their productivity with them. Just as Wagner (2009) argues, there exists continuity between the abstract representations of grammatical aspect of adults and those of children. Children's aspectual system is not qualitatively distinct from the adult system and the discrepancies between the two are quantitative. This view contrasts sharply with the discontinuity view that assumes a fundamental difference between children's grammar and the adult's grammar (e.g. Tomasello, 2003). With regard to both the aspect hypothesis and the continuity issue, there is no consensus yet and controversies still continue. To test the explanatory power of different accounts, there is obviously a need for more cross-linguistic studies, particularly early comprehension studies. It is against this background that the current study exploring Mandarin-speaking children's comprehension of grammatical aspect was conducted. We hope that the early comprehension data from 30-year-old Mandarin-speaking children reported in this paper can make some important contributions to our understanding of universal as well as language-specific properties of the acquisition of aspect.

In Mandarin Chinese, grammatical aspect is marked by aspect markers, a set of free-standing morphemes which are neither phonologically bound to the verb stems nor confounded with tense. The most frequently used and studied aspect markers include the perfective marker *le*, the experiential marker *guo*, the progressive marker *zai* and the durative marker *zhe* (Chao, 1968; Li and Thompson, 1981; Lin, 2002; Liu, 1988; Smith, 1991; Yeh, 1993; Zhu, 1981; among others). *Le* and *guo* encode a perfective situation while *zai* and *zhe* describe an imperfective situation. Thus it is obvious that *le* and *zhe* serve as a pair of contrast. While both appear post-verbally, they contrast in aspectual meanings: *le* describes a perfective situation that is completed or terminated and *zhe* encodes an imperfective situation that is enduring and continuous. Aspect marker *le* denotes a closed event, which spans the initial and the final points. In other words, *le* marks the termination of an event. As the examples show in (1), *le* provides a terminal point for both events. However, the terminal point brings the event in (1a) to a stop, but in (1b) it marks the completion of the event. Such a distinction is attributed to the different properties of the events encoded by the verbs, viz. the property of telicity. Telic events such as *dao shanding* ('reach the hilltop') have an inherent outcome or goal. Atelic events such as *he niunai* ('drink milk') do not have an intrinsic endpoint, and they are simply processes, but the use of *le* imposes a boundary to this activity which turns the inherently atelic event as encoded by the verb phrase to a telic event.

(1) a. *Ta* *he* *le* *niunai.*

he drink *le* milk

'He has drunk milk.'

b. *Ta* *dao* *le* *shanding.*

he reach *le* hilltop

'He (has) reached the hilltop.'

On the other hand, the imperfective marker *zhe* focuses on an interval of the situation with no reference to the endpoint. It may present either a dynamic progress or a static duration, depending on the type of situation it combines with, as illustrated in (2) below. The interval in (2a) has a dynamic progressive interpretation and in (2b) it suggests a stative durative interpretation. Again, the difference in interpretations derives from different types of the situation described by verbs. According to Lin (2002), the imperfective marker *zhe* should obligatorily select an atelic situation as its complement. Thus, only activities and states satisfy this requirement. Activities consist of dynamic processes. The interval made visible by z*he* is naturally a dynamic process. The event of *he niunai* ('drink milk') in (2a) is an atelic event. When z*he* views the event from an internal vantage point, it obtains the ongoing-ness of the action, which naturally has a dynamic progressive reading. Unlike activities, the state comprises a static, undifferentiated period. Thus, the interval taken by *zhe* is also duration of the state. The situation in (2b) concerns the state of the door being open. In this case, *zhe* focuses on an interval of the static situation of the door, thus leading to a static durative reading of the sentence.

(2) a. *Ta* *he* *zhe* *niunai.*

he drink *zhe* milk

'He is drinking milk.'

b. *Men* *kai* *zhe.*

door open *zhe*

'The door is open.'

So far, the acquisition of aspect in Mandarin Chinese is still an underexplored area, compared with the fact that aspect figures prominently in Chinese syntax and semantics. Erbaugh (1982) pioneered the acquisition study of aspect by Mandarin-speaking children and yielded many interesting findings that have been attested in subsequent acquisition studies. Using longitudinal data from four Mandarin-speaking children in Taiwan with an age range of 1;9 to 3;9, Erbaugh found that the perfective marker *le* and progressive marker *zai* appeared earlier than *zhe* and *guo* and that *le* was used far more frequently than other markers in early speech. This acquisition sequence of aspect markers was also evidenced by Lin (1986). In Erbaugh's data, the perfective *le* was found to occur with telic verbs such as *kai* 'open' and *lai* 'come', and also with activity verbs such as *ku* 'cry' and *fei* 'fly'. But the progressive *zai* was used only with activity verbs. Li and Bowerman (1998) and Chen and Shirai (2010) directly address the issue of whether the aspect hypothesis could accommodate the Mandarin acquisition data. Li and Bowerman (1998) experimentally tested the understanding of aspect markers with six types of predicates by children aged from 2;9 to 6;4. The data showed that children of all ages understood the perfective *le* better with telic predicates (i.e. resultatives, achievements and accomplishments than when they were co-occurring with atelic verbs (activity and semelfactive verbs), but for the progressive *zai* and *zhe*, children understood them better with atelic predicates than with telic predicates. This indicates children's sensitivity to the association between the perfective marker *le* and telic verbs and the connection between the imperfective markers *zai* and *zhe* and atelic verbs, as

predicated by the aspect hypothesis. Chen and Shirai's (2010) investigation of development of aspect using four children's (aged between 1;4 and 3;5) longitudinal speech data produced similar findings: children initially produced perfective *le* and *guo* with telic verbs and progressive *zai* exclusively with activities. Other studies also provide evidence in support of the aspect hypothesis (Chang, 2013; Li, 1990; Li and Shirai, 2000) .

Two acquisition studies have provided a different angle for us to look at aspect in child Mandarin. Liu (2009) explored young children's acquisition of aspect markers and the interaction between aspect and modals and negators in development within the generative framework. Based on a detailed analysis of the use and omissions of aspect markers in obligatory contexts, and also the use of modals and negators in three children's (aged between 1;9 and 2;2) production data drawn from CHILDES (MacWhinney, 2000), Liu argued that functional projections of aspect and modals (i.e. AspectP and ModalP) are available to Mandarin-speaking children very early on, which is consistent with the continuity hypothesis. Using the visual world paradigm, Zhou, Crain, and Zhan (2014) experimented with three-to-five-year-old children and adults by engaging them in an online sentence processing task. The test sentences contained aspect markers *le* and *zhe*, each of which was presented together with two pictures on the screen: one picture depicting a completed event and the other depicting an on-going event. The results showed a facilitatory effect triggered by the aspect marker on the eye movements of both the children (of all age groups) and adults: the appearance of the aspect marker *le* in the test sentence led to more eye movements to the completed event picture and the aspect marker *zhe* led to more eye movements to the on-going event picture. Thus, the temporal information encoded in aspect

markers constituted an important source that assisted event recognition in on-line sentence comprehension by children as young as three. This suggests that by age three, children already have a good command of syntactic and semantic knowledge of aspect markers that allows them to use it in sentence processing as efficiently as adults. The study thus gives further evidence for the continuity hypothesis: young children's knowledge and use of aspect is not different from that of adults.

From previous acquisition studies of aspect in Mandarin Chinese, we obtain a general picture of when children start to produce aspect markers, and whether they have a tendency to use them restrictively like what is observed with children learning other languages. Yet, issues about young children's comprehension are almost left untouched, such as when children start to be sensitive to the aspectual distinctions involving *le* and *zhe*? Zhou et al. (2014) indicate this sensitivity by three-year-old Mandarin-speaking children, but it is likely that children at a younger age may already have developed it, as is the case for English-speaking children (Wagner et al., 2009). This is what we tried to explore in the present study. We assessed 30-month-old Mandarin-speaking children's understanding of aspect markers *le* and *zhe*.[1] Since they have been found to occur in the production of children under age three and they are used to facilitate event recognition in on-line sentence processing, it would be interesting to determine whether children younger than this age are

[1] The reason we chose *zhe* instead of *zai* is that *zhe*, just like *le*, follows the verb, whereas *zai* precedes the verbs. We decided to use the post-verb *zhe* to match it with the post-verb *le*. This choice made it possible for us to analyze the exact same time window from the offset of the verb across the sentence types. Our on-going study of Mandarin-speaking children's temporal reference in early production shows that aspect marker *zhe* has already occurred in the speech of two-year-olds and *zhe* is more frequently produced than *zai*. Evidence for early use of *zhe* also comes from Chen and Shirai (2010).

able to differentiate between *le* and *zhe* when processing sentences with them, i.e. they know that the former denotes a completed or terminated event and the latter describes an on-going event. Specifically, we tried to determine at which time points children would attend to the matching events in the on-line processing of a sentence with *le* or *zhe*. We focused on on-line comprehension because studies of this type are scarce concerning the acquisition of Mandarin Chinese and so little is known about early comprehension of the language that exhibits unique surface properties distinct from languages like English. Another reason for the selection of on-line comprehension was that we could directly tap children's knowledge of subtle meaning properties such as aspectual distinctions which might not surface in production and on-line comprehension measures enabled us to determine the immediate effect of children's knowledge of aspect markers on sentence processing. We adopted the intermodal preferential looking paradigm, a paradigm that has been used widely in studies tapping syntactic, semantic, and phonological knowledge of children younger than age three (Hirsh-Pasek and Golinkoff, 1996). In a typical intermodal preferential looking experiment, children are presented with two pictures or videos side by side when they hear an audio (i.e. speech stimulus) matching only one of them. Children's looking behavior in the experiment demonstrates their understanding or knowledge of a particular target item: children usually look longer at the picture or video matching the speech stimulus. Previous studies have successfully employed the experimental method to examine young children's comprehension of tense/aspect morphology (e.g. Wagner et al., 2009; Weist et al., 1999). To our knowledge, this is the first study that adopts the preferential looking paradigm to investigate young Mandarin-speaking children's competence with aspectual distinctions.

2. Method

2.1 Participants

Thirty-two normal Mandarin-speaking children were included in the experiment (Mean age: 2;7;15; age range: 2;6;03-2;8;01; gender: 11 females, 21 males). All children were normally developing, with no reported history of any hearing or speech disorder. They were recruited through online advertising and were distributed across four counterbalancing groups.

2.2 Test stimuli

Speech stimuli included test sentences describing four events: drinking milk, eating apples, pushing a stroller, and drawing balloons. The corresponding verbs in Mandarin Chinese used were: *he niunai* ('drink milk'), *chi pingguo* ('eat apple'), *tui xiaoche* ('push stroller'), and *hua qiqiu* ('draw balloon'). These verbs were all activity verbs familiar to young children, as the parental reports we collected after the experiment showed, and should not pose any difficulty for the child participants to process. The predicate *he niunai* is atelic, as mentioned earlier, so are *chi pingguo*, *tui xiaoche*, and *hua qiqiu* in Mandarin.[2] Given that the focus of the present study was young children's sensitivity to the aspectual distinction between *le* and *zhe*, and that *zhe* is only restricted to atelic predicates, we did not include telic predicates in the design.

For each event, three types of test sentences were designed, one with *le* (the *le* sentence),

[2]These predicates are atelic because they describe a process that does not have an end point. We can use various tests to test their telicity. For instance, Gu (1999) suggested that atelic predicates can co-occur with the adverbial *yige zhongtou* '(for) one hour' that measures how long the activity lasts, but telic predicates cannot. In our case, all the four predicates can co-occur with *yige zhongtou*, such as *he yige zhongtou niunai* ('drinking milk for an hour'). However， predicates like *he liangbei niunai* ('drink two glasses of milk') are telic, thus not compatible with *yige zhongtou*, e.g. **he yige zhongtou liangbei niunai* ('drinking two glasses of water for one hour').

one with *zhe* (the *zhe* sentence) and one with no aspect marker (the control sentence), with the basic form of a mono-syllabic pronoun subject + verb + a bi-syllabic object NP. The three types of sentences are illustrated in (3) below. The 4 (events) x 3 (sentence types) design yielded a total of 12 test sentences, the order of which was pseudo-random with the constraint that events and aspect markers for any two successive trials would always be different.

(3) a. *Ta he le niunai*.

He drink LE milk

'He has drunk milk.'

b. *Ta he zhe niunai*.

he drink ZHE milk

'He is drinking milk.'

c. *Ta he niunai*.

he drink milk

possible meaning : 'He drinks/drank/he is drinking milk.'

A native female speaker of Mandarin-Chinese produced the speech stimuli in a child-directed manner in a sound-proof booth. The speech stimuli were digitally recorded. We carefully selected the final stimulus set to generally match the duration of test sentences as a whole and also that of aspect markers. We also designed several carrier phrases to introduce the characters, objects, and the events in the familiarization, contrast and test trials.

Two cartoon clips of each event were created, one in which the event was in progress and the other in which the event began and terminated. The two clips depicted the same

action and contrasted only in terms of whether the event was a closed one or an on-going one: the closed event was depicted as an action that started, lasted for a while and then terminated (e.g. the boy is drinking milk and then stops drinking by putting the empty bottle on the table and then his hand behind the back) whereas the on-going event was depicted as a continuous action (e.g. the boy keeps drinking milk with the bottle touching his lips throughout). Furthermore, the affected object of the closed event (i.e. milk, apple, stroller, and balloon) was also depicted as going through a visible change in quantity, location, or shape. This guaranteed that the perceptual properties of the two contrastive events were salient and clear to children. See the sample images representing the two events of *he niunai* in Fig. 1 a and b.

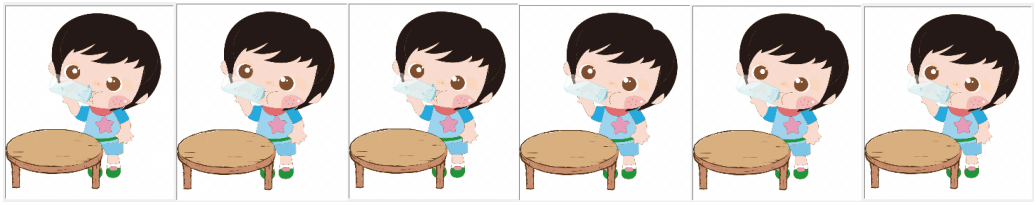

Figure 1a. The ongoing event of *he niunai*

Figure 1b. The closed event of *he niunai*

If children were sensitive to the aspectual contrast between *le* and *zhe*, they were expected to look more to one of the two videos that matched the test sentence with the compatible aspect marker, namely, the closed event video should match the *le* sentence and the on-going event video should match the *zhe* sentence. Both videos should be compatible

with the control sentence. All video clips were prepared using digital equipment and were edited to ensure a frame-by-frame accuracy in timing. The first part of the video clip, lasting 4s (*s* stands for second) was a dynamic scene with parts of the character moving (e.g. moving lips, a hand drawing a balloon with a pen) or a visible change in the object (e.g. water becoming less, a half-drawn balloon becoming fully drawn). The second part of the clip, also lasting 4s was static with the last image of the dynamic clip where the action terminated in the closed event (e.g. empty bottle on the table, a fully drawn balloon) or the character was still performing the action without any sign of stopping in the on-going event. To control for children's potential preference for a specific direction, the two clips were counterbalanced in terms of their positions across trials. Specifically, half of the ongoing events or the closed events appeared on the left and half of them on the right.

2.3 Procedure

Children were tested individually in a sound-proof acoustic chamber. They spent some time getting accustomed to the lab environment before taking the preferential looking test with a parent. During the experiment, the child sat on the parent's lap, facing an LCD screen, while the parent listened to masking music from headphones so as to be blind to the auditory stimuli, which helped prevent the parent from cuing the child during the experiment. Loudspeakers that delivered speech stimuli were next to both sides of the screen. A video camera hidden below the screen recorded the child and sent simultaneous video signals of the child to a monitor outside the test booth, where an experimenter who was blind to the test stimuli observed the child and sent instructions to the parent if necessary. Once the child

fixed on the center of the screen, the experimenter started the experiment. Following the test session, the parent was asked to complete a questionnaire on his/her child's understanding and production of the nouns, verbs and aspect markers in the test stimuli.

2.4 Design

Each trial consisted of three phases. The trial began with a familiarization phase that presented one event on the left or right side of the screen followed by the other event on the other side. The purpose of this phase was to introduce the two events to the child. Carrier phrases that accompanied the event presentations during this phase just introduced the participants in the event (i.e. the character and object), without any use of the verb and aspect marker appearing in the test sentence (i.e. *Kan, xiaopengyou! Haiyou niunai!* 'Look, kid! There is also milk!' and *Youshi xiaopengyou! Haiyou niunai!* 'Again kid! And also milk!')

Following the familiarization phase was the contrast phase. The two events were presented on either side of the screen simultaneously. The side-by-side presentation of the two events served to draw the child's attention to both events at the same time and give him/her more time to perceive the differences between the closed and on-going events. Again, carrier phrases that accompanied the video presentations were neutral without target verbs and aspect markers (i.e. *Hai shit ta! Liangbian douyou!* 'It's still him! On both sides!') The video presentations in the familiarization and contrast phases had a mean duration of 5.5s and were separated by 0.75s of a blank screen.

The test phase followed immediately. The test trials presenting three types of test sentences were all structured in the same way. The crucial part of the speech stimulus of each

test trial (the target verb and the aspect marker) was first introduced to the child during a blank screen interval of 4s. The speech stimulus was not used in the previous familiarization and contrast phases. The only difference between the speech stimulus in the blank screen interval and the test sentence was that the former had *xiaopengyou* ('the kid') as the subject NP whereas the test sentence used *ta* ('he) as the subject NP. Then, the two clips depicting the two events appeared on the screen side-by-side in silence. The silent period lasted 1 second. At the 1st second, the carrier phrase (*Zai nabian a* 'On which side?'), which was the same across trials, started, followed by the speech stimulus. In the *le* and *zhe* trials, *le* or *zhe* occurred exactly at the 3.2nd second. At the 4th second, the audio stopped and the video became static with the last image shown for another 4s. This static period gave the child sufficient time to make their decisions on the basis of the test sentence heard. Thus, the whole test trial lasted 8s. The event that matched the speech stimulus was the target while the other event was not. In other words, the closed event was considered as the target when the speech stimulus was a *le* sentence, whereas the closed event was not the target when the speech stimulus was a *zhe* sentence. In the latter case, the on-going event would be the target. In doing so, the test phase served to assess children's understanding of aspectual contrast between *le* and *zhe*. In test trials, the side of the matching video was counterbalanced, with the matching video occurring half the time on the left and half the time on the right. Figure 2 displays the timeline for a test trial. The labels 'Silence', 'Post-AM', and 'Static' in the last line of the figure illustrates the three windows that will be used for analysis (cf. section 2.5).

Table 1 shows the partial layout of a sample trial.

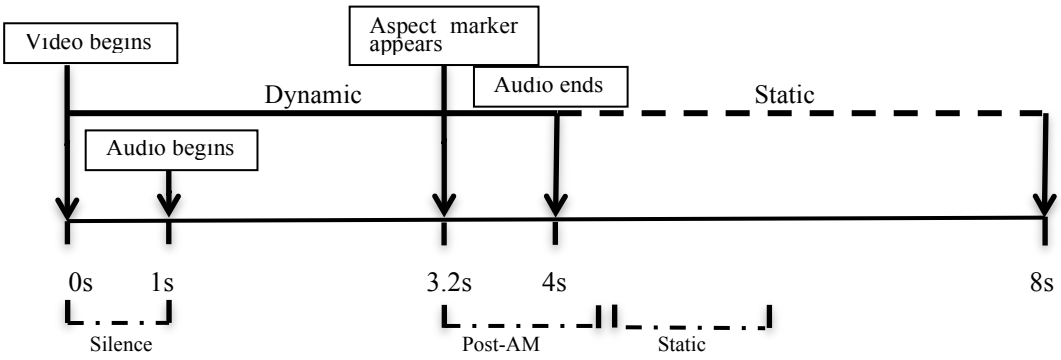

Figure 2 Timeline of stimuli presentation during a test trial

Table 1 A partial layout of a sample trial

	Visual Stimuli	Speech Stimuli	Visual Stimuli
Familiarization phase	Blankness	Kan, xiaopengyou! Haiyou niunai! 'Look, kid ! There is also milk!'	The boy is drinking milk.
	Blackness		
	The boy completes drinking milk.	Youshi xiaopengyou! Haiyou niunai! 'Again, kid! And also milk!!'	Blankness
Contrast phase	Blackness		
	The kid completes drinking milk.	Hai shi ta! Liangbian douyou! 'It's still him! On both sides!'	The boy is drinking milk.
Test phase	Blackness	Xiaopengyou he le niunai. 'The kid has drunk milk!'	Blackness
	The boy completes drinking milk.	Zai na bian a ? Ta he le niunai. 'On which side? He has drunk milk.'	The boy is drinking milk.

To make the test more attractive to children, four pairs of static pictures with colorfully painted animals were inserted between the trials as filler trials. They also heard a speech stimulus (i.e. animal names) that matched one of the pictures. A rotating cartoon moon with

the sound of Aeolian bells appeared at the center of the screen served as the attention getter to capture children's attention between trials.

Considering children's attention span at 30 months, we tried to limit the duration of the whole test within 5 minutes. For this reason, our study adopted a between-subject design where each child would only hear one sentence per event. For instance, the child took the *le* sentence of the *he niunai* ('drinking milk') event would not take the *zhe* sentence of the same event. That was also the case for the other three events. Therefore, each child completed four sentences with aspect markers, four sentences with no markers, and four filler items. Besides, after counterbalancing all the factors, we had four experiment orders of the test trials. During the experiment, the child was randomly assigned to one of them.

2.5 Coding and analysis

Children's looking behavior (i.e. eye direction and duration of looking) was coded off-line by a blind researcher frame-by-frame for the test trials at a rate of 30 frames/second. Each frame was coded as left look, right look, or looking elsewhere. Trials where the child looked elsewhere over 80% of the time were excluded for analysis. A total of 2.3% of the trials fell into this category and were excluded.

Our major question was whether children were able to differentiate between the two aspect markers *le* and *zhe*, by looking longer to the closed event upon hearing the sentence with *le* and looking longer to the on-going event upon hearing the sentence with *zhe*. To answer this question, we chose three windows of analysis starting from specific time points in each test trial. The first time window, the Silence window, was the 1s-silent phase at the start

of the test trial, when the visual stimulus was present in the absence of the speech stimulus. The Silence window was taken as the baseline window as the child was not presented with the test sentence in this phase. The second time window, the Post-AM window (AM=aspect marker), was the 1.5s-phase following the onset of the occurrence of *le* or *zhe* in the *le*, *zhe* sentences, or the corresponding phase in the control sentence (frames 96-141). The window served to examine whether children could make their judgment right after hearing the aspect marker. In fact, this was what was observed for 36-month-old Mandarin-speaking children: their eye-movement to the matching event was triggered by the appearance of aspect markers in the test stimuli (Zhou et al., 2014). The third time window, the Static window, was the 1.5s-phase after the presentation of the auditory stimulus ended (frames 144-189). This choice was motivated by the consideration that children might make their decision a bit later after they heard the test stimulus. The latter two windows constituted our test windows. As the window names suggest, the image was static in the Static window whereas the image was from dynamic to static in the Post-AM window.

In previous preferential looking studies, the entire test trial was compared with the baseline control trial in which two visual stimuli were simultaneously shown to the child without the test audio stimulus (e.g. Wagner et al, 2009; Candon et al., 2012). In the current study, we were trying to examine young children's real-time processing of aspect markers using IPLP. Our research design thus has several features different from design features of those studies. First, we included three types of test sentences, namely *le*, *zhe* and control without aspect markers, and we compared children's looking while listening to these three types of sentences. Second, we intentionally included 1s-silence period before the appearance

of the audio (cf. Figure 2). This period, together with the two latter windows (i.e. the Post-AM window and the Static window) was used for analysis for the three types of sentences. We did not take children's looking patterns during the first half and the second half of the trials as previous preferential looking experiments did (e.g. Candon et al. 2012), but instead used the onset of aspect markers as the starting point. The motivation for this was that the time point when the aspect marker appeared was crucial to us. Choosing two successive windows (1.5s each) after the aspect marker appeared (instead of one larger window) enabled us to obtain more detailed real-time information about children's processing of the markers. This design could potentially provide an interesting perspective of young children's processing of aspect markers.

For each window, we calculated the proportion of looking to the 'closed event' by taking the total looking time to that event divided by the sum of looking time to both 'closed' and 'ongoing' events. Thus, a preference for the 'closed' event would yield a proportion of looking towards 1, while a preference for the 'ongoing' event should show a looking proportion towards 0. We then computed differential scores for *le*, *zhe*, and control sentences. Specifically, we calculated the differential scores of each infant by considering his or her looking to the 'closed event' after the aspect marker (*le*, *zhe* sentences) appeared or the same time phase in the control sentence. The following formula was used in calculating the scores of the two test windows (Post-AM and Static):

Mean % Looking (Closed event)$_{\text{Post-AM}}$ – Mean % Looking (Closed event) $_{\text{Silence}}$

Mean % Looking (Closed event)$_{\text{Static}}$ – Mean % Looking (Closed event) $_{\text{Silence}}$

The differential score between the test windows and the Silence window made it possible for us to use each stimulus as its own control and thus any inherent preference for the visual stimulus on a particular side in each trial would be eliminated.

We predicted that if children perceived and distinguished the aspect markers *le* and *zhe*, differential scores for the three sentence types should differ significantly. If they understood the aspect marker *le*, they should increase looking towards the closed event upon hearing *le*, i.e., with a differential score significantly above the 0 chance level. If children understood the aspect marker *zhe*, they should decrease looking towards the closed event upon hearing *zhe*, i.e., with a differential score significantly below the 0 chance level. Furthermore, looking was expected not to differ from the 0 chance level for the control sentence since the absence of an aspect marker made the sentence compatible with both events. It was also predicted that if an aspect marker was processed online, a significant difference from the 0 chance level should be observed during the Post-AM window. On the other hand, significant differences might emerge in the Static window if children's processing of aspect markers was slow.

3. Results

To assess whether children exhibited differential understanding of aspect markers *le* and *zhe* by looking longer to the closed event when hearing the *le* sentence and looking longer to the on-going event when hearing the *zhe* sentence, we conducted two statistical analyses. The first was a one sample T-test that compared each differential score with the 0 chance level. The second was an omnibus ANOVA that compared differential scores of the three types of test sentences (i.e. the *le*, *zhe* and control sentences), that took sentence type and window as

within-subject variables. In what follows, we present the t-test results in the Post-AM window and the Static window separately. Remember that the Post-AM window was the 1.5s-time phase from the onset of the aspect marker in the auditory stimulus and the Static window was the 1.5s-time phase after the completion of the auditory stimulus presentation.

The differential scores of the Post-AM window (i.e. Post-AM minus Silence) are depicted in Fig. 3. The one-sample T-tests provided results that confirmed our predictions. The results demonstrated that the differential score was significantly different from chance for *le* (M = .17, SE = .074, t (31) = 2.299, $p < .05$). As predicated, the differential scores were not significantly different from chance for *zhe* (M = .122, SE = .068, t (31) = 1.794, $p > .05$), nor for control (M = .055, SE = .044, $t(31) = 1.264$, $p > .05$) in the same window. This result shows that *le* did have an effect on children's looking behavior in the Post-AM window: as soon as they heard *le*, they would look at the closed event and held their attention to the target above chance level. But z*he* or the control did not have the 'triggering' effect in this window.

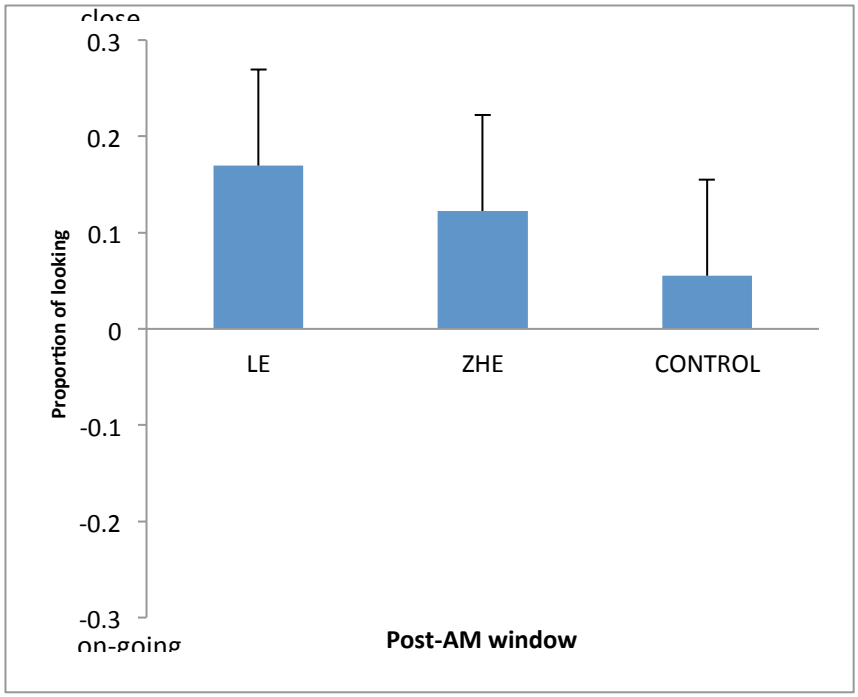

Figure 3. Mean differential scores and standard errors in the Post-AM window. Trials are on the X-axis. The Y-axis illustrates the differential scores for *le*, *zhe*, and control sentences. The upper part of the vertical scale indicates increased looking to the closed event, and the lower part of the scale indicates increased looking to the on-going event.

The differential scores of the Static window (i.e. Static minus Silence) are displayed in Fig. 4. With the closed event as the target in the calculation, the negative values on the vertical axis in this window indicate that children looked away from the closed event and turned to the on-going event, as the phrase 'on-going' at the bottom of the vertical axis shows. The T-test results showed that the differential score was significantly below chance for *zhe* (M = -.17, SE = .081, $t(31) = -2.138$, $p < .05$). It indicates an effect of *zhe* on children's looking behavior in the Post-AM window: when tested on the *zhe* sentence, children significantly increased looking to the on-going event. As predicated, the differential score was not significantly different from chance for *le* (M = -.067, SE = .073, t (31) = -.911, $p > .05$), nor for the control (M = .084, SE = .068, t (31) = -1.244, $p > .05$) in the same window.

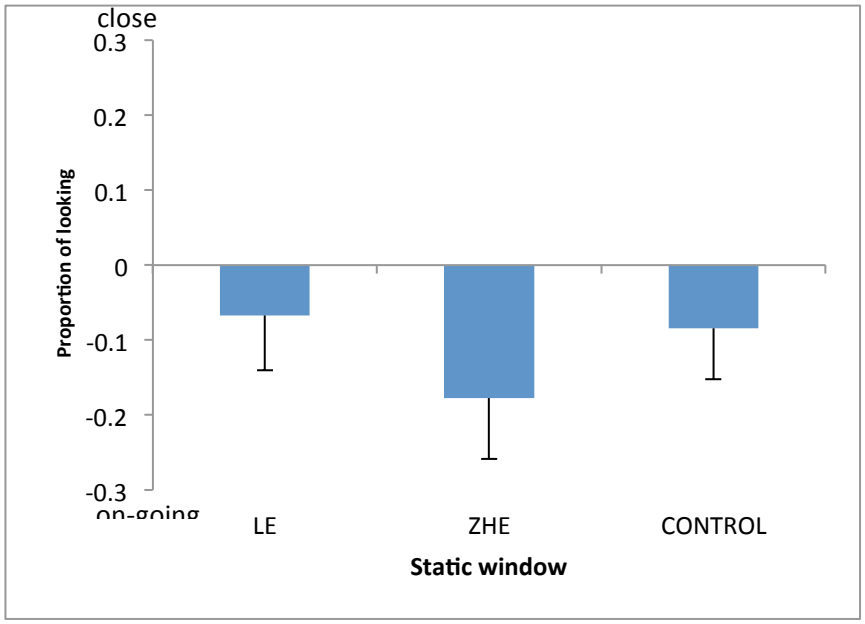

Figure 4. Mean differential scores and standard errors in the Static window. Trials are on the X-axis. The Y-axis illustrates the differential scores for *le*, *zhe*, and control sentences. The upper part of the vertical scale indicates increased looking to the closed event, and the lower part of the scale indicates increased looking to the on-going event.

We conducted an omnibus ANOVA that incorporated sentence type and window to further examine the effect of sentence type, window and their interactions. Our prediction was that if children could distinguish *le* and *zhe*, then differential scores for the three sentence types should differ significantly. The ANOVA failed to yielded a significant effect of sentence type ($F(2, 62) = .509$, $p = .604$) and no significant effect of the sentence type and window interaction ($F(2, 62) = 1.483$, $p = .235$), though there was a significant effect of window ($F(2, 62) = 35.45$, $p = .000$). We predicted a difference in sentence type, but this result did not support the prediction.

Overall, this pattern of results reveals some effect of aspect markers on children's looking behavior. The key evidence comes from the comparison between the differential

scores and the 0 level chance score. The results show the test sentence with *le* or *zhe* would lead to children's increased looking to the event that matched the sentence, but not the control sentence without any aspect marker. Specifically, they would increase looking to the closed event hearing the *le* sentence and to the on-going event when hearing the *zhe* sentence. It is interesting to note that the effect of *le* was immediate whereas the effect of *zhe* was later. As the results show above, in the Post-AM window, children looked significantly more to the closed event when tested with *le*. This echoes findings from Zhou et al. (2014) which also showed an immediate effect of *le* in sentence processing. But the result that the differential score was not significantly higher or lower than the chance level when tested with *zhe* suggests that *zhe* did not attract children's attention at this time point. In other words, while the hearing *le* immediately affected children's looking behavior, hearing *zhe* did not lead to a change. However, in the Static window, the effect of *zhe* appeared. The significant difference between the differential score and the chance level suggests that children increased looking to the on-going event after they heard the *zhe* sentence.

On the other hand, the omnibus ANOVA results showed that children's looking behavior did not differ significantly across the three test sentences in both windows. Thus, the types of test sentences did not affect children's looking preference according to this statistical analysis, in contrast to the results of the chance level T-tests. Taken together the results of both types of statistics, children at 30 months of age show some understanding of aspect markers in Mandarin, although this knowledge is not yet robust.

4. Discussion

We started out trying to assess the ability of young Mandarin-speaking children to understand aspect markers *le* and *zhe*. In Mandarin Chinese, *le* is a perfective marker that always describes a completed or terminated event. In contrast with *le*, *zhe* is an imperfective marker associated with a durative or progressive meaning. Are children as young as 30 months sensitive to the aspectual distinctions encoded by *le* and *zhe*? In seeking evidence for this sensitivity in young learners of Mandarin Chinese, we designed a preferential looking task and collected thirty-two 30-month-old children's looking preference data. In the test, we presented our child subjects with a choice between two video clips (one depicting a closed event and the other depicting an on-going event), in the presence of an auditory stimulus (either the *le* sentence, the *zhe* sentence or the control sentence without any aspect marker). Children's looking behavior in the task was recorded and analyzed. If children perceived and understood *le* and *zhe*, their looking behavior would be affected by the presence or absence of the aspect marker in the test sentence. In particular, they would prefer the video matching the test sentence by looking at it longer. They would look longer at the close event when they were presented with the *le* sentence and look longer at the on-going event when they were presented with the *zhe* sentence. When they heard the control sentence, no special preference would be detected as it was compatible with either event.

Three findings emerged from the present study. First, the results revealed 30-month-old children's sensitivity to the aspectual contrast between *le* and *zhe*. This was manifest by an increase in looking to the closed event when hearing the *le* sentence and a decrease in looking to the closed event when hearing the *zhe* sentence in the two test windows. The absence of *le*

or *zhe* in the control sentence did not result in any increase or decrease in looking to either event. Second, the results suggested a timing difference in the effect of aspect markers on children's looking behavior. This was evidenced by the fact that while the onset of *le* in the test sentence led to a significant increase in children's looking to the closed event in the Post-AM window, the onset of *zhe* did not result in a significant increase in looking to the on-going event in the same window. The effect of *zhe* emerged in the Static window after the presentation of the *zhe* sentence: there was a significant increase in looking to the on-going event. Finally, the study failed to support the prediction that children's looking behavior would be significantly different for the three types of test sentences. We deliberately designed the *le*, *zhe* and control sentences so that if children were aware of the aspectual properties of *le* and *zhe*, the *le* sentence should direct their looking to the closed event, the *zhe* sentence to the on-going event, and the control sentence to neither. But children did not show much difference in looking preference by sentence type in the omnibus ANOVA.

Children tended to look more to the closed event regardless of sentence types during the Post-AM window, as Figure 3 seems to show. This may be related to children's sensitivity to the event boundary when processing an event structure. Children's preference for particular objects or events is not uncommon. Wagner et al. (2009) also reported children's overall preference for a particular event in the test. In their study 1a, the general preference was for the closed event and in their study 2, the preferred event was the on-going event. The perceptual properties of the depicted event may exhibit some influence on children's looking behavior. The closed event video in our task might be attractive to the child subjects as we tried to make the 'closure' of the event perceptually salient for the child to identify the

difference between this event and the on-going event. In addition, it has been found that as early as six months, infants are able to individuate and count events in a sequence of continuous activity based on perceptual changes (Wynn, 1996). Children's early sensitivity to perceptual changes may possibly amplify the effect of the perceptual salience of the closed event. It seems that the delayed effect of *zhe* could also be explained this way. The Post-AM phase featured a change from dynamic scenes to static scenes whereas in the Static phase, the video presented a static picture. Children's interpretation of *zhe* could thus be interfered by perceptual factors, i.e. the dynamic scenes and the perceptual salience of the closed event before the picture became static. Even so, the perceptual bias cannot explain why the T-test results fail to show a significant difference for *zhe* and control sentences in the Post-AM window and also why the T-test results only indicate a significant difference for *zhe* in the Static Window.

As mentioned above, the perceptual factors also occurred in Wagner et al. (2009) and English-speaking children show similar overall preference for the closed event. Yet, there was a significant effect of sentence type (test, control) in Wagner et al's study, while our results show no effect of sentence type (*le*, *zhe*, and control) in the present study. We would like to suggest one possibility for this difference. In English, the perfective morpheme -*ed* is directly attached to the verbal base but the imperfective marker -*ing* is usually in the form of *be* verb-*ing*. In Mandarin Chinese, the perfective marker *le* and imperfective marker *zhe* both occur post-verbally without any other auxiliary. It is then possible that for English-speaking children, there are more cues that draw their attention to the difference between -*ed* and -*ing*. In other words, English-speaking children may benefit from cues of different types and have

a better performance. Indeed, Koudier et al.'s (2009) report that twenty-four-month-old children did not make the singular-plural distinction when the number was on the noun alone but their performance drastically improved when there were cues from verbs, nouns and quantifiers.

Three-year-old children in Zhou et al.'s (2014) study could immediately process aspect markers *le* and *zhe*. Our data shows that two-year-olds (30-month-olds) were able to do the same when processing *le*. The finding that 30-month-olds exhibited immediate processing of aspect marker *le* contrasts with previous reports that Mandarin-speaking two-and-three-year-olds showed latency in looking to scenes matching test sentences such as the horse pushes the bird (Candon et al. 2012). We hypothesize that the discrepancy between the immediate processing of *le* and the latency effect exhibited in previous studies could be attributed to two factors. First, our test sentences were made up of activity verbs involving inanimate themes. So the relation between the participant roles in the activity was quite clear and the issue of reversibility did not exist. This presumably led to quicker processing of test sentences in our study. But in sentences like *the horse pushes the bird*, both NPs were animate and they were reversible. Reversibility of NPs may have complicated the processing task and thus children could take longer time to compare the two videos to give a response. Second, *le* and *zhe* are functional morphemes that encode subtle meanings. Whether children are aware of the distinctions between the two aspectual markers is the focus of the current study, however, it should not be difficult for children to know that these morphemes are different from lexical categories such as nouns or verbs. In fact, numerous studies have reported infants' ability to differentiate functional categories and lexical categories long

before functional categories occur in production (e.g. Shi et al., 1998, Shi and Werker, 2001, 2003, among others). According to the prosody-functor bootstrapping hypothesis, functional morphemes are present in children's grammar right from the start and bootstrap language acquisition long before they occur in production (Shi, 2014). Following this view, from an early stage, infants benefit from functional categories in word segmentation, learning word meanings, word categorization and online comprehension. It is possible that in processing test sentences in our study, *le* might facilitate processing in such a way that it immediately anchored children to semantic features other than those encoded in lexical words (e.g. nouns and verbs), which were consistent with the aspectual features of *le*. In this sense, we think that our children's immediate processing of *le* is not a surprise.

Our results have some implications for understanding early comprehension of aspect markers. First, the fact that the children in our study were aware of the aspectual distinctions between *le* and *zhe* indicates that young Mandarin-speaking children have developed some sensitivity to aspect markers that guides them in sentence comprehension. While our study replicates some findings of Wagner et al. (2009), we have to be cautious as to whether Mandarin-speaking children have already created an abstract grammar of the aspect category by 30 months. Maybe it is the case, as Wagner et al's study has convincingly shown English-speakign children's remarkable ability to comprehend morphemes *-ed* and *–ing* productively with novel verbs. But further study is certainly required to explore this aspect with Mandarin-speaking children. Second, the results are relevant to the debate concerning the semantic bias in the development of aspect. The verbs of our test sentences were all verbs of activity that described atelic events. Following the aspect hypothesis, children should

understand the imperfective *zhe*-atelic predicate combination better than the perfective *le*-atelic predicate combination. Yet, our results did not show any sign of this. At least, the combination of *le* and atelic verbs did not seem to pose any comprehension difficulty to the children in the experiment.

In conclusion, the results from the present study show that despite a general preference to a particular event, 30-month-old Mandarin-speaking children display some ability to comprehend the perfective marker *le* and the imperfective marker *zhe* differentially. In comprehending sentences with *le* and *zhe*, they tend to look more at the video that matches the relevant aspect marker: when hearing *le*, they look more to the closed event and when hearing *zhe*, they look more to the on-going event. That Mandarin-speaking children have an early sensitivity to the distinctions between *le* and *zhe* is thus consistent with a continuity view of language development.

References

Antinucci, F., & Miller, R. (1976). How Children Talk About What Happened. J*ournal of Child Language*, 3, 167–189.

Behrens, H. (1993). The relationship between conceptual and linguistic development: The early encoding of past reference by German children. *Papers from the Parasession on Conceptual Representation* (Chicago Linguistic Society), 29, 63–75.

Berwick, R. C. (1985). *The Acquisition of Syntactic Knowledge.* The MIT Press, Cambridge, MA.

Bloom, L., Lifter, K., & Hafitz, J. (1980). Semantics of verbs and the development of verb inflection in child language. *Language*, 56, 386-412.

Bronckar, J-P., & Sinclair, H. (1973). Time, tense and aspect. *Cognition*, 2, 107-130.

Brown, R. (1973). *A First Language: The Early Stages.* Cambridge, MA: Harvard University Press.

Candan, A., Kuntay, A. C., Yeh, Y., Cheung, H., Wagner, L., & Naigles, L. R. (2012). Language and age effects in children's processing of word order. *Cognitive Development*, *27*, 205–221.

Chang, H, -H. (2013). The aspect marker -le in early child Mandarin. *Journal of Universal Language*, 14, 7–54.

Chao, Y.-R. (1968). *A Grammar of Spoken Chinese*. Berkeley, CA: University of California Press.

Chen, J. and Shirai, Y. (2010). The development of aspectual marking in child Mandarin Chinese. *Applied Psycholinguistics*, 31, 1-28.

Clark, E. V. (1996). Early verbs, event-types, and inflections. In E. J. Carolyn, & H. V. J. John (Eds.), Children's language, Vol.9, (pp.61-73). Hillsdale, NJ: Lawrence Ellbaum.

Comrie, B. (1976). *Aspect.* Cambridge, UK: Cambridge University Press.

Crain, S., & Pietroski, P. (2002). Why language acquisition is a snap. *Linguist Review*, 19,

163-183.

Dahl, Ö. (1985). *Tense and Aspect Systems*. Oxford: UK: Blackwell.

Erbaugh, M. (1982). *Coming to order: Natural selection and the origin of syntax in the Mandarin-speaking child.* Unpublished doctoral dissertation. University of California at Berkeley: Berkeley.

Green, L. and Roeper, T. (2007). The acquisition path for tense-aspect: Remote past and habitual in child African American English. *Language Acquisition*, 14: 269–313.

Gu, Y. (1999). Dongci de ti ji titai [Aspect and aspectuality of verbs]. In L. Xu (Ed)., *Gongxin yu Gexing: Hanyu Yuyanxue zhong de Zhengyi* [*Universals and Specifics: Controversies in Chinese Linguistics*]. Beijing: Beijing Language and Culture University Press.

Guasti, M. T. (2002). *Language Acquisition*. Cambridge, MA: The MIT Press.

Haegeman, L. (1995). Root infinitives, tense and truncated structures in Dutch. *Language Acquisition*, 4, 205-255.

Hamann, C. and Plunkett, K. (1998). Subjectless sentences in child Danish. *Cognition*, 69, 35-72.

Hirsh-Pasek, K.and Golinkoff, R. M. (1996). *The Origin of Grammar: Evidence from Early Language Comprehension*. Cambridge, Massachusetts: The MIT Press.

Hoekstra, T. and Hyams, N. (1995). Aspects of Root Infinitives. *Lingua*, 106, 91–112.

Hohenstein, J. and Akhtar, N. (2007). Two-year-olds' productivity with verbal inflections. *Journal of Child Language*. 34(4), 861–873.

Hyams, N. (1996). The underspecification of functional categories in early grammar. In H. Clahsen (Eds.), *Generative perspectives on language acquisition*, Amsterdam: John Benjamins.

Hyams, N. (2007). Aspectual effects on interpretation in early grammar. *Language Acquisition*, 14(3), 231-268.

Klein, W. (1994). *Time in Language*. New York: Routeldge.

Kouider, S., Halberda, J.,Wood, J.,& xCarey, S. (2006).Acquisition of English number-marking: The singular-plural distinction. *Language Learning and Development*,

2, 1–25.

Li, P. (1990). Aspect and aktionsart in child Mandarin. Ph.D. dissertation, Leiden University, the Netherland.

Li, P., & Bowerman, M. (1998). The acquisition of grammatical and lexical aspect in Chinese. *First Language*, 18, 311–350.

Li, P. and Shirai, Y. (2000). *The Acquisition of Lexical and Grammatical Aspect*. New York: Mouton de Gruyter.

Li, C and Thompson, S. (1981). *Mandarin Chinese: A Functional Reference Grammar*. Berkeley/Los Angeles/London: University of California Press.

Lin, H.-Z. (1986). A developmental study of the acquisition of aspect markers in Chinese children. Unpublished Master's Thesis, Fu Jen Catholic University, Taipei, Taiwan.

Lin, J.-W. (2002). Aspectual selection and temporal reference of the Chinese aspectual marker –zhe. *The Tsing Hua Journal of Chinese Studies*, 32, 257–295.

Liu, X. (1988). Xianda hanyu ciwei 'le' de yufa yiyi [The grammatical meanings of 'le' in modern Chinese]. *Zhongguo Yuwen [Chinese Language],* 5, 321–330.

Liu, H. (2009). The acquisition of Mandarin aspects and modals: Evidence from the acquisition of negation. *Language and Linguistics*, 10(1), 133-160.

MacWhinney, B. (2000*). The CHILDES Project: Tools for Analyzing Talk (3rd ed.)*. Mahwah, NJ: Lawrence Erlbaum Asoociates.

Olsen, M. and Weinberg, A. (1999). Innateness and the acquisition of grammatical aspect via lexical aspect. In A. Greenhill, H. Littlefield, & C. Tano (Eds.), *Proceedings of the 23rd Annual Boston University Conference on Language Development*. Somerville, MA: Cascadilla Press.

Platzack, C. (1992). Functional categories in early Swedish. In J. Meisel (Eds.), *The acquisition of verb placement*. Dordrecht: Kluwer.

Pinker, S. (1984). *Language Learnability and Language Development*. Cambridge, MA: Harvard University Press.

Rizzi, L. (1993/1994). Some notes on linguistic theory and language development: The case of root infinitives. *Language Acquisition,* 3, 371-393.

Rothstein, S. (2004). *Structuring Events: A Study in the Semantics of Lexical Aspect.* Oxford, UK: Blackwell.

Shi, R. (2013). Functional morphemes and early language acquisition. *Child Development*, 8, 6-11.

Shi, R., Morgan, J. L., & Allopenna, P. (1998). Phonological and acoustic bases for earliest grammatical category assignment: A crosslinguistic perspective. *Journal of Child Language*, 25, 169–201.

Shi, R., & Werker, J. F. (2001). Six-month-old infants' preference for lexical words. *Psychological Science*, 12, 70–75.

Shi, R., & Werker, J. F. (2003). The basis of preference for lexical words in six-month-old infants. *Developmental Science*, 6, 484–488.

Shirai, Y. (1991). Primacy of aspect in language acquisition: Simplified input and prototype. Ph.D. dissertation, University of California, Los Angeles.

Shirai, Y. (1993). Inherent aspect and the acquisition of tense/aspect morphology in Japanese. In H. Nakajima, & Y. Otsu (Eds.), *Argument structure: Its syntax and acquisition*. Tokyo: Kaitakusha.

Shirai, Y. (2009). Temporality in first and second language acquisition. In W. Klein & P. Li (Eds.), *The expression of time*. New York: Mouton de Gruyter.

Shirai, Y., & Andersen, R. W. (1995). The acquisition of tense-aspect morphology: A prototype account. *Language*, 71(4), 743-762.

Smith, C. S. (1991). *The Parameter of Aspect*. Dordrecht & Boston: Kluwer.

Stephany, U. (1981). Verbal grammar in Modern Greek early child language. In S. Philip, & D. Ingram (Eds.), *Child language: An international perspective*. Baltimore, MD: University Park Press.

Stoll, S. (1998). The role of Aktionsart in the acquisition of Russian aspect. *First Language*, 18, 351-377.

Tenny, C. (1994). *Aspectual Roles and the Syntax-Semantics Interface*. Dordrecht: Kluwer Academic Publishers.

Tonhauser, J. (2015). Cross-linguisitic temporal reference. *The Annual Review of Linguistics*,

1, 129-154.

Tomasello, M. (1992). *First Verbs: A Case Study of Early Grammatical Development*. Cambridge, UK: Cambridge University Press.

Tomasello, M. (2003). *Constructing a Language: A Usage-Based Theory of Language Acquisition*. Cambridge, MA: Harvard University Press.

Valian, V. (2006). Young children's understanding of present and past tense. *Language Learning and Development*, 2(4), 251-276.

Vendler, Z. (1967). Verbs and times. In Z. Vendler (Eds.), *Linguistics in philosophy*. Ithacha, NY: Cornell University Press.

Verkuyl, H. (1993). *A Theory of Aspectuality*. Cambridge, UK: Cambridge University Press.

Wagner, L. (2001). Aspectual influences on early tense interpretation. *Journal of Child Language,* 28, 661–681.

Wagner, L. (2009). I'll never grow up: Continuity in aspectual representations. *Linguistics*, 47(5), 1051–1074.

Wagner, L., Swensen, L. D., & Naigles, L. R. (2009). Children's early productivity with verbal morphology. *Cognitive Development*, 24(3), 223-239.

Weist, R. M. (1986). Tense and aspect. In P. Fletcher, & M. Garman (Eds.), *Language acquisition (2nd ed.)*. Cambridge, UK: Cambridge University Press.

Weist, R. M., Atanassova, M., Wysocka, H., & Pawlak, A. (1999). Spatial and temporal systems in child language and thought: A cross–linguistic study. *First Language*, 19, 267–311.

Wexler, K. (1994). Optional infinitives, verb movement and the economy of derivation in child grammar. In D. Lightfoot, & N. Hornstein (Eds.), *Verb movement*, Cambridge: Cambridge University Press.

Wexler, K. (1999). Very early parameter setting and the unique checking constraint: A new explanation of the optional infinitive stage. In A. Sorace, C. Heycock, & R. Shillock, (Eds.), *Language acquisition: Knowledge representation and processing*. Amsterdam: North-Holland.

Wynn, K. (1996). Infants' individuation and enumeration of actions. *Psychological Science*,

7 , 164-169.

Yeh, M. (1993). The stative situation and the imperfective Zhe in Mandarin. *Journal of the Chinese Language Teachers Association*, 28, 69–98.

Zhou, P., Crain, S., & Zhan, L.-K. (2014). Grammatical aspect and event recognition in children's online sentence comprehension. *Cognition*, 133, 262–276.

Zhu, D. (1981). "Zai heiban-shang xie zi" ji xiangguan jushi ["To write characters on the blackboard" and its related sentence patterns]. *Yuyan Jiaoxue yu Yanjiu* [Language Teaching and Research], 1, 4-18.