Disentangling the effects of cognitive development and linguistic expertise: A longitudinal study of the acquisition of English in internationally-adopted children

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A R T I C L E   I N F O

A B S T R A C T

Early language development is characterized by predictable changes in the words children produce and the complexity of their utterances. In infants, these changes could reflect increasing linguistic expertise or cognitive maturation and development. To disentangle these factors, we compared the acquisition of English in internationally-adopted pre-schoolers and internationally-adopted infants. Parental reports and speech samples were collected for 1 year. Both groups showed the qualitative shifts that characterize first-language acquisition. Initially, they produced single-word utterances consisting mostly of nouns and social words. The appearance of verbs, adjectives and multiword utterances was predicted by vocabulary size in both groups. Preschoolers did learn some words at an earlier stage than infants, specifically words referring to the past or future and adjectives describing behavior and internal states. These findings suggest that cognitive development plays little role in the shift from referential terms to predicates but may constrain children's ability to learn some abstract words.

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1. Introduction

Early language production can be characterized as a series of roadblocks that are gradually removed. Most infants use single-word utterances for many months before they begin combining words (Bloom, 1973; Nice, 1925). Children's first words are largely limited to social routines and labels for the people and things around them. Verbs, adjectives and closed-class words only become common at larger vocabulary sizes (Bates et al., 1994; Doran, 1907; Gentner, 1982; McCarthy, 1930). Two central

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questions in language acquisition are: What accounts for these early limitations, and how are they over-come (Bloom, 1973; Cromer, 1974; Gleitman, 1981; Lenneberg, 1967)? Specifically, are the initial stages present because the child is cognitively or perceptually immature, or do they represent necessary steps in acquiring the target language? Are new linguistic abilities partially due to broad changes in the cog-nitive abilities of the learner, or are they solely attributable to the child's growing knowledge of the lan-guage itself? These questions are difficult to answer because cognitive development and language acquisition are confounded in typically-developing children. Young infants are cognitively immature and limited in their linguistic knowledge, while older children are more sophisticated in both respects.

When confronted with confounds like this, developmental psychologists often turn to special populations in which the variables of interest can be disentangled. Much of what we know about language development comes from studies of atypical populations (see e.g., Bellugi, Marks, Bihrle, & Sabo, 1988; Cromer, 1974; Curtiss, 1989; Goldin-Meadow & Feldman, 1977; Landau & Gleitman, 1985; Senghas, 2003). These natural experiments allow us to explore the effects of factors that are impossible or unethical to manipulate.

International adoption is one such natural experiment, creating the opportunity to disentangle the effects of linguistic expertise and cognitive maturation. Between 2000 and 2009, almost 200,000 inter-nationally-adopted children entered the US (US Department of State, 2011). While most are infants or toddlers, thousands of older children are also adopted. Many of these children are well within the critical or sensitive period for learning language (Newport, 1990). These older children appear to rapidly lose their birth language (Glennen, 2002; Gindis, 2005) and become fluent speakers of their adoptive lan-guage (Hyltenstam, Bylund, Abrahamsson, & Park, 2009; Pallier et al., 2003). But we know little about the path they take to get there. While a number of researchers have studied language development in children adopted as infants or toddlers (see e.g., Gauthier & Genesee, 2011; Glennen & Masters, 2002; Hwa-Froelich, 2009; Roberts et al., 2005; Tan & Yang, 2005), there is less work on acquisition in children adopted after 30 months (but see Glennen, 2009) In addition, most of the prior research has focused on comparing the performance of adopted children with age-matched peers (or norms) to identify possible deficits (see Scott, Roberts, & Glennen, 2011 for a meta-analysis). To date, only one study has explored the pathway of early language learning in older adoptees (Snedeker, Geren, & Shafto, 2007).

The learning problem faced by internationally-adopted preschoolers is broadly similar to that of infants learning their first language: they are exposed to child-directed speech in the context of daily routines; they must learn the new language to communicate with their families; unlike most second language learners, they do not have access to written texts or bilingual informants; and they lack many of the metalinguistic skills that are available to school-aged children and adults (Gombert, 1992). However, these preschoolers are more cognitively and physically mature than their infant counterparts and have already started to learn one language. Thus international adoption could pro-vide a way to explore the role that cognitive development and maturation play in shaping the course of first language acquisition, by allowing us to see how acquisition proceeds when these roadblocks have been removed. Such a tool would be useful for distinguishing between two broad classes of hypotheses about qualitative changes during language acquisition:

(1) Developmental Hypotheses: Theories of this kind attribute the order of acquisition or the emer-gence of new abilities to changes in the learner that are independent of her experience with a given language. Immaturity constrains language acquisition, limiting the kinds of words that a child can learn, the kinds of utterances she can produce or the kinds of representations she can create. When these limitations are removed, by biological maturation or cognitive development, new linguistic abilities can emerge.

(2) Contingent-Acquisition Hypotheses: These theories attribute the order of acquisition to the interdependence of different linguistic representations, processes, or learning algorithms. Critically, the emergence of new abilities is driven by the child's growing knowledge of the lan-guage. If knowledge of form A is necessary for acquiring form B, then the acquisition of B will have to await the acquisition of A.[1]

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[1] The contingent-acquisition hypotheses under consideration make the weaker claim that one type of knowledge is needed for efficient acquisition or utilization of another type. This is desirable since the generalizations under consideration are strong but violable. For example, children do learn some verbs early on (Bates, Dale, & Thal, 1995).

Critically, this distinction is orthogonal to the nativist/empiricist and domain-specific/domain-general dichotomies that typically organize theoretical discussions of language development. Contingent-acquisition hypotheses necessarily attribute shifts to the child's growing knowledge of the language, but they differ in their claims about how the child acquires that knowledge in the first place. Thus there are contingent-acquisition hypotheses which invoke innate language-specific representations and highly-constrained learning mechanisms (e.g., Snedeker & Gleitman, 2004) and others which posit that language acquisition is largely driven by domain-general learning abilities (e.g., Bates & Goodman, 1997). The developmental hypotheses are even more diverse. For example, Wexler has argued that the development of tense and agreement depends on the maturation of domain-specific innate syntactic knowledge (Wexler, 1999). In contrast, others have suggested that the length of children's early utterances depends on a domain-general increase in memory capacity (see e.g., Shore, 1986). These two proposals differ in the mechanisms they invoke and the phenomena they seek to explain, yet both are developmental hypotheses because they attribute changes in linguistic abilities to events that are distinct from the process of language acquisition itself and are tightly linked to the child's biological or cognitive development. Consequently, both theories predict that older learners, with mature grammars and longer memory spans, would initially produce more complete utterances than young children who begin acquiring the language in infancy.

Our work tests central predictions of developmental hypotheses by tracking the early language development of internationally-adopted children. Developmental hypotheses deal with diverse phenomena, ranging from the timing of babbling in infancy to the mastery of complex constructions during the early school years, thus no single method or population can be used to address all of these proposals. In the present study, we focus on two qualitative changes that typically occur between 12 and 30 months of age: (1) the systematic shift in the composition of the child's lexicon from concrete nouns to more abstract words such as verbs, adjectives and grammatical function words and (2) the end of the one-word stage and the emergence of combinatorial speech. These phenomena were selected because they are robust, easy to observe and central to theories about children's early word learning and language production.

In the remainder of this introduction, we examine these two shifts in greater detail. For each one, we describe the relevant developmental and contingent-acquisition hypotheses and briefly review the prior research. We conclude that the evidence to date is consistent with both classes of explanation. Finally, we describe our initial work on language acquisition in internationally-adopted children (Snedeker et al., 2007) laying out the motivations for the present study.

1.1. Accounting for changes in early vocabulary composition

Children's early vocabularies are dominated by social routines ("bye bye") and nouns that refer to people, animals, and small moveable objects. Although adults speak to children in full sentences, complete with verbs and grammatical function words, these elements are massively underrepresented in children's early vocabularies (Bates et al., 1994; Behrens, 2006; Gentner, 1982). As children's lexicons grow the proportion of social words declines and more verb, adjectives and function words appear, resulting in systematic correlations between vocabulary size and vocabulary composition (Bates et al., 1994). These systematic shifts lend themselves to both developmental accounts and contingent-acquisition hypotheses (see Conboy & Thal, 2006).

Developmental accounts of vocabulary shifts appeal to a range of mechanisms. For example, some theorists have suggested that the skewed nature of children's early lexicons may reflect their conceptual limitations (Huttenlocher, Smiley, & Ratner, 1983; O'Grady, 1987). Perhaps the relative dearth of verbs and adjectives is attributable to the infant's inability to conceive of relations, states or actions, while the overabundance of nouns is attributable to the conceptual primacy of object categories. As children overcome these limitations and develop the relevant concepts, they are able to acquire the words that encode them. This account provides a particularly intuitive explanation for young children's failure to learn words, like mental state verbs or temporal connectives, that are very frequent, highly abstract, and known to cause conceptual difficulties later in childhood.

The maturation of perceptual mechanisms could also play a role in the diversification of vocabulary. Closed-class words (or function words) are typically short in duration, rarely receive stress, and often have reduced vowels (Morgan, Shi, & Allopena, 1996; Selkirk, 1996). These factors could make them difficult for infants to accurately perceive or produce, raising the possibility that their emergence between 24 and 30 months is caused by improvements in perception or motor control.

But the changing composition of children's lexicons is equally amenable to contingent-acquisition hypotheses. For example, Gleitman and her colleagues have argued that shifts in lexical composition reflect the child's growing mastery of a particular language, rather than conceptual or perceptual development (Gillette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, Cassidy, Papafragou, Nappa, & Trueswell, 2005; Snedeker & Gleitman, 2004). An infant who is just breaking into language can only learn the meanings of words by observing the situational contexts in which they are used. This information may be sufficient for learning social routines, names for people, and labels for objects, because the meanings of these words can be readily inferred from nonlinguistic social cues (e.g., points or eye gaze). But as the child's knowledge of language grows, she is increasingly able to decode the sentence in which a new word appears and use this information to infer its meaning. This strategy (syntactic bootstrapping) could allow her to acquire more abstract relational words, such as verbs, adjectives and closed-class items. Perceptual bootstrapping could also play a role in vocabulary diversification. Closed-class words rarely appear in isolation (Brent & Siskind, 2001), instead they are typically part of the same prosodic unit as an adjacent open-class word (Selkirk, 1996). Thus stable representations of open-class words may be necessary for the accurate segmentation (and acquisition) of many closed-class words.

Although vocabulary composition is a well-studied topic, only a few lines of research appear to bear on the distinction between developmental and contingent-acquisition hypotheses. First, there is an extensive literature documenting that early vocabulary composition varies across linguistic and cultural contexts. Specifically, children who are learning object-dropping languages like Mandarin or Korean produce more verbs early in development than those who are learning languages like English (Choi & Gopnik, 1995; Tardif, 1996). If a given ability emerges early in one language and late in another, it seems reasonable to conclude that its emergence in the later language cannot be attributed to cognitive or maturational changes. There are two reasons, however, to reject this conclusion. First, the phenomenon of interest appears to be universal—*under the correct description*. As Gentner points out, the relevant question is not whether every child knows more nouns than verbs, but rather whether children systematically learn more nouns than we would expect given their frequency in the input (Gentner & Boroditsky, 2001). If the noun bias is characterized in this way, the current evidence suggests that it is a cross-linguistically robust feature of development (see e.g., Bornstein et al., 2004; Kim, McGregor, & Thompson, 2000; Tardif, Gelman, & Xu, 1999). Second, it is possible for shifts which are specific to particular languages to be caused by universal developmental changes. For example, suppose that the acquisition of function words in languages like English is driven by the maturation of perceptual abilities that allow children to accurately represent reduced syllables at the beginning of a phonological phrase. This skill would be unnecessary in languages in which function words have full vowels or appear at the end of phonological phrases. Consequently, the age at which function words appeared would vary across languages, but their emergence in English would (by hypothesis) depend on perceptual maturation.

A second line of research has explored the contingent-acquisition hypothesis by simulating the effects of linguistic development in the absence of cognitive limitations. In a series of studies, Gleitman and her colleagues asked adults to identify common words from different representations of the contexts in which they occurred in child-directed speech (Gillette et al., 1999; Snedeker & Gleitman, 2004). When limited to situational cues, adults could only identify the concrete nouns. However, when they were given information about the linguistic context, they were able to learn abstract nouns and verbs as well. These experiments demonstrate that changes in vocabulary composition are not necessarily attributable to changes in the learner's conceptual repertoire. But there are several differences between these human simulation experiments and the experiences of young language learners which might limit their validity. The adult observers are not participants in the interactions, which may affect both their level of motivation and their access to information about the participants' goals. Unlike infants, the participants in these studies do not have to segment utterances or create a representation

of the phonological form of the word. While young children must simultaneously grapple with several unknown words, the adults in these studies were given massed presentations of each target item, drastically reducing the memory demands of the task. If these differences merely improve or hinder performance equally for words of all kinds, then the simulations would still allow us to conclude that situational cues are more informative for nouns than for verbs. However, if these factors have differential effects on words of different classes, then such studies may not provide the relevant characterization of the input.

In contrast, the task and input of the adopted child appear to closely parallel that of the typically developing infant. Like the infant, the adopted child gets prolonged exposure to her new language in the context of meaningful social interactions. Like the infant she must simultaneously isolate the words and determine what they mean. However, like the adults in the human simulations, the adopted child is cognitively more mature than the infant. If shifts in vocabulary composition primarily reflect the changing cognitive capacities of the learner, then adopted children should acquire words from a variety of categories, much like their monolingual age mates. If vocabulary composition is largely a function of linguistic knowledge, then the adopted child should initially resemble the infant learner.

1.2. The emergence of combinatorial speech

For about 4–6 months after they begin speaking, children primarily produce single-word utterances. Short telegraphic utterances appear at about 16–19 months of age, when the child has acquired a vocabulary of about 100 words (Bates et al., 1995; Nice, 1925). Between 24 and 30 months, children's utterances continue to grow in complexity as they add determiners, auxiliaries and inflectional markers to their initially sparse statements (Brown, 1973). Both of these grammatical developments are tightly correlated with the child's productive vocabulary, suggesting that lexical and grammatical developments are linked (Bates & Goodman, 1997).

Two types of developmental hypotheses have been proposed to account for the development of combinatorial speech. Some theorists have suggested that the transition to multiword speech is driven by the development of a domain-general cognitive capacity to isolate and combine elements in novel ways (see e.g., Brownell, 1988; Shore, 1986). Others have argued that the onset of combinatorial speech depends on the maturation of a domain-specific grammatical capacity (Lenneberg, 1967; Locke, 1997).

However the onset of combinatorial speech could also reflect a pattern of contingent acquisition. The tight correlation between vocabulary size and the complexity of children's utterances raises the intriguing possibility that children may have to learn a critical mass of words before they are able to acquire the grammatical knowledge that they need to combine them. While this proposal has been associated with theories in which grammatical knowledge emerges from the lexicon (Bates & Goodman, 1997), it is compatible with any theory of acquisition which proposes that lexical knowledge is essential for the creation (or proper identification) of grammatical representations (see e.g., Locke, 1997; Pinker, 1984; Redington, Chater, & Finch, 1998; Tomasello, 1992).

Two lines of research support a developmental hypothesis for the emergence of combinatorial speech. First, in typical children, this milestone in language acquisition is associated with milestones in other domains (Lenneberg, 1967). For example, combinatorial speech usually appears around the same time as symbolic play (Fenson & Ramsay, 1980), block construction (Greenfield, 1978), sequenced imitation (McCall, Parke, & Kavanaugh, 1977), and changes in nonverbal categorization (Sugarman, 1983). Many of these associations are reliable even when age is controlled or factored out. For example, Shore and colleagues found reliable correlations between the length of children's utterances at 20 months and the complexity of their symbolic play sequences (Shore, O'Connell & Bates, 1984). Such findings have led many to suggest that combinatorial speech may have to await the development of some domain-general cognitive ability affecting memory, sequencing, or symbolic representation (Bauer, Hertsgaard, Dropik, & Daly, 1998; Brownell, 1988; Shore, 1986).

Additional support for this developmental hypothesis comes from studies of early language acquisition in children with developmental disorders. Both children with Down syndrome and children with Williams syndrome show substantial delays in early language production which are roughly proportional to their cognitive delays, resulting in productive vocabularies that are roughly the size of

mental age matched controls (Laing et al., 2002; Singer-Harris, Bellugi, Bates, Jones, & Rossen, 1997; Vicari, Caselli, Gagliardi, Tonucci & Volterra, 2002). This early association between general cognitive ability and language production is quite robust; even mentally-retarded persons who go onto develop extraordinary linguistic skills appear to have had early language delays proportional to their cognitive impairments (Rondal, 2003).

In Williams syndrome, the onset and growth of combinatorial speech is also synchronized to vocabulary size and mental age, just as it is in typical children (Singer-Harris, Bellugi, Bates, Rossen, & Jones, 1997; Vicari et al., 2002). In contrast, children with Down syndrome produce fewer and shorter combinations than typical children of the same mental age. These findings are consistent with the hypothesis that the onset of combinatorial speech is usually triggered by the development of a domain-general cognitive capacity closely linked to general intelligence. In typical development and in Williams syndrome, acquisition of this ability is sufficient for combinatorial speech. In children with Down syndrome, other impairments may stand in the way (or the critical cognitive skill itself is slow to develop).

However, while these findings are compatible with the developmental hypothesis, they do not provide definitive evidence for it. Patterns of association—in typical children or in developmental disorders—are consistent with multiple causal accounts. These associations could reflect effects of general cognitive development on language development, or they could reflect effects of linguistic abilities on nonlinguistic tasks. Alternatively, language and cognitive development could proceed along independent lines but still be associated, so long as the pace of development in each domain was sensitive to some of the same variables (e.g., differences in general learning abilities, neural efficiency or the pace of biological maturation).

Support for the contingent-acquisition hypothesis comes from studies exploring the close relation between vocabulary growth and the development of combinatorial speech. Bates and her colleagues have demonstrated that the same pattern of lexical grammatical synchrony which characterizes typical development is also present in early-talkers, late-talkers and children with Williams syndrome, suggesting that lexical learning may fuel syntactic development (Bates & Goodman, 1997). These studies, however, cannot rule out the possibility that both aspects of language depend upon the development of some other cognitive ability, one which is accelerated for early-talkers, delayed for late-talkers, and proportional to mental age in children with Williams syndrome.

The goal of the present study is to test the contingent-acquisition hypothesis by examining the relation between lexical and grammatical development in children who acquiring English as preschoolers. If vocabulary acquisition and combinatorial speech are causally connected, then this relationship should persist in maturationally-advanced learners. In contrast, if the correlation is created by rate-limiting development in another domain, then it should be possible to find disassociations in older learners.

A similar motivation underlies two recent studies of language production in young Spanish–English bilinguals (Conboy & Thal, 2006; Marchman, Martínez-Sussmann, & Dale, 2004). Because bilingual children split their time between two languages, vocabulary growth in each language is often delayed relative to monolinguals. Thus bilingual learners could potentially be maturationally-advanced learners, reaching each stage of acquisition at a later age than monolinguals. Both studies used a parental report measure and found that bilinguals showed the same qualitative shifts during acquisition as monolinguals. While these results are consistent with the contingent-acquisition hypothesis, they do not provide a strong test of the developmental hypothesis. In both studies, the bilingual children had language skills within the normal range for monolinguals of their age and no information was provided about their cognitive abilities.[2]

1.3. Our prior work and the goals of the present study

To explore the role of cognitive development and maturation in these shifts, we conducted a preliminary study of the acquisition of English by internationally-adopted preschoolers (Snedeker et al.,

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[2] For example, the mean English vocabulary size for the cross-sectional sample in Conboy and Thal (2006) was 176 words at 20 months, a value which is near the median for English monolinguals (Fenson et al., 1993).

2007). Parental reports and speech samples were collected from preschoolers, 3–18 months after they were adopted from China. The children showed the same qualitative shifts in language production as monolingual infants (matched for vocabulary size). Early on, their vocabularies were dominated by nouns, their utterances were short, and grammatical morphemes were generally omitted. Children at later stages had more diverse vocabularies and produced longer utterances with more grammatical morphemes.

This study had four limitations that are addressed in the present paper. First, the average participant had been in the US for 8 months at the time of the first session, thus many of the children had already passed through the initial stages of language acquisition before data collection began. Second, the limited number of data points available for each child made it unclear whether these shifts characterized development on an individual level. Only 27% had data points spanning a range of 200 words or more, and thus the shifts in vocabulary composition that were observed in this study were primarily driven by differences across individuals. Third, in the previous study we did not collect any data that would allow us to verify that the children in the study were in fact more cognitively capable and physically mature than infants learning their first language. While this seems like a safe assumption, documentation would be helpful, particularly in light of delays that are associated with institutional care (Sloutsky, 1997). Fourth, in the previous study our control group consisted of typically developing infants learning English as a first language. Thus, the adopted preschoolers were not only older that the control children, they were also drawn from a different population and were being raised by parents who had chosen adoption and might differ in their linguistic behavior or parenting style. In the present study, we address this concern by using a control group of internationally-adopted infants.

2. Methods

2.1. Participants

Information about the participants appears in Table 1. The preschool group consisted of nine children who had been adopted between 2.6 and 5.6 inclusive (M = 4.0), while the infant group consisted of fourteen children who were adopted before 16 months of age (range 0.6–1.4, M = 1.0). Preschoolers were enrolled shortly after arriving, thus they were between 2.7 and 5.8 (M = 4.1) at the beginning of the study. Infants began the study after they were speaking and they were between 1.3 and 1.10 (M = 1.7) at the time of the first session.

Only children adopted from China or from Slavic-speaking countries were recruited. All of the children were believed to have been primarily exposed to a dialect of Mandarin, Cantonese or Russian, though some of the children may have been exposed to regional languages as well. Information about the study appeared periodicals, online newsletters and discussion boards for families with adopted children. Two of the children (F & G) were biological siblings who came from different orphanages but entered the US at the same time.

Three exclusionary criteria were used for both the preschool and infant groups. First, we excluded any family in which the parent regularly used a language other than English with the child. Families attending weekly classes in which the birth language was used were not excluded. Second, we excluded children who had been diagnosed with a major developmental disorder, including Down syndrome, an autism spectrum disorder or mental retardation. Children who were reported to have developmental delays or language delays were not excluded, but this information was recorded (Table 1). We reasoned that if we excluded children who were perceived as delayed, we would run the risk of disqualifying children who were simply learning English at slower rate and thus overestimate the pace of language acquisition in this population. Third, children who had a sensory or motor impairment that might affect speech perception or production were excluded, including those with bilateral hearing loss or an uncorrected cleft palate. Children with hearing loss in one ear or with tubes for ear infections were not excluded.

Twenty-one infants and twenty preschoolers began the study. Fourteen infants and nine preschoolers completed the study; these children comprise the longitudinal sample described above. Three additional preschoolers completed all sessions but were excluded because of new information

Table 1
Background information about participants.

Participant	Sex	Age at arrival	Birth language (country)	Developmental concerns[*]	Knowledge of birth language (first/final session)	Continued exposure to birth language (first/final session)	Frequency of use of birth language (first/final session)
Preschool adoptees							
A	M	2.5	Russian	1, 2	⩽5 words/none	Never/never	50%/<25%
B	F	5.0	Russian	None	4–5 word sentences/5–15 words	Daily sibling[**]/never	>75%/never
C	F	3.1	Russian (Belarus)	None	4–5 word sentences/⩽5 words	Sitter 1 day a week/2 days a month (sitter)	>75%/never
D	F	5.6	Russian	1	4–5 word sentences/none	Never/rarely	>75%/never
E	M	4.3	Mandarin	3	4–5 word sentences/no data	Never/no data	>75%/no data
F	M	5.4	Russian	2	4–5 word sentences/none	Never/rarely	>75%/never
G	M	4.2	Russian	2	4–5 word sentences/none	Never/rarely	>75%/never
H	F	2.9	Longyou (China)	3	4–5 word sentences/⩽5 words	Never/never	>75%/never
I	F	3.1	Russian	3	Some 2-word phrases/⩽5 words	Never/rarely	<25%/never
Infant adoptees							
1	F	1.4	Mandarin	None	None/5–15 words	Never/1 class each week	Never/<25%
2	F	1.2	Cantonese	1	Never learned	Never/never	Never/never
3	F	1.3	Mandarin	1	Never learned	Never/never	Never/never
4	M	0.6	Russian	1	Never learned	Never/rarely	Never/never
5	F	0.10	Cantonese	None	Never learned	Never/never	Never/never
6	F	0.11	Cantonese	None	Never learned	Never/rarely	Never/never
7	F	1.4	Mandarin	None	Never learned	Never/rarely	Never/never
8	F	0.7	Russian (Kazakhstan)	None	Never learned	Never/rarely	Never/never
9	F	1.0	Mandarin	1	None/some 2-word phrases	1 class a week/1 class a week	Never/<25%
10	F	1.3	Russian	None	Never learned	Never/never	Never/never
11	F	1.0	Mandarin	None	⩽5 words/⩽5 words	Never/rarely	Never/never
12	F	1.1	Cantonese	None	Never learned	Never/never	Never/never
13	F	0.11	Cantonese	No data	None/no data	Never/no data	Never/no data
14	F	1.3	Cantonese	None	⩽5 words/none	Never/rarely	Never/never

[*] 1 = developmental delays, 2 = hearing related (all participants had normal hearing in at least one ear), 3 = physical health.

[**] Younger adoptive sibling, adopted at same time.

indicating that they did not meet our criteria (two families regularly used the child's birth language and one child was diagnosed with a severe bilateral hearing loss). An additional seven infants contributed between one and five sessions (M = 3.4) and an additional eight preschoolers contributed between one and four sessions (M = 2.4). Our analyses will focus on the longitudinal sample. However, to guard against the possibility that the children who completed the study were substantially different than those who did not, all analyses were also conducted on the entire data set, and unless otherwise noted the pattern of effects remained the same.

2.2. Measures

All materials for the study were mailed to the parents who collected the data in their home. Four measures were used: a background questionnaire, the MacArthur–Bates Communicative Development Inventory 2 (CDI-2), videotaped speech samples, and a modified version of the Ages and Stages Questionnaire. The background questionnaire was based on one used by Glennen and Masters (2002) and Pollock (2005). It asked about the child's history and health, their level of proficiency in their birth language, their adoptive family, their current use of English and their native language, and their current language environment. This information was used to characterize our sample and to exclude children who did not meet our selection criteria.

We examined the early English development of the adopted children using the CDI-2 (Fenson et al., 1993). The CDI-2 is a parent report measure which includes a 680-item vocabulary checklist, questions about children's early word combinations and a forced-choice sentence-complexity measure which asks about the child's use of inflectional morphemes and closed-class words. The CDI-2 is normed for children 16–30 months of age. However, it has also been used to track language development in older children with limited language skills (Singer-Harris et al., 1997; Thal, O'Hanlon, Clemmons & Frailin, 1999).

The speech samples were collected by the participating parent who was instructed to videotape herself interacting with her child two times a month for 30–40 min. Families were given a standard set of toys to use while making the recordings. The speech sample was transcribed and used to validate the parental report of the child's language use and linguistic environment.

Our fourth measure was a parental report of children's cognitive, social and motor development. This measure was based on the Ages and Stages Questionnaires (ASQs). The ASQ is a set of parental checklists that are used to screen children between 2 months and 6 years for developmental delays that might warrant clinical attention (Bricker & Squires, 1999). The questions probe gross-motor, fine-motor, personal–social, problem solving and language skills. We constructed a modified version of the ASQ by pooling the questions from the checklists for children between 12 months and 60 months and eliminating questions assessing language development and questions which in our judgment required a linguistic prompt or response. The remaining questions were assigned to one of three age categories, based on the age by which children are expected to acquire the ability as listed in the ASQ manual. The early milestones were ones that we would expect typically developing children to pass prior to developing the linguistic skills assessed on the CDI-2 (11–21 months). The concurrent milestones were ones that typically emerge simultaneously with these linguistic abilities (21–36 months), while the late milestones would typically be achieved after these linguistic abilities developed (36–60 months). Answering the questions on the ASQ, requires fairly extensive knowledge of a child's abilities in a wide range of contexts, thus we did not send the modified ASQ to parents until their child had been in US for 3 months.

2.3. Enrollment and assessment schedule

Because adopted preschoolers begin rapidly acquiring English immediately after adoption (Snedeker et al., 2007), all the preschoolers were enrolled in the study within a month after arriving in the US. The families completed the first assessment between 1 week and 3 months after adoption (M = 1.3 months). For the adopted infants, our goal was to begin data collection when the child could produce between 5 and 20 words. Parents with eligible children between 12 and 16 months were encouraged to enroll. At first contact, the parents were asked if their child was producing five words

yet. If they were, the parent was sent materials for the first session. If they were not, the parent was sent the MacArthur–Bates Communicative Development Inventory-1 (infant form) every month until the child produced 5 words, at which point they were sent the materials for the first session.

The parents of adopted preschoolers were asked to participate every month for 6 months, with follow-up sessions 3 months and 6 months later for a total of eight sessions. The parents of infants were asked to participate every month for a year. This difference reflected our expectations about the pace of vocabulary development in the two populations. Our central questions focused on changes that happen as children acquire their first 400 words. On the basis of our earlier study, we expected that most of the preschoolers would acquire 400 words within the first 6 months of the study. In contrast, infants take about a year to move from a vocabulary of 20 words on the CDI-2 to a vocabulary of 400 words, thus we monitored them monthly throughout this period. Not all families completed every session on time. To be included in the longitudinal sample, families had to complete at least six sessions, spanning at least 9 months.

Each session consisted of a parental report of language development (CDI-2) and two videotaped speech samples (recorded approximately 2 weeks apart). Parents completed the background questionnaire on entering and exiting the study. The modified ASQ was sent every 3 months but only after the child had been with their adoptive family for at least 3 months. Thus the infants typically received it at sessions 1, 4, 7 and 10, while the preschoolers typically received it at sessions 3, 6 and 9 with some variation depending on when they enrolled.

3. Results

We began by testing the three working assumptions on which this study rested. These analyses are available in the supplementary materials posted online.[3]

First, we have been assuming that internationally-adopted children, like infant learners, are rapidly immersed in an English language environment and have little access to bilingual informants. This was confirmed by the parents' responses on the background questionnaires (Table 1); most of the children rarely or never heard their birth language. To verify that families were primarily using English in the home, fluent speakers of Russian and Chinese transcribed the speech samples for five of the oldest preschool adoptees (B, D, E, F & G). We found that even in the first recording session, over 90% of the parental utterances were entirely in English. At the beginning of the study, parents reported that the preschool adoptees generally spoke in their birth language and could produce 4–5 word sentences. By the end of the study, they reported that their children appeared to know only a few words in his/her birth language and rarely used it. Our analysis of the tapes confirmed this. After around 2 months in the US, each of the children produced more utterances in English than in their birth language. In contrast, most of the parents of infant adoptees reported that their child had never learned any words in their birth language.

Next, we confirmed that the preschoolers were more cognitively mature than the infants by analyzing the parents' responses on the modified ASQ. We focused on the ASQ that was administered in month 3 of the study (which was typically the first ASQ) and the one that was administered around month 10 (which was typically the last). By month 3, the adopted preschoolers had already mastered most of the gross-motor, fine-motor, problem solving and social skills that typically coincide with early language development ($M = 89\%$) and they were making substantial progress on the milestones that characterize development in the preschool years ($M = 70\%$). The adopted infants, in contrast, had acquired only half of the concurrent milestones ($M = 50\%$) and, unsurprisingly, had passed few of the preschool milestones ($M = 13\%$). In fact, the ASQ scores for the preschoolers at the beginning of the study were considerably higher than the scores for the infants at the end of the study ($M = 74\%$ for concurrent milestones and $M = 41\%$ for preschool milestones). Thus the adopted preschoolers appear to already possess have the cognitive skills that are developing at the time that typical language learners are mastering the linguistic skills measured by the CDI-2.

Finally, we demonstrated that the CDI-2 is a valid assessment of language development in internationally-adopted preschoolers by documenting parallel relations between the CDI-2 and transcript measures in both populations. Specifically, we found that there was a strong and reliable correlation

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between the number of word types in a sample and the CDI-2 vocabulary size for that session ($R^2_{y,y} = .53$). There was also a robust association between the child's MLU in a given sample and the parents evaluation of whether the child was able to combine words ($R^2_{y,y} = .35$). In both cases, the relationship was similar in both groups of participants, resulting in no effects of age group and no interactions between group and the predictor variable.

3.1. Description of CDI-2 data and the hierarchical analyses

Table 2 summarizes the data that was collected using the CDI-2 parental reports of language development. To facilitate comparisons across the children we estimated the age at which each child had acquired 20 words in their productive vocabulary. This was defined as the age of language onset. For children who had an observation at which their total CDI-2 vocabulary was between 10 and 35 words, this session was used for the age of onset. Several of the preschoolers had larger vocabularies at their first session, for these children their age of arrival was used as their age of onset. This is a conservative solution, in the sense that any systematic error it introduces works counter to our hypothesis that the pace of acquisition is faster in preschoolers than in infants. Two infants had also passed 35 words by the time they participated in the first session. However, both families had submitted an earlier questionnaire (a CDI-1) with a production vocabulary between 10 and 35 words which was used to calculate the age of language onset. While many of the preschoolers had reached the ceiling of the CDI-2 vocabulary checklist by the end of the study, few of the infants did. Because only half of the infants had observations beyond 450 words, we focused our analysis on changes that occur before this point in typical language development.

Our data contains multiple observations nested within participants and thus requires a statistical technique that models this internal structure, accounting for both variation within a participant and variation between participants. Hierarchical linear models provide a means for conducting regression analyses on data sets with two or more levels of structure. The hierarchical analyses were conducted in HLM-6 (Raudenbush, Bryk, & Congdon, 2005) using the HLM2 module.[4]

Our analytic strategy was largely guided by Singer and Willett (2003). For each analysis we began by constructing the unconditional means model. This is a model with no predictors which provides a baseline for assessing subsequent models. Next we explored the effects of the predictors that varied across sessions (level-one predictors). Our level-one predictors included: time since adoption, current age, age since language onset and current vocabulary size. Once the best level-one model was identified, we examined the effects of level-two predictors. Level-two predictors are factors that are stable across sessions in an individual participant, such as age of arrival or whether the participant was a part of the preschool or infant group. All models included an error term in each equation (the level-one equation and all level-two equations).

Models were compared in a stepwise fashion. If several factors could be added at a given step, then the factor that resulted in the smallest deviance statistic was added first. The more complex model was selected only if it resulted in a reliable decrease in the deviance statistic (which was evaluated with a chi-squared test) and if the new parameter was reliably greater than zero (according to a *t*-test).

To facilitate informal comparisons between the models, we calculated the total variance in the level-one sample that could be accounted for by each model. To do this, we predicted the value of the outcome variable for each observation using the level-two parameter estimates produced by hierarchical model and conducted a simple regression of this value on the observed value. Singer and Willett (2003) call this measure $R^2_{y,y}$. By taking the value of $R^2_{y,y}$ for a model that includes a given effect and subtracting out the model that excludes this effect we can calculate the partial $R^2_{y,y}$ of the effect, or the proportion of the variance that it accounts for. This measure of effect size is directly comparable to the R^2 values used in simple regressions and allows us to compare level-one predictors with level-two predictors using the same scale.

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[4] Each model was fit twice, once using the restricted maximum likelihood method, and once using the full maximum likelihood method. Parameter estimates and *t*-tests were taken from the model fitted with restricted maximum likelihood, while the deviance statistic and variance components were taken from the model fitted with full maximum likelihood (see discussion in Singer & Willett, 2003). In all cases, the two methods of model fitting produced very similar results.

Table 2
Summary of data collected.

Subject	# of Sessions	Age of onset[*]	First session			Last session		
			Time in US (months)	CDI vocab	Combining words	Time since onset (months)	CDI vocab	Combining words
Preschool adoptees								
A	9	2.7	1.6	12	Never	13	625	Often
B	6	5.3	0.6	29	Sometimes	12	678	Often
C	8	3.3	1.1	10	Never	12	580	Often
D	8	5.8	1.2	32	Never	12	482	Often
E	7	4.4	0.3	27	Sometimes	14	647	Often
F	8	5.4	1.1	84	Never	15	647	Often
G	8	4.3	1.1	72	Never	15	663	Often
H	8	2.11	1.1	24	Never	13	640	Often
I	6	3.1	3.2	197	Often	12	602	Often
Mean	7.6	4.2	1.3	54		13.1	618	
Infant adoptees								
1	12	1.11	2.5	7	Never	9	412	Often
2	12	1.10	6.4	8	Never	12	419	Often
3	12	1.10	5.6	14	Never	11	181	Sometimes
4	12	1.10	6.0	10	Sometimes	11	538	Often
5	12	1.8	5.4	6	Never	10	568	Often
6	12	1.5	6.0	14	Never	11	532	Often
7	12	1.6	0.9	7	Never	11	406	Often
8	11	1.6	10.4	30	Sometimes	12	615	Often
9	10	1.4	8.8	159	Sometimes	15	601	Often
10	12	1.9	6.0	22	Never	11	598	Often
11	11	1.3	3.1	23	Never	11	570	Often
12	11	1.10	9.6	25	Never	12	427	Often
13	11	1.10	9.4	8	Never	9	119	Often
14	12	1.7	6.7	107	Never	15	680	Often
Mean	11.6	1.7	6.8	31		11.4	476	

[*] Age of Onset: age at which child had a productive vocabulary of approximately 20 English words. See text for details.

For most analyses we only considered linear effects of the level-one predictors. Hierarchical models are based on the estimated level-one regression equations for each participant. In many analyses, some of the participants had only two or three data points in the relevant vocabulary range, making it difficult to rule out the linear model (or accurately estimate more complex functions). Fortunately, in typically-developing infants most of the effects of interest appear to be roughly linear, provided that one restricts the range of the analysis. For example, prior studies have found that the relation between noun proportion and vocabulary size has a quadratic component; initially it increases, then after about 200 words it declines (Bates et al., 1994). However, if we restrict the range to under 200 words (or over 200 words) the effect is approximately linear.

There is one exception to this. Prior research on vocabulary growth in typical infants has demonstrated that the pace of acquisition accelerates as more words are acquired, which is typically captured by a quadratic component in the growth model (see e.g., Fenson et al., 1994; Ganger & Brent, 2004). For this reason we explored quadratic models in our comparison of vocabulary growth in preschool and infant adoptees. This analysis incorporated every session that each child contributed prior to reaching the ceiling of the CDI-2, thus there was sufficient data to estimate quadratic level-one models for each participant (5–12 sessions).

3.2. Does the age of the learner affect the pace of vocabulary acquisition?

For internationally-adopted children, there are three temporal dimensions that could be relevant to language development: the length of time that they have been in the US, their current age, and their

age at the time of adoption. Our preliminary analyses demonstrated that these variables had quite different effects on word learning in the two age groups (see supplemental online materials). In the infants, vocabulary size was predicted by the child's age ($R^2_{y,y} = .44$) and time in the US and age of arrival did not account for substantial additional variance (partial $R^2_{y,y} \leqslant .02$ for both). In contrast, in the preschoolers, vocabulary size primarily depended on the amount of time that they had spent US ($R^2_{y,y} = .60$). Neither their current age nor their age of arrival predicted substantial additional variance (partial $R^2_{y,y} \leqslant .03$ for both).

It is not surprising that the most relevant measure of time is different for these populations. An infant who is adopted at 5 months of age, will acquire few words in the first 6 months, while a child who arrives at 15 months of age may begin speaking shortly after adoption. The preschoolers, in contrast, are ready to learn from the moment they walk off the plane, and so their vocabulary size is tightly linked to the amount of time that they have been in the US. To compare the pace of lexical development in the two populations, we need a way to equate these two time scales.

Our solution was to align the children at an early point of language acquisition and then observe how rapidly they progressed from there. Language onset was defined as the point at which the child knew approximately 20 words. We calculated the time of each session relative to language onset and conducted a stepwise analysis of vocabulary size with age since onset as a level-one predictor and participant group (infant or preschooler) as a level-two predictor. To minimize the effects of ceiling-level performance on growth rates, we identified the first session in which the participant knew at least 90% of the words on the CDI-2 (612) and then removed all subsequent data points for that participant from the analysis. Six sessions were removed from four preschoolers and three sessions were removed from one infant.

Table 3 describes the models fitted in this analysis. Because vocabulary growth accelerates in typical learners, we tested a quadratic model in addition to the linear one. Although, the quadratic model did not account for more level-one variance than the linear model, it did have a substantially lower deviance statistic, suggesting that there was a reliable quadratic component for some of the participants, but that the sign of this component was variable. In the remaining models, group (1 = preschooler, 0 = infant) was added as a predictor of the intercept, slope and acceleration in a stepwise fashion.

The model with the best fit includes group as a predictor of both slope and acceleration (partial $R^2_{y,y} = .09$ and partial $R^2_{y,y} = .04$, respectively). Specifically, older children initially learn at a much faster rate than infants (85 vs. 23 words per month). However, the rate of word learning gradually decelerates in preschoolers, suggesting either that the children are nearing the ceiling of the instrument or that the words which are acquired later present more challenges for them than the ones that are acquired earlier. In contrast the infant learners show acceleration with time, replicating the pattern observed in other longitudinal studies of early word learning. Fig. 1 illustrates the vocabulary growth curves and the observed data points for both groups of adoptees in the longitudinal sample. These findings confirm our previous observation that adopted preschoolers learn more quickly than infants, suggesting a role for cognitive development (or prior linguistic experience) in the pace of language development.

3.3. Do older learners show the same shifts in vocabulary composition?

Next we explored the shifts in vocabulary composition that occur during early language development. The dependent variable in these analyses is the percentage of the words in the child's lexicon that belong to a particular category. For example, if the child knows 10 words and 3 are verbs then the verb percentage is 30%. In each analysis vocabulary size was entered as a level-one predictor of vocabulary composition to explore whether these shifts occurred reliably across participants. Next, group was entered as a predictor of both the intercept and the slope (of vocabulary size) to explore whether there were any differences between the infants and preschoolers. To validate these effects within individual participants we took the first and last session that each participant contributed to the analysis, tallied the number of participants who conformed to the predicted pattern and conducted a sign-test.

Our first analyses explored two changes that occur in the initial stages of vocabulary development as children's lexicons grow from 0 to 200 words (Bates et al., 1994; Caselli et al., 1995). Many of the

Table 3
Hierarchical models of vocabulary growth.

	Parameter	Unconditional Model	Linear Growth Model	Quadratic Growth Model	Quadratic Growth Model 2	**Quadratic Growth Model 3**	Quadratic Growth Model 4
Fixed Effects							
Initial vocabulary size	Intercept γ_{00}	249.70** (19.28)	-7.29 (11.28)	4.20 (5.76)	4.78 (5.73)	**4.62** **(5.71)**	-9.70 (7.11)
π_{0i}	Group: preschooler relative to infant γ_{01}						7.88 (12.10)
Rate of Change (time since 20 words)	Intercept γ_{10}		53.08** (4.88)	47.44** (10.03)	35.64** (8.65)	**22.64*** **(8.54)**	20.46* (9.09)
π_{2i}	Group: preschooler relative to infant γ_{11}				28.32** (6.89)	**62.66**** **(12.32)**	69.07** (14.81)
Acceleration (time since 20 squared)	Intercept γ_{20}			0.391 (0.770)	0.504 (0.774)	**2.03**** **(0.758)**	2.16** (0.783)
π_{2i}	Group: preschooler relative to infant γ_{21}					**- 4.11**** **(1.20)**	- 4.52** (1.31)
Variance Components							
Level 1	Within person σ^2_{ε}	32840.47**	2042.14**	897.62**	884.22**	**897.14***	894.60**
Level 2	Initial vocabulary σ^2_{0}	4335.91**	1908.79**	104.43	104.49	**93.39**	94.31
	Rate of change σ^2_{1}		494.62**	2088.75**	1335.22**	**937.07***	950.38**
	Acceleration σ^2_{2}			11.76**	11.92**	**6.76***	6.90**
Pseudo R2 statistic and Goodness-of-fit							
	$R^2_{y,y}$		0.627	0.627	0.715	**0.758**	0.757
	Deviance	2718.05	2261.60	2144.20	2134.91	**2124.80**	2124.15
	AIC	2724.05	2273.60	2164.20	2156.91	**2148.80**	2150.15
	BIC	2727.46	2280.41	2175.55	2169.40	**2162.43**	2164.91
	# parameters	3	6	10	11	**12**	13

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.
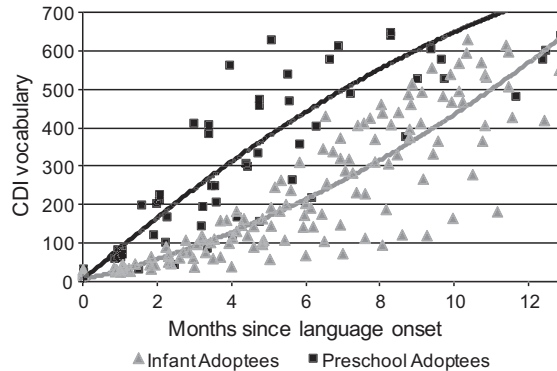* $p < .05$.
** $p < .005$.

Fig. 1. Vocabulary growth in adopted infants and preschoolers. Language onset was defined as the estimated time at which each child had a vocabulary of 20 words.

words that children learn first are social words (names, exclamations or verbal routines). The percentage of social words declines as the child develops a broader repertoire. Second, during this same time period the proportion of nouns grows, peaking at around 200 words.

To explore whether these shifts occur in older and more cognitively mature learners, we selected all sessions with total CDI-2 vocabulary scores between 0 and 230 and analyzed them.[5] Social Words were defined as all items in the CDI-2 categories *games and routines*, *names* and *sound effects*. As Fig. 2a illustrates, both groups showed the expected profile: high but variable social word percentages at the beginning of acquisition, followed by a sharp decline. The models confirmed that there was a reliable (negative) relation between vocabulary size and the proportion of social words, which accounted for 58% of the variance. The two groups of adoptees did not differ in their initial preference for social words or in the magnitude of the subsequent drop, as evidenced by the lack of reliable effect of group on the intercept or slope (Table 4). The decline in social words was observed in all fourteen infants and all eight of the preschoolers who contributed at least two sessions to this analysis ($p < .001$, $p < .01$, respectively).

Nouns included all items in the categories: *animals*, *toys*, *food and drink*, *clothing*, *body parts*, *small household objects*, *furniture*, *rooms* and *vehicles*. As Fig. 2b illustrates the proportion of nouns for both groups increased during this early phase of word learning and there were no differences between the groups in the intercept or slope of this function (Table 5). This increase accounted for 30% of the variance and was observed in all fourteen infants and seven of the eight preschoolers who contributed at least two sessions to this analysis ($p < .001$, $p = .07$, respectively).

Our next analysis explored the gradual drop in noun proportion that occurs after 200 words. When children are near the ceiling of the CDI-2, vocabulary composition necessarily reflects the composition of the checklist. To ensure this did not unduly influence our findings, we removed observations where children had acquired over 90% of words from these analyses. Thus vocabulary size in this sample ranged from 200 to 612 words. In our statistical analysis we subtracted 200 words from the child's total vocabulary so that the intercept of our model would reflect the proportion of nouns in the child's lexicon at the beginning of this period (Table 6). The results confirm that there is a substantial drop in the noun proportion as vocabulary rises (accounting for 38% of the variance). There are no reliable group differences between the infants and preschoolers (see Fig. 2c). The decline in nouns was observed in eleven of the twelve infants who contributed to the analysis and all nine of the preschoolers ($p < .01$, $p < .005$, respectively).

This decline in nouns is brought on by an increase in other word types. For example, between 0 and 400 words many children begin to produce more predicates, such as verbs and adjectives. Verbs may

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[5] Many children who did not have a CDI-2 vocabulary observation between 150 and 200 words had one between 200 and 230. Thus expanding the range helped ensure more robust level 1 models.
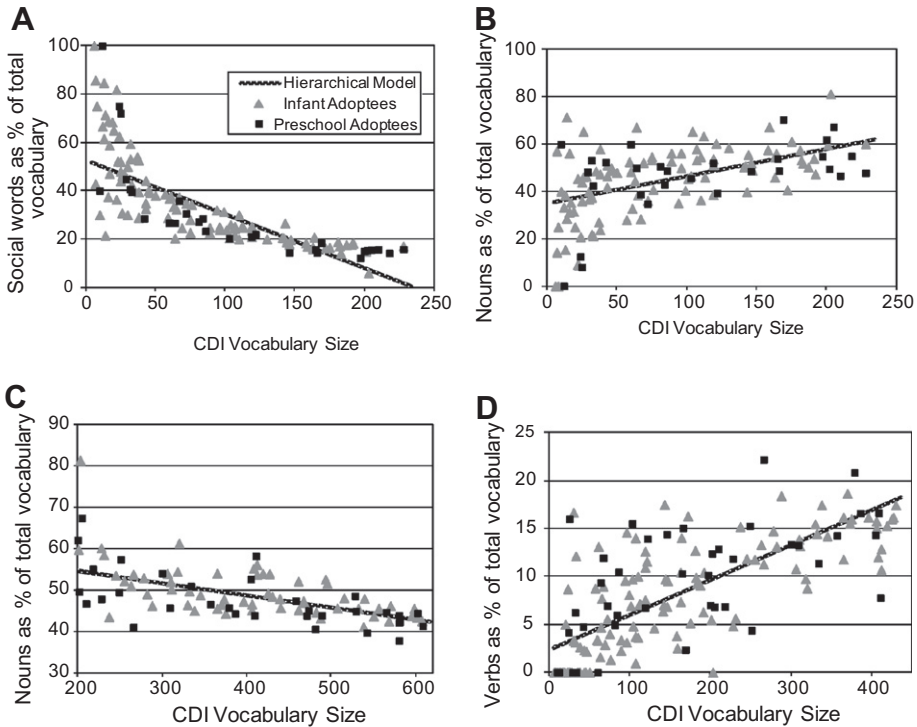
Fig. 2. Changes in vocabulary composition that are similar in infant adoptees and preschool adoptees: (A) the proportion of social words in the children's vocabularies declines between 0 and 430 words; (B) the proportion of nouns rises from 0 to 230 words and then (C) falls from 200 to 610 words; (D) the proportion of verbs rises from 0 to 430 words.

be difficult for early learners to acquire because they are syntactically complex words and their meanings and referents are often tightly linked to the arguments that they take (see Gleitman, 1990; Gentner & Boroditsky, 2001, for reviews). Many verbs refer to events that are short in duration and thus may not be going on at the time the word is spoken. In contrast, adjectives are typically less syntactically complex and often refer to properties that are relatively stable. Thus we chose to analyze verbs and adjectives separately. We also examined a third class of words (time words) which are abstract and late to develop in typical infants.

The verbs conformed to the pattern seen in previous studies of typically-developing infants. As vocabulary size grew, the proportion of the child's words that were verbs increased (see Fig. 2d). This effect accounted for 56% of the variance, and there were no differences between the groups (Table 7). An increase in the proportion of verbs was observed in all fourteen infants and eight of the nine of the preschoolers ($p < .001$, $p < .05$, respectively).

The adjectives, however, patterned differently (Table 8, Fig. 3a). In both groups, the proportion of adjectives increased as vocabulary grew, as we expected. This increase was somewhat more variable across participants appearing in twelve of the fourteen infants and seven of the nine of the preschoolers ($p < .05$, $p > .1$, respectively). But critically, there was also a main effect of group (present in the model as an effect of group on the intercept); older children knew more adjectives than infant learners.

To explore the source of this effect, the adjectives were split into three classes. The first consisted of 20 adjectives describing behavior or a person's internal states. This class included: words for physiological states (*tired*, *hungry*), words for mental states (*scared*), evaluative adjectives (*good*, *naughty*), and adjectives that are often used as behavioral directives (*be careful*, *be quiet*). Many of these words are abstract in the sense that they do not describe properties that are typically visible. However, they

Table 4
Hierarchical models of social word percentage in children's vocabularies between 0 and 230 words.

		Parameter	Unconditional Model	**Vocabulary Growth Model**	Vocabulary Growth Model 2	Vocabulary Growth Model 3
Fixed Effects						
Initial percentage	Intercept	γ_{00}	34.05** (2.34)	**52.60** (3.15)**	52.26** (3.21)	52.87** (3.16)
π_{0i}	Group: preschooler relative to infant	γ_{01}			1.65 (2.64)	
Rate of Change	Intercept	γ_{10}		**-0.223** (0.025)**	-0.224** (0.025)	-0.230** (0.026)
π_{2i}	Group: preschooler relative to infant	γ_{11}				0.016 (0.020)
Variance Components						
Level 1	Within person	σ^2_ε	358.30**	**120.10**	119.62**	119.62**
Level 2	Initial percentage	σ^2_0	48.23**	**130.58**	131.14**	128.70**
	Rate of change	σ^2_1		**0.00720**	0.00726**	0.00712**
Pseudo R2 statistic and Goodness-of-fit						
	$R^2_{y,y}$			**0.584**	0.584	0.587
	Deviance		1135.32	**1005.71**	1005.31	1005.05
	AIC		1141.32	**1017.71**	1019.31	1019.05
	BIC		1150.73	**1036.52**	1041.26	1041.00
	# of parameters		3	**6**	7	7

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.
[*] $p < .05$.
[**] $p < .005$.

Table 5
Hierarchical models of noun percentage in children's vocabularies between 0 and 230 words.

		Parameter	Unconditional Model	**Vocabulary Growth Model**	Vocabulary Growth Model 2	Vocabulary Growth Model 3
Fixed Effects						
Initial percentage	Intercept	γ_{00}	45.10** (2.30)	**34.99** (3.32)**	35.75** (3.48)	34.93** (3.31)
π_{0i}	Group: preschooler relative to infant	γ_{01}			-2.49 (3.30)	
Rate of Change	Intercept	γ_{10}		**0.115** (0.020)**	0.116** (0.020)	0.121** (0.021)
π_{2i}	Group: preschooler relative to infant	γ_{11}				-0.015 (0.019)
Variance Components						
Level 1	Within person	σ^2_ε	151.22**	**96.64***	96.23**	96.35**
Level 2	Initial percentage	σ^2_0	82.88**	**156.90***	157.91**	156.30**
	Rate of change	σ^2_1		**0.00305**	0.00317	0.00317
Pseudo R2 statistic and Goodness-of-fit						
	$R^2_{y,y}$			**0.296**	0.297	0.301
	Deviance		1042.08	**987.36**	986.77	986.68
	AIC		1048.08	**999.36**	1000.77	1000.68
	BIC		1057.49	**1018.17**	1022.72	1022.63
	# of parameters		3	**6**	7	7

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.

* $p < .05$.
** $p < .005$.

Table 6
Hierarchical models of noun percentage in children's Vocabularies between 200 and 610 words.

		Parameter	Unconditional Model	Vocabulary Growth Model	Vocabulary Growth Model 2	Vocabulary Growth Model 3
Fixed Effects						
Initial percentage	Intercept	γ_{00}	48.85** (0.943)	**54.70** (1.73)**	55.37** (1.76)	54.60** (1.73)
π_{0i}	Group: preschooler relative to infant	γ_{01}			-1.80 (1.09)	
Rate of Change	Intercept	γ_{10}		**-0.029** (0.005)**	-0.029** (0.005)	-0.027** (0.005)
π_{2i}	Group: preschooler relative to infant	γ_{11}				-0.005 (0.003)
Variance Components						
Level 1	Within person	σ^2_ε	31.97**	**9.69***	9.42**	9.42**
Level 2	Initial percentage	σ^2_0	10.04**	**50.67***	49.82**	50.84**
	Rate of change	σ^2_1		**0.0034***	0.0035**	0.0035**
Pseudo R2 statistic and Goodness-of-fit						
	$R^2_{y,y}$			**0.369**	0.392	0.382
	Deviance		597.71	**514.13**	511.35	511.69
	AIC		603.71	**526.13**	525.35	525.69
	BIC		612.84	**544.40**	546.66	547.00
	# of parameters		3	**6**	7	7

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.

* $p < .05$.

** $p < .005$.

Table 7
Hierarchical models of verb percentage in children's vocabularies between 0 and 430 words.

		Parameter	Unconditional Model	**Vocabulary Growth Model**	Vocabulary Growth Model 2	Vocabulary Growth Model 3
Fixed Effects						
Initial percentage	Intercept	γ_{00}	7.94** (0.654)	**2.39*** **(0.952)**	2.00 (1.04)	2.38* (0.956)
π_{0i}	Group: preschooler relative to infant	γ_{01}			1.09 (1.39)	
Rate of Change	Intercept	γ_{10}		**0.036*** **(0.004)**	0.036** (0.004)	0.038** (0.005)
π_{2i}	Group: preschooler relative to infant	γ_{11}				-0.005 (0.006)
Variance Components						
Level 1	Within person	σ^2_ε	31.03**	**6.71***	6.71**	6.69**
Level 2	Initial percentage	σ^2_0	4.81**	**15.86***	14.49**	15.95**
	Rate of change	σ^2_1		**0.0032***	0.0032**	0.0030**
Pseudo R2 statistic and Goodness-of-fit						
	$R^2_{y,y}$			**0.555**	0.566	0.545
	Deviance		1108.67	**914.03**	913.44	913.53
	AIC		1114.67	**926.03**	927.44	927.53
	BIC		1124.08	**944.85**	949.39	949.48
	# of parameters		3	**6**	7	7

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.
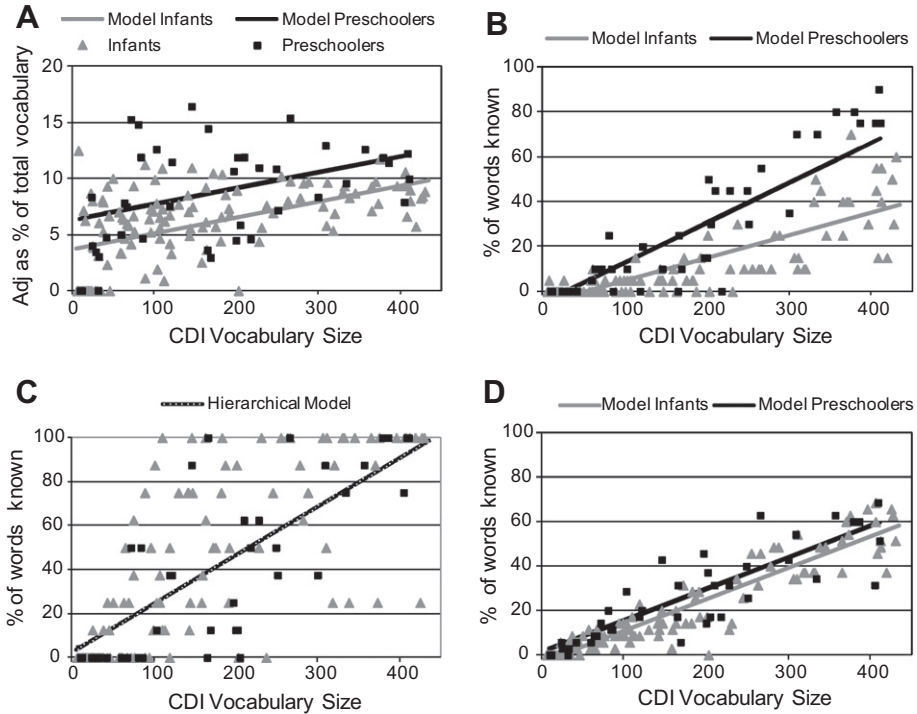
* $p < .05$.
** $p < .005$.

Table 8
Hierarchical models of adjective percentage in children's vocabularies between 0 and 430 words.

		Parameter	Unconditional Model	Vocabulary Growth Model	**Vocabulary Growth Model 2**	Vocabulary Growth Model 3	Vocabulary Growth Model 4
Fixed Effects							
Initial percentage	Intercept	γ_{00}	6.81** (0.552)	4.65** (0.686)	**3.67** (0.682)**	4.51** (0.666)	3.56** (0.752)
π_{0i}	Group: preschooler relative to infant	γ_{01}			**2.61* (0.850)**		3.11* (1.38)
Rate of Change	Intercept	γ_{10}		0.014** (0.002)	**0.014** (0.002)**	0.012** (0.002)	0.015** (0.002)
π_{2i}	Group: preschooler relative to infant	γ_{11}				0.006* (0.003)	-0.002 (0.005)
Variance Components							
Level 1	Within person	σ^2_ε	11.29**	7.67**	**7.70***	7.76**	7.68**
Level 2	Initial percentage	σ^2_0	4.89**	76.82**	**4.69***	6.08**	4.82**
	Rate of change	σ^2_1		0.00002*	**0.00001***	0.00002*	0.00001*
Pseudo R2 statistic and Goodness-of-fit							
	$R^2_{y,y}$			0.279	**0.343**	0.321	0.341
	Deviance		947.64	886.86	**878.26**	883.23	878.06
	AIC		953.64	898.86	**892.26**	897.23	894.06
	BIC		963.05	917.67	**914.21**	919.18	919.14
	# of parameters		3	6	**7**	7	8

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.

* $p < .05$.
** $p < .005$.

Fig. 3. Acquisition of some adjectives is accelerated in preschool adoptees. (A) The proportion of adjectives in children's vocabularies rises from 0 to 430 words. Percentage of the adjectives on the checklist that children know divided into three categories: (B) adjectives regulating behavior or describing internal states; (C) color words; (D) all other descriptors.

are of great social and practical importance because they allow adults to determine the child's needs and verbally regulate the child's behavior. The second class, color words ($N = 8$) which refer to a concrete perceptual property that is not typically critical for social interaction. However, these words are often the focus of explicit parental teaching. The third class included the remainder of the adjectives on the checklist ($N = 35$), words which are primarily used to describe things (*big, pretty, wet*).

The goal of these analyses was to understand which adjectives were learned when, rather than to determine the proportional representation of different classes of words in the child's lexicon. Thus our dependent measure was the percentage of adjectives, of a given type, that the child knew. For example a child who knew four of the eight color words would be credited with 50%, no matter how large his vocabulary was. These values will inevitably rise as vocabulary increases. The question of interest is whether they rise faster for preschoolers than for infants. The results of these analyses are summarized in Table 9 and Fig. 3b–d. The behavioral adjectives appear to be the primary source of the preschoolers' precocious adjective use. In the model with the best fit, there is a significant interaction between vocabulary size and group (modeled as an effect of group on the slope). Preschoolers learn behavioral adjectives at almost twice the rate of infants. Color words in contrast are learned quickly by both infants and preschoolers and there are no reliable differences between the two groups. For the other descriptors there is a small but reliable main effect of group. At any given vocabulary level, preschoolers know one or two more of these words than infants. Additional analyses on subgroups of the descriptors (e.g., size vs. other properties, positive valence vs. negative valence) failed to reveal any further differences between them.

Our next analysis focused on words for time. These are a syntactically diverse set of words including some nouns, adverbs and prepositions, which develop relatively late in first language acquisition and are notoriously abstract. While several children had acquired one or two time words early on

Table 9

Hierarchical models of the proportion of the adjectives on the checklist that the child knows. Adjectives were divided into: behavior and internal states, colors, and other descriptors.

			Behavior and Internal States		Colors		Other Descriptors	
		Parameter	Vocabulary Growth Model	**Vocabulary Growth Model 2**	**Vocabulary Growth Model**	Vocabulary Growth Model 2	Vocabulary Growth Model	**Vocabulary Growth Model 2**
Fixed Effects								
Initial percentage	Intercept	γ_{00}	-5.73** (1.13)	**-5.14** (1.05)**	**2.59 (3.15)**	4.67 (3.68)	-2.53** (.771)	**-3.56** (.776)**
π_{0i}	Group: preschooler relative to infant	γ_{01}				-7.79 (7.24)		**4.68* (1.64)**
Rate of Change	Intercept	γ_{10}	0.133** (0.016)	**0.100** (0.014)**	**0.221** (0.017)**	0.218** (0.022)	0.146** (0.007)	**0.142** (0.007)**
π_{2i}	Group: preschooler relative to infant	γ_{11}		**0.078** (0.018)**		0.015 (0.039)		
Variance Components								
Level 1	Within person	σ^2_{ε}	56.76**	**57.81***	**342.02***	340.17**	28.72**	**27.08***
Level 2	Initial percentage	σ^2_{0}	7.48*	**3.24**	**73.90***	66.05*	.730	**.548**
	Rate of change	σ^2_{1}	0.00451**	**0.00192***	**.00275***	0.00290**	.00064**	**.00068***
Pseudo R2 statistic and Goodness-of-fit								
	$R^2_{y,y}$		0.622	**0.788**	**0.609**	0.615	0.846	**0.853**
	Deviance		1174.75	**1160.94**	**1448.90**	1447.72	1051.52	**1043.51**
	AIC		1186.75	**1174.94**	**1460.90**	1461.72	1063.52	**1057.51**
	BIC		1205.56	**1196.89**	**1479.71**	1483.67	1082.33	**1079.46**
	# of parameters		6	**7**	**6**	7	6	**7**

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.

* $p < .05$.

** $p < .005$.

Table 10
Hierarchical models of time words as a percentage of all words in children's vocabularies between 0 and 430 words.

	Parameter		Unconditional Model	Vocabulary Growth Model		**Vocabulary Growth Model 2**	Vocabulary Growth Model 3	Vocabulary Growth Model 4
Fixed Effects								
Initial percentage	Intercept	γ_{00}	4.45** (0.837)	2.24	(1.30)	**0.130 (1.22)**	1.95 (1.23)	-.147 (0.565)
π_{0i}	Group: preschooler relative to infant	γ_{01}				**5.12** (1.15)**		6.16 (3.32)
Rate of Change	Intercept	γ_{10}		0.016** (0.004)		**0.017** (0.004)**	0.012* (0.004)	0.018** (0.003)
π_{2i}	Group: preschooler relative to infant	γ_{11}					0.014** (0.004)	-0.004 (0.010)
Variance Components								
Level 1	Within person	σ^2_ε	21.83**	15.92**		**15.61**	15.67**	15.52**
Level 2	Initial percentage	σ^2_0	11.74**	27.42**		**19.69**	27.16**	20.79**
	Rate of change	σ^2_1		0.00010**		**0.00012**	0.00018**	0.00013**
Pseudo R2 statistic and Goodness-of-fit								
	$R^2_{y,y}$			0.211		**0.291**	0.288	0.283
	Deviance		1066.12	1024.27		**1008.60**	1014.36	1008.46
	AIC		1072.12	1036.27		**1022.60**	1028.36	1024.46
	BIC		1081.53	1055.08		**1044.55**	1050.31	1049.54
	# of parameters		3	6		**7**	7	8

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group. Because the absolute percentage of time words was small the models were run with the percentage of time words multiplied by ten. This was done to minimize rounding error and simplify data presentation.

* $p < .05$.
** $p < .005$.

(resulting in high proportion of time words in the early sessions), the children as a whole showed a significant increase in the proportion of time words as vocabulary size increased (Table 10, Fig. 4a). This effect was quite variable across participants appearing in eleven of the fourteen infants and only five of the nine of the preschoolers ($p < .1$, $p > .3$ respectively). There was a reliable main effect of participant group—the preschoolers had a larger proportion of time words in their vocabularies than the infants.

We divided these words into two classes. The first contained four words that can be readily used to describe the present (*morning, night, day*, and *now*). These are examples of what Nelson (1996) called *natural time*: temporal concepts that she argues are directly experienced and independent of culture. The second class consisted of words that are used most naturally to refer to events in the future or past (*after, before, later, tomorrow, tonight, yesterday* and *today*). Nelson has argued that these temporal notions must be abstracted from experience and constructed, making it more difficult to transform them into concepts that could be linguistically encoded. We reasoned that if preschooler's precocious use of time terms is driven either by a better understanding of time or a more robust ability to think about events occurring at different times, then this should be particularly helpful in learning the terms for the future/past.

Again for each session, we calculated the percentage of words in each class that the child knew (Fig. 4b–d). Older children showed a robust advantage for the future/past terms (Table 11). The slope of their learning curve was four times as great as that of the infants, who acquired very few of these words. At 400 words only four of the fourteen infants had learned one of the future or past terms, while eight of the nine preschoolers had (with an average of two terms per child). In contrast, the words for the present were relatively easy for both groups, seven of the infants and six of the preschoolers produced one of these terms before reaching a vocabulary of 200 words.
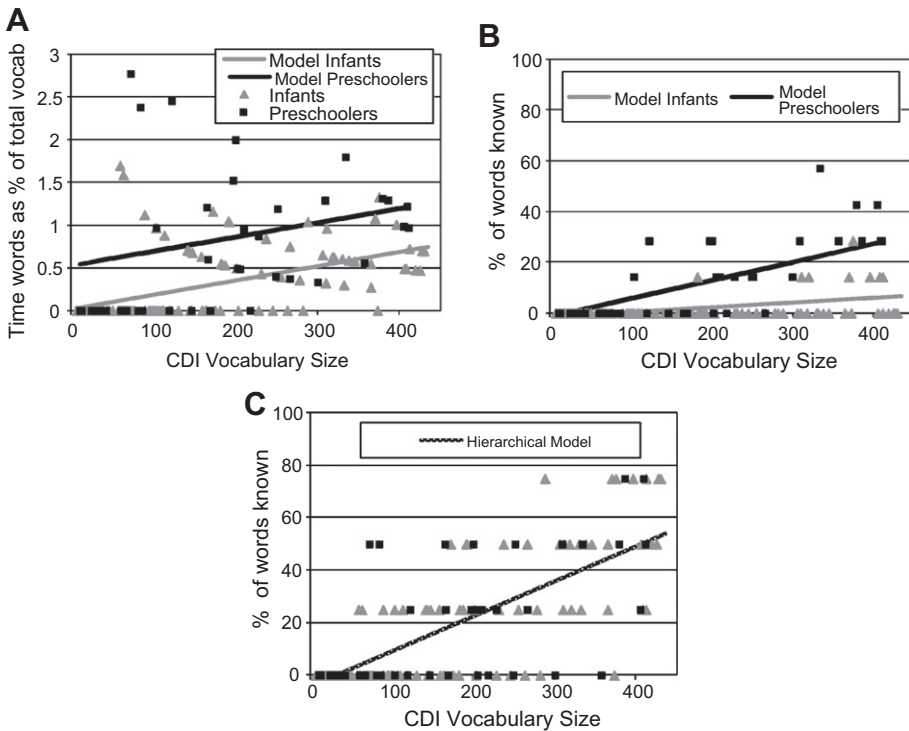

Fig. 4. Acquisition of some words for time is accelerated in preschool adoptees. (A) The proportion of time words in children's vocabularies between 0 and 430 words. The percentage of the time words on the checklist that children know divided into two categories: (B) words that typically refer to the future or past and (C) time words that readily refer to the present.

Table 11

Hierarchical models of the proportion of the time words on the checklist that the child knows. Time words were divided into: (1) terms used for future or past events and (2) terms often used for present events.

			Terms for Future or Past Events		Terms for Present Events	
		Parameter	Vocabulary Growth Model	Vocabulary Growth Model 2	Vocabulary Growth Model	Vocabulary Growth Model 2
Fixed Effects						
Initial percentage	Intercept	γ_{00}	-2.05* (.760)	**-1.55*** **(0.688)**	**-4.20*** **(1.59)**	-4.19* (1.71)
Rate of Change	Intercept	γ_{10}	0.041** (0.010)	**0.019*** **(0.007)**	**0.133**** **(0.012)**	0.134** (0.015)
π_{2i}	Group: preschooler relative to infant	γ_{11}		**0.053**** **(0.009)**		-0.001 (0.023)
Variance Components						
Level 1	Within person	σ^2_{ε}	23.73**	**24.41****	**178.14****	180.28**
Level 2	Initial percentage	σ^2_0	4.16	**1.63**	**1.03**	.755
	Rate of change	σ^2_1	0.00177**	**0.00053****	**0.00156****	0.00151**
Pseudo R2 statistic and Goodness-of-fit						
	$R^2_{y,y}$		0.216	**0.606**	**0.555**	0.555
	Deviance		1030.92	**1011.89**	**1333.87**	1329.50
	AIC		1042.92	**1025.89**	**1345.87**	1343.50
	BIC		1061.73	**1047.84**	**1364.68**	1365.45
	# of parameters		6	**7**	**6**	7

Outlined cells indicate the model selected on the basis of fit; the parameter estimates and standard errors for the predictors in that model; and the total variance accounted for by that model. The grey cells indicate the effects of participant group.

* $p < .05$.

** $p < .005$.

Thus we found both parallels and differences in the words that the older and younger children produced. All children began word learning with a rich set of social words. As vocabulary size grew to 200 words, the proportion of social words declined and more nouns began to emerge. This was followed by a period of growth for verbs and adjectives in both groups. However, there were fine-grained differences between the two groups which suggest ways in which cognitive and social development might influence language acquisition. The adopted preschoolers learned more adjectives than the infants. This advantage appeared to mostly stem from greater knowledge of adjectives that might be applied to their own behavior or internal states. They also acquired words for future and past events substantially earlier than the infant learners.

3.4. Do older learners have a one-word stage?

The final goal of this study was to explore the emergence of combinatorial speech in older learners. In infant learners, word combinations begin appearing when children know about 50–100 words and become a robust feature of children's speech at a vocabulary size of around 200–300 words (Fenson et al., 1994). On the CDI-2 parents are asked to indicate whether their child is producing multiword utterances never, sometimes or often. Table 2 lists the parent's response to this question at the first and last session. In both the infant and preschool samples, most of the children were producing no combinations at the outset of the study but were producing combinations "often" when the study ended approximately 1 year later. Thus we confirmed that a one-word stage is present in at least most adopted preschoolers.

Bates and her colleagues noted that the point at which children are reported to "often" produce word combinations appears to be a more stable measure than the point at which they "sometimes" do (Bates et al., 1995). In our sample many parents would check "sometimes" on one session and then revert back to "never" on the next session. If we use this more stringent standard for producing combinations, all of the children except for one preschooler (Child I) were observed during the one-word stage. This family was unable to collect the first data set until 3 months after adoption, at which point the child knew 159 words. Four of the other eight children who had gone through a one-word stage were reported to "often" produce combinations by 3 months. Thus it is possible that Child I had passed through a one-word stage before data collection began.

Two of the preschoolers (Child B and Child E) were reported to be producing combinations "sometimes" in the first parental report. In both cases, data collection began during their first month in the US when their vocabularies were quite small. To determine whether these children went through a one-word stage in their acquisition of English, we examined the two videotaped speech samples that were returned with the first CDI-2. In their first sample, both children produced one-word utterances in English and multiword utterances in their native language. However, neither child produced a multiword utterance in English that was clearly combinatorial.[6] For both children, simple combinations began to emerge in their second session, about 2 weeks later (e.g., "daddy please" "Sandy's school"). Thus both children appear to be breaking into multiword speech during the period in which the first CDI-2 was filled out. In contrast, Child I, whose first speech sample occurred at 3 months, was already producing clear multiword utterances at that time (e.g., "I want dinosaur" and "This a big one").

Next, we examined whether the transition to multiword speech happened at the same point relative to vocabulary development in each group. We estimated the child's vocabulary size at the point at which they began "sometimes" producing combinations and at the point at which they began "often" producing combinations. This was done by averaging the child's vocabulary size on the session before the benchmark was reached with their vocabulary size on the session in which it was first reported. There were no differences between the groups on either measure [$t(15) = .19$, $p > .5$, $t(19) = .57$, $p > .5$, for "sometimes" and "often" respectively]. As Fig. 5 illustrates both the infants and the preschoolers began occasionally producing combinations at around 80 words and began producing them regularly

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[6] Child E uses the phrases "this one" and "thank you". However he does not use any of these words in other contexts. Child B produces count sequences several times suggesting that she has the articulatory wherewithal to produce longer chunks, but she never combines these numbers with other words.
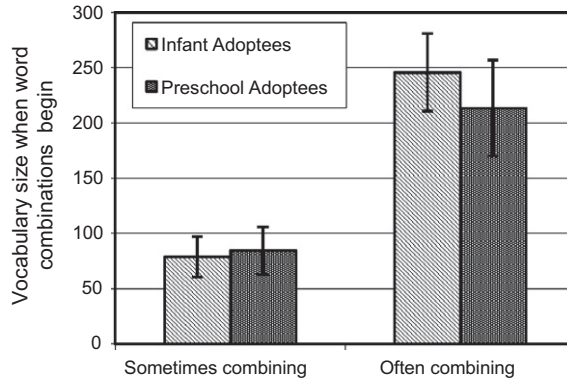
Fig. 5. Mean vocabulary size at the onset of word combinations in adopted infants and preschoolers.

at about 230 words. These numbers closely match the prior findings for typically-developing infants (Bates et al., 1995).

4. Discussion

The present study tracked the acquisition of English for 1 year in a small group of internationally-adopted preschoolers and infants, focusing on content of the children's vocabularies and the emergence of combinatorial speech. Four clear findings emerged from this work.

First, we discovered that internationally-adopted preschoolers, like infant learners, go through a period at the beginning of language production during which they primarily produce single-word utterances. This period was observed in all of the preschoolers who contributed data during their first 2 months in the US (8 of 9) suggesting that it is a robust feature of language acquisition in older children. Thus, the one-word stage in typical children cannot be attributed *solely* to cognitive immaturity, since it appears even in children who have reached the ripe old age of three or four. In both groups of children, the onset of word combinations was closely linked to vocabulary development, with the first combinations appearing around 80 words and combinations becoming frequent at around 200 words. This systematic relation between vocabulary size and combinatorial speech has been observed many times in a variety of populations (Bates & Goodman, 1997) suggesting that it may be causally informative. These results clearly favor contingent acquisition hypotheses—specifically ones in which lexical knowledge (or experience with lexical production) is required before combinatorial speech can develop.

Second, both the infant and preschool adoptees showed the same broad shifts in vocabulary composition that characterize typical first-language acquisition (Bates et al., 1995). In both groups of children, the earliest words to be acquired were primarily social words (routines, names and sound effects). As vocabulary grew, the proportion of nouns increased until children acquired about 200 words and then decreased. In contrast, the proportion of verbs and adjectives steadily increased as vocabulary expanded. These findings demonstrate that these qualitative shifts cannot be solely attributed to the cognitive maturation of the child, since they appear older children who presumably have the cognitive pre-requisites for learning verbs and adjectives. Thus these results favor contingent acquisition hypotheses which posit that knowledge of some words (the easy ones) is necessary to acquire knowledge of other words (the harder ones). This contingency could result from perceptual factors shaping children's ability to segment words or from semantic factors affecting their ability to learn word meanings.[7]

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[7] Presumably these properties are only intrinsic to the process of language acquisition as it is carried out by young children. Adult learners, who can rely on bilingual informants, texts and a greater capacity for metalinguistic reasoning, seem to follow a very different path (Clahsen, 1990).

Third, we investigated two facets of children's lexical development that we had not explored before—the acquisition of adjectives and time words—and found surprising differences between the older and younger learners. In both preschoolers and infants, adjectives and time words increased proportionally as vocabulary grew from 0 to 400 words. However, the preschoolers learned more of these words at an earlier stage in lexical development. In the case of the adjectives, this was primarily attributable to the precocious acquisition of words that are used to direct children's behavior or describe a person's internal state. The preschoolers' advantage for temporal terms was driven by the early acquisition of words that are typically used to refer to events in the past and future (e.g., *later*, *yesterday* and *tomorrow*). This pattern is consistent with the developmental hypothesis. Specifically, it raises the possibility that the acquisition of abstract adjectives and temporal terms in younger children is hampered by cognitive immaturity. This might explain why these words are acquired late, even though many of them are very high frequency (e.g., "before" or "yesterday"). Thus while cognitive development appears to play little role in the broad categorical shifts in early vocabulary composition, it may play a central role in the acquisition of specific subsets of abstract words.

Finally, we discovered that the initial pace of word learning was almost four times as fast in the preschoolers as it was in the infants. While the rate of word learning in infants steadily accelerated with age, the preschoolers showed no such effect (in fact, there was a slight deceleration). This finding is in congruent with prior studies which find that children adopted between 18 and 30 months have faster initial rates of vocabulary acquisition than children adopted prior to 12 months (Glennen & Masters, 2002; Krakow, Tao & Roberts, 2005; Pollock, 2005). This overall pattern is consistent with a maturational hypothesis. Specifically, it suggests that the acceleration of learning that occurs in typical first-language learners during the second and third year of life (Ganger & Brent, 2004) could be due to maturation or cognitive development.

In the remainder of this discussion, we examine the implications of these four findings for theories of language development more broadly. Finally, we discuss the study from a methodological perspective, noting both the advances in relation to our earlier work and the degree to which the limitations of this study affect the conclusions that we can draw.

4.1. On time and internal states

Perhaps our most surprising finding was the differences that we found between the preschoolers and the infants in the acquisition of adjectives and temporal terms. In both cases, the older children were more successful in learning precisely those words that appear later in typical infants. Adjectives for behavior and internal states were late to develop in the infants but appeared fairly early in the adopted preschoolers. In contrast, color words emerged very early in both groups, with no differences between the two. Similarly, words for the past and future were slow to emerge in both groups but were learned more readily by the older children, while time words that are often used to describe the present (*night*, *day*, *morning*) appeared much earlier and showed no group differences.

There are several possible explanations for the group differences. First, infants may have difficulty representing the very concepts that are encoded in these terms. For example, in the case of internal and behavioral adjectives, young learners might have limited abilities to reflect on these states (in themselves or in others), making it difficult for them to learn the words that encode them. Alternately, the development of general cognitive skills could facilitate the acquisition of these terms in older children. For example, infants might have difficulty remembering the events in the past that are being referred to or predicting the future events that are under discussion, limiting their ability to learn the meanings of temporal terms. Similarly infants may have more difficulty then older children in inferring when internal states are under discussion, even if they can represent these states.

Another possibility is that learning words for these tricky concepts in one language, aids the child in acquiring these words in their second language. The limited evidence that we have suggests that the preschoolers in this study had made substantial progress in acquiring their birth language prior to adoption. While most were said to have mild to moderate language delays, they were also reported to use sentences of at least four to five words. This is consistent with studies on the cognitive development of children in Russian orphanages, which find systematic but moderate delays, equivalent to about 25% of the child's chronological age (Sloutsky, 1997; The St. Petersburg-USA Orphanage

Research Team, 2005). In typically developing infants these abstract time words and adjectives are generally produced by around 30 months of age (Dale & Fenson, 1996). Thus it is certainly plausible that many of our preschool adoptees had learned the translation equivalents of some of these words in their birth language prior to adoption.

It is also possible that older children could have social goals and motivations that lead them to seek out words that encode these particular concepts, or that parents have expectations of older children which lead them to use these words more often in conversation. The temporal terms for future and past events are words that are often used in discussing the postponement or scheduling of events, a common area of dispute between parents and young children (*you can watch more T.V. tomorrow, we are going to eat the ice cream after dinner*). The behavioral and internal adjectives might also be more relevant to an older child who has more experience fulfilling her needs and regulating her actions. While it is reasonable to ask a preschooler if she is hungry or tired, parents of young toddlers are more likely to rely on behavioral cues.

We cannot disentangle these hypotheses with the data that we have. To tease apart cognitive and linguistic factors we would have to manipulate the child's age independent of their level of experience with the birth language, an impossibility in our population. Distinguishing motivational and cognitive factors may not be possible in any population: what is motivating is likely to depend in part on the cognitive system of the agent. Similarly, parental input is likely to be shaped by the interests and apparent comprehension of the child.

An alternate approach is to evaluate each hypothesis on the basis of what we know about typical first-language acquisition. For example, an increase in input frequency is only a plausible explanation for older children's success in acquiring abstract temporal terms, if we believe that young infants lack sufficient exposure to these words. But corpus analyses have documented that temporal terms for future or past events are ubiquitous in conversations with young toddlers (Levy & Nelson, 1994; Lucariello & Nelson, 1987; Sachs, 1983). Infants' slow acquisition of past and future temporal terms appears to reflect a difficulty in grasping their meanings rather than a limitation in the input or motivation. Children begin talking about the past and future long before they master temporal terms, suggesting that they are motivated to express these relations (Nelson, 1996). In fact, young toddlers often produce past and future temporal terms in appropriate discourse contexts before they fully understand what they mean (Levy & Nelson, 1994; Tare & Shatz, 2005). These early uses respect the distributional constraints of the terms but may violate their meanings (e.g., *tomorrow* being used for *yesterday*, or *before* for *after*). This is precisely what we would expect to see if infants were able to extract temporal terms from fluent speech and identify their domain of reference, but were unable to ascertain their precise meanings (see Tare, Shatz, & Gilbertson, 2008). This line of reasoning suggests that preschool adoptees may use more temporal terms early on because they are more successful in determining their meanings. This could result from: better access to concepts that have previously been lexicalized, improvements in memory which make it easier for children to hold the relevant events in mind (and thus ascertain their relation), or conceptual/maturational changes that alter the range of concepts that are available for word learning (or their relative salience).

4.2. Accounting for the differences in the pace of lexical acquisition

While the infants initially learned words slowly, the adopted preschoolers hit the ground running, acquiring an average of 85 words in the first month after arrival. Despite this increase in speed, the content of early lexical development was largely unchanged (with the two exceptions noted above). The proportion of nouns initially increased but then declined after 200 words, while the proportions of verbs, adjectives and time words increased as vocabulary size grew. Thus the preschoolers went through the same stages as the infants but they did so more quickly. The uniformity of this acceleration is inconsistent with developmental hypotheses that posit a qualitative shift in the kind of words that children can learn. For example, if this speeded pace was attributable to the development of new abilities to learn relational terms then we would expect to see more verbs in the initial vocabularies of the preschool adoptees.

One possibility is that this speeded up acquisition trajectory reflects the development of domain-general processes affecting learning rate. Older children might require fewer exposures to link a word

and concept, or they might be more likely to encode the input or better able to retain it. Development of this kind could play a role in the acceleration in word learning that is observed in typical first-language learners during the second and third years of life. Alternatively, the difference in learning rate between the preschoolers and infants could reflect improvements in lexical processing that are attributable to the older children's prior experience acquiring a natural language and producing words. These findings are not readily accounted for by theories which posit that the acceleration in vocabulary growth in typical first language acquisition is a mere side effect of children gradually accumulating knowledge about words over a long time span (McMurray, 2007). If this were the case, then we would expect that the preschoolers in the present study would learn words more slowly than the infants (since they had less exposure to English before beginning to talk) and would show an acceleration in vocabulary acquisition over time (since they would also be acquiring many words gradually over time).

A more puzzling question is why vocabulary growth appears to decelerate in preschoolers. It is unlikely that these children became less effective word learners as they acquired more words. There are three more plausible explanations for this finding. First, this deceleration could simply be an artifact created by the ceiling of our instrument. To minimize this possibility we removed all sessions that occurred after the child had acquired 90% of the words on the CDI-2. However, given the speed with which the children were learning English, this may not have eliminated the ceiling effect. Second, deceleration could occur because the words that children are learning at higher vocabulary levels are, in some objective sense, more difficult and thus take longer given a learner with constant abilities. A third possibility is suggested by research comparing the CDI-2 checklist with diary studies (Robinson & Mervis, 1999) or speech samples (Hart, 2004). When children's vocabularies are small the CDI appears to capture almost all of the words that they know. However, as vocabulary size grows, the proportion of the child's vocabulary that is on the checklist shrinks. For example, Robinson and Mervis found that the checklist captured fewer than 50% of the words that their participant had used when his CDI-2 vocabulary was at 500 words. Consequently, if the CDI-2 vocabulary growth function was linear, then rescaling it to predict the total vocabulary growth would reveal acceleration over time. While we do not know how variable this function is across children, the Robinson and Mervis data suggests that this hidden acceleration is more than an order of magnitude greater than the deceleration in CDI-2 vocabulary that we observed in our preschool sample. Thus there is no reason to assume that vocabulary growth is actually slowing in this population. Notice that this data also has implications for interpreting the infant growth curves. Like prior longitudinal studies using the CDI-2, we found a modest acceleration in vocabulary growth for infants over time, but because the CDI-2 samples a smaller proportion of the child's lexicon at larger vocabulary sizes, the true rate of acceleration is likely to be much greater.

4.3. Implications for theories of lexical development

The present study demonstrated that the broad shifts that characterize early vocabulary development persist in older learners. This finding is clearly inconsistent with any account that attributes these shifts to the availability of new concepts or to domain-general cognitive development. In contrast, it supports theories which attribute changes in vocabulary composition to contingencies in the process of acquisition itself.

This contingency could have a perceptual basis, with vocabulary composition reflecting the ease with which children can isolate and identify spoken word forms. For example, many social words are used in isolation as exclamations ("Hi!" "Daddy!" "Beep beep!") making it easy for the child to segment the word and ensuring that it is more perceptually similar across contexts. Prior research suggests that words that appear in isolation are acquired earlier than other words of the same frequency (Brent & Siskind, 2001). In English, nouns often appear at the end of the utterance (Tardif, Shatz & Naigles, 1997). This ensures that one boundary is unambiguous and increases the phonological salience of the word (since default stress is placed on the final word of the utterance and the lengthening occurs at the end of each intonational phrase). In contrast, verbs are often utterance medial and are less likely to receive stress (Tardif et al., 1997). Perhaps children need to accurate identify the nouns in a sentence before they can robustly segment the verb or create an accurate perceptual

representation of it. Function words, which are frequently phonologically reduced and rarely appear at the end of phonological phrase—at least in English—might require even more support.

These results are also fully compatible with the syntactic bootstrapping hypothesis (Gleitman, 1990) which posits that vocabulary composition is largely shaped by the child's access to information which will allow her to infer the meaning of the word. Novice learners cannot understand the utterance in which the word appears and are forced to rely on situational cues which allow them to learn many nouns, but few verbs. But as the learner gains linguistic knowledge, she is able to create increasingly sophisticated representations of linguistic context which support the acquisition of increasingly abstract words (Gillette et al., 1999; Gleitman et al., 2005; Snedeker & Gleitman, 2004). On this hypothesis the mechanism of change remains the same regardless of the age of the learner, predicting the strong similarities that we observed between infants and preschool learners.

For over 20 years, research on early vocabulary composition has largely centered on Gentner's noun-dominance hypothesis (1982). Thus it is reasonable to ask how this work bears on that proposal. We chose not to frame the study in this way, primarily because we believe that the noun-dominance hypothesis lives a dual life. Many readers have interpreted it as a cognitive/maturational hypothesis (see e.g., Hoff, 2001). On this construal nouns are acquired before verbs because the concepts that they encode are available at an earlier stage in development. Our results clearly speak to this interpretation of the noun-dominance hypothesis. Preschool-aged children with prior linguistic experience have presumably developed the concepts encoded by the verbs that are typically learned by toddlers. Yet they go through the same shifts in vocabulary composition, suggesting that there is no need to invoke cognitive change to explain this phenomenon in first language learners.

In subsequent writings, however, Gentner herself has explicitly rejected this cognitive/maturational account and has argued instead that the shift in vocabulary composition is caused by the child's growing knowledge of the language-specific conflation patterns that organize verb meanings (Gentner & Boroditsky, 2001). This is clearly a contingent-acquisition hypothesis, since the cause of the change is the child's growing knowledge of her language and not changes in her general cognitive abilities. But it is not clear what predictions this hypothesis makes for second-language acquisition in childhood.

If children simply attempt to map second-language labels onto the conceptual conflations provided in their first language, then we would expect to see precocious verb learning to the degree that verb semantics in the two languages are aligned. From a typological perspective the verb lexicalization patterns of English, Russian and Chinese are quite similar (Talmy, 2000). All three are considered satellite-framed languages, a distinction with far reaching effects on the division of labor between verbs and grammatical morphemes. In fact, many of the most common verbs in child-directed speech in English have direct translation equivalents that are among the most common verbs in Mandarin child-directed speech (Snedeker, Li, & Yuan, 2003). Nevertheless, these results provide no evidence that children from China, or Russia, learn verbs at an earlier stage than monolingual infants.[8]

On the other hand, if child learners attempt to map second-language labels directly to prelinguistic representations of event components, then the noun-dominance hypothesis would predict that second-language verb learning, like first-language verb learning, would initially be slow and effortful, accelerating as the child learns more about the language and its conflation patterns. The current data is consistent with this reading of noun-dominance hypothesis as well as Gleitman's informational change hypothesis (but see Havasi & Snedeker, 2004).

4.4. Why is there a one-word stage?

Our dense longitudinal data set provided clear evidence that most, if not all, older adoptees go through a short stage in which they primarily produce single-word utterances. This cannot be accounted for by limitations in their motor skills, memories or articulatory abilities; these children were reported to produce 4–5 word utterances in their birth languages. The transition to combinatorial speech was closely linked to vocabulary size. Both preschoolers and infants produced occasional

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[8] There were only two preschoolers from China in the present sample. However, in our previous cross-sectional sample which consisted of 25 children from China (Snedeker et al., 2007), we also found no evidence of precocious verb acquisition. We have not investigated the degree to which early English verbs have direct translation equivalents in Russian.

combinations after acquiring about 50–100 words and produced frequent combinations at about 150–300 words. This suggests that the connection between lexical development and combinatorial speech is not simply a side effect of some general maturational time table (like the correlation between first words and first steps). Instead it reflects more systematic connections between the two processes.

Obviously the present study cannot tell us what those connections are. Two constraints should shape our conjectures. First, this correlation is one between *producing* words and *producing* combinations. There is ample evidence that children interpret sequences of words many months before they produce them (Gertner, Fisher, & Eisengart, 2006; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987). Receptive word knowledge is unlikely to play a critical role in this correlation, since comprehension vocabulary is not strongly correlated with production vocabulary (Bates et al., 1995). Second, this correlation is not a necessary consequence of the content of children's early lexicons. Early word combinations often involve two words that the child has been using separately for many months like *hi dad* or *my cookie* (Bloom, 1973). One possibility is that children need to gain sufficient practice retrieving a variety of words during production before they gain sufficient skills to grab two of them quickly enough to produce them in a single intonational phrase.

4.5. Methodological advances and limitations

The present study had three features that were absent from our prior work but which are critical to the claims that we are making (Geren, Snedeker, & Ax, 2005; Snedeker et al., 2007). First, the present study used a truly longitudinal design. Our prior findings largely depended on comparisons between children who had different levels of linguistic knowledge at the time of data collection. Consequently, the correlations between vocabulary size and vocabulary composition could have reflected individual differences in ability and tactics (e.g., perhaps smarter children both have larger vocabularies and are more likely to acquire verbs and closed-class items). In the present experiment, we found that the critical shifts in vocabulary composition occurred for over 85% of the children in each group, demonstrating that these are robust patterns that characterize development at an individual level.

Second, by using internationally-adopted infants as our comparison group, rather than non-adopted infants, we controlled for several factors that were confounded with age in the previous study. Like the internationally-adopted preschoolers, these infants are drawn from a population of children who were put up for adoption, thus they are likely to have experienced many of the same early biological risk factors. In addition, both the adopted infants and preschoolers are being raised by families that chose to adopt children and met the financial and personal criteria imposed by the adoption system. The parents had similar levels of education and were likely to have had parallel motivations for participating in our study.

Finally, by collecting additional data, we were able to test some of the working assumptions that underlie this research design (see the supplemental online materials). Specifically, we confirmed that adopted preschoolers were more cognitively mature than infant language learners by collecting information about the children's non-linguistic abilities (using the modified ASQ). At the first assessment, the adopted preschoolers had already mastered most of the gross-motor, fine-motor, problem solving and social skills that typically coincide with early language development, and they were making substantial progress on the milestones that characterize development in the preschool years. In addition, our analyses of the children's speech samples confirmed our working assumption that adopted children, like infants, learn their new language through daily interactions with their caregivers with little continued access to their native language or bilingual informants. Specifically, we found that even in the earliest sessions (just weeks after arrival), adoptive parents communicated with their children almost entirely in English.

Nevertheless, there are two clear limitations to the present study. First, like all natural experiments our comparison between older and younger learners is complicated by other differences between the two populations. In the present study, we equated the two groups to the greatest degree possible by comparing internationally-adopted preschoolers with internationally-adopted infants. But there are some ways in which the older and younger children were necessarily different. Not only were the infants younger but they also had had less exposure to their birth language and had spent less time in institutional care and thus would be expected to have less pronounced cognitive delays (Miller &

Hendrie, 2000). Our analysis of the ASQ scores ruled out the possibility that global cognitive delays in the preschoolers were substantial enough to jeopardize our manipulation of maturational age. On every dimension we measured, the preschool adoptees were more cognitively sophisticated than the infants who were at of similar point in vocabulary development. Thus the parallels that we find between the early language development a older and younger learners are unlikely to be due to a common set of cognitive changes in both groups. More problematic for this line of work is the possibility that the development of children from orphanages might be divergent, rather than merely delayed. Institutional environments can have lasting effects on qualitative features of children's emotional development and social cognition (Camras, Perlman, Fries, & Pollak, 2006; Fries & Pollak, 2004; Yagmurlu, Berument, & Celimli, 2005). Presumably this experience might also alter the course of cognitive or linguistic development (see Eigsti, Weitzman, Schuh, de Marchena, & Casey, 2011). If these effects are greater for children adopted at older ages then this is a confound in the design of our natural experiment.

Note that, while confounds like this hinder our ability to interpret differences between the populations, they have little effect our ability to interpret similarities. For example, we cannot conclusively determine whether the faster pace of early language development in the adopted preschoolers is attributable to their relative cognitive maturity, their prior experience with language, or their prolonged experience in the orphanage (though the last hypothesis seems implausible). However, these confounds do not undermine our claims that vocabulary composition and the presence of a one-word stage reflect contingencies in the process of language learning. Where we find no differences between the preschool and infant learners we can conclude either that none of the three factors affect that feature of acquisition, or that two or more of the factors do so but they just happen to cancel each other out. Parsimony and probability favor the former explanation.

Concerns about these other differences are further mitigated by looking more closely at the effects that we would expect each of them to have. While we know of no concrete proposal about how institutionalization might affect subsequent language acquisition, one plausible hypothesis is that institutionally-raised children would be less sensitive to social-pragmatic cues to word meaning, such as eye-gaze or pointing. Since these cues typically highlight locations in space and the objects that occupy them, we might predict that institutionalization would initially hinder noun learning, resulting in a more balanced early vocabulary, and slowing down the pace of early acquisition. We see no sign of this in our data set.

Similarly, while prior linguistic experience could account for the rapid pace of word learning in the internationally-adopted preschoolers, it seems unlikely that it could mask the effects of cognitive maturation on vocabulary composition or sentence complexity. In fact, we would expect that heavy reliance on prior linguistic experience would, like maturation or cognitive development, eliminate some of the characteristic patterns of early language acquisition. For example, if shifts in vocabulary composition depend upon acquisition-induced insights about the kinds of ontological categories that can be lexicalized, then we would expect internationally-adopted preschoolers to have precociously diverse lexicons.

The second limitation of this study is the small size of our sample. Our dense longitudinal design allowed us to closely track lexical development in individual children, however it limited our sample size because of the demands that it made on the parents and on our resources. Although hierarchical models do not lend themselves to conventional power analyses, a close examination of the results suggests that these analyses were capable of detecting fairly small effects.

First, several of the differences that we did find between the preschoolers and infants were modest in size. For example, the effect of participant group on the adjective proportion accounted for just 6.4% of the variance, while the deceleration of vocabulary growth in the older adoptees accounted for only 4.3% of the variance. Thus our methods appear to be sensitive to subtle effects of age on qualitative and quantitative features of early language acquisition.

We can hazard a guess about the possible magnitude of the effects of participant group by comparing the $R^2_{y,y}$ values for models which contained these predictors, to the $R^2_{y,y}$ values for models without them. For social words, nouns and verbs these nonsignificant effects were quite small, accounting for between 0.1% and 2.3% of variance. In contrast, the effect of vocabulary size in these analyses accounted for between 29.6% and 58.4% of the variance. While we cannot conclude that there are

no differences between our older and younger children on these dimensions, we can conclude that any differences that exist are considerably smaller than the effects of vocabulary size.

Finally, the differentiation that we see across lexical classes confirms that the parental report provides multiple distinct indices of vocabulary development. For example, we saw age group differences for the adjectives but not the verbs, even though these two lexical classes typically develop in tandem.

More caution is warranted in generalizing from this sample to the broader population of internationally-adopted children. Because our sample is both small and self selected, it is unlikely to reflect the full range of variation, and thus there could be some subgroup of adopted preschoolers that have a different acquisition trajectory than the one documented here. For example, older preschoolers or children who are more metalinguistically savvy may use different learning strategies and thus might begin acquisition with a more diverse lexicon. There was considerable variation in developmental rate and vocabulary composition in both groups, but with the present small sample we cannot determine the correlates of this variation. These concerns are mitigated by several considerations. First, as we noted in the results section, the critical patterns were present in all or almost all of the older children, suggesting that they are widespread. Next, many of the patterns that we observed here were also documented in our prior study in which families only agreed to participate in a single session (Snedeker et al., 2007), suggesting that they persist over changes in selection pressures. Finally, the pattern of drop out in the sample suggests that the selection demands of the longitudinal study had similar effects in both populations: 60% of the preschoolers who began the study completed it and 67% of the infants did. Additional analyses were conducted on the full sample (including the children who dropped out) and the results confirmed those reported here.

4.6. Final words

The present study demonstrates that several critical features of early language development are present in older learners. Like young infants, preschoolers who are learning a new language through immersion in the home go through a one-word stage before they begin producing combinatorial speech. Like infants, their vocabulary is initially dominated by social words and then nouns. Thus these features appear to reflect contingent properties of language acquisition, rather than the maturation of language-specific abilities or broad cognitive changes in the learner. Other features of acquisition, however, vary with the maturational status of the learner. Older children were quicker to learn temporal terms that situate events in the past or future and adjectives for behavior and internal states, suggesting that cognitive development or experience with a language may play a critical role in the acquisition of these words.

While our findings have been primarily focused on vocabulary acquisition, they may have implications for the role of maturation in other facets of language development. Lexical representations link together the phonological form of a word with its semantic content and syntactic features. Thus the process of word learning constrains other aspects of language development and is constrained by them in turn. We have not yet examined phonological acquisition in this population. Given the rapid onset of word production in these children, it is likely that phonological acquisition and lexical learning are occurring simultaneously. Our analysis of the transition to combinatorial speech (in the present paper) and our analysis of syntactic complexity (in Snedeker et al., 2007) provide a preliminary glimpse into the relation between word learning and syntactic production. Both analyses find that internationally-adopted preschoolers show the same systematic connection between utterance complexity and vocabulary acquisition as typically-developing infants (Bates & Goodman, 1997). Thus it appears that these aspects of syntactic acquisition are not primarily governed by maturation or cognitive development.

Nevertheless, the present data leave open the possibility that maturation plays a role in other aspects of syntactic development. For example, nothing in our data speaks to the question of whether the onset of mandatory tense marking is driven by maturation (Wexler, 1999). In fact, the population differences that we observed for time words and behavioral adjectives highlight the importance of testing specific developmental hypothesis about particular phenomena. We cannot assume that there will be just one answer to the question of whether (or how) cognitive development influences language acquisition.

Acknowledgments

References

Bates, E., Dale, P. S., & Thal, D. (1995). Individual differences and their implications for theories of language development. In P. Fletcher & B. MacWhinney (Eds.), *The handbook of child language* (pp. 96–151). Oxford, England: Blackwell Publishers.

Bates, E., & Goodman, J. C. (1997). On the inseparability of grammar and the lexicon: Evidence from acquisition, aphasia, and real-time processing. *Language and Cognitive Processes., 12*, 507–584.

Bates, E., Marchman, V., Thal, D., Fenson, L., Dale, P., Reznick, J. S., et al (1994). Developmental and stylistic variation in the composition of early vocabulary. *Journal of Child Language, 21*(1), 85–124.

Bauer, P. J., Hertsgaard, L. A., Dropik, P., & Daly, B. P. (1998). When even arbitrary order becomes important: Developments in reliable temporal sequencing of arbitrarily ordered events. *Memory, 6*, 165–198.

Behrens, H. (2006). The input–output relationship in first language acquisition. *Language and Cognitive Processes, 21*, 2–24.

Bellugi, U., Marks, S., Bihrle, A., & Sabo, H. (1988). Dissociation between language and cognitive functions in Williams syndrome. In D. Bishop & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 177–189). London: Churchill Livingstone.

Bloom, L. (1973). *One word at a time: The use of single-word utterances before syntax*. The Hague: Mouton.

Bornstein, M. H., Cote, L. R., Maital, S., Painter, K., Park, S. Y., Pascual, L., et al (2004). Cross-linguistic analysis of vocabulary in young children: Spanish, Dutch, French, Hebrew, Italian, Korean, and American English. *Child Development, 75*(4), 1115–1139.

Brent, M. R., & Siskind, J. M. (2001). The role of exposure to isolated words in early vocabulary development. *Cognition, 81*, 31–44.

Bricker, D., & Squires, J. (1999). *Ages and stages questionnaires: A parent-completed child-monitoring system* (2nd ed). Baltimore: Paul Brookes.

Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.

Brownell, C. (1988). Combinatorial skills: Converging developments over the second year. *Child Development, 59*, 675–685.

Camras, L., Perlman, S., Fries, A., & Pollak, S. (2006). Post-institutionalized Chinese and Eastern European children: Heterogeneity in the development of emotion understanding. *International Journal of Behavioral Development, 30*(3), 193–199.

Caselli, M. C., Bates, C., Casadio, P., Fenson, L., Fenson, J., Sanderl, L., et al (1995). A cross-linguistic study of early lexical development. *Cognitive Development, 10*, 159–199.

Choi, S., & Gopnik, A. (1995). Early acquisition of verbs in Korean: A cross-linguistic study. *Journal of Child Language, 22*(3), 497–529.

Clahsen, H. (1990). The comparative study of first and second language development. *Studies in Second Language Acquisition, 12*, 135–154.

Conboy, B. T., & Thal, D. (2006). Ties between the lexicon and grammar: Cross-sectional and longitudinal studies of bilingual toddlers. *Child Development, 77*(3), 712–735.

Cromer, R. (1974). The development of language and cognition: The cognition hypothesis. In B. Foss (Ed.), *New perspectives in child development* (pp. 184–252). Harmondsworth: Penguin.

Curtiss, S. (1989). Abnormal language acquisition and the modularity of language. In F. Newmeyer (Ed.). *Linguistics: The Cambridge survey* (Vol. 2, pp. 96–116). Cambridge, UK: Cambridge University Press.

Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavioral Research Methods, Instruments, & Computers, 28*, 125–127.

Doran, E. W. (1907). A study of vocabularies. *Pedagogical Seminary, 14*(4), 401–438.

Eigsti, I. M., Weitzman, C., Schuh, J. M., de Marchena, A., & Casey, B. J. (2011). Language and cognitive outcomes in internationally adopted children. *Development and Psychopathology, 23*, 629–646.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5), 173. v.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., et al (1993). *MacArthur communicative development inventories: User's guide and technical manual*. San Diego, CA: Singular.

Fenson, L., & Ramsay, D. S. (1980). Decentration and integration of the child's play in the second year. *Child Development, 51*, 171–178.

Fries, A., & Pollak, S. (2004). Emotion understanding in postinstitutionalized Eastern European children. *Development and Psychopathology, 16*(2), 355–369.

Ganger, J., & Brent, M. (2004). Re-examining the vocabulary spurt. *Developmental Psychology, 4*, 621–632.

Gauthier, K., & Genesee, F. (2011). Language development in internationally-adopted children: A special case of early second language learning. *Child Development, 82*(3), 887–901.

Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. A. Kuczaj, II (Ed.), *Language development. Language, thought, and culture* (Vol. 2, pp. 31–53). Hillsdale, NJ: Erlbaum.

Gentner, D., & Boroditsky, L. (2001). Individuation, relativity, and early word learning. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development*. Cambridge, England: Cambridge University Press.

Geren, J., Snedeker, J., & Ax, L. (2005). Starting over: A preliminary study of early lexical and syntactic development in internationally adopted preschoolers. *Seminars in Speech and Language, 26*(1), 44–53.

Gertner, Y., Fisher, C., & Eisengart, J. (2006). Learning words and rules: Abstract knowledge of word order in early sentence comprehension. *Psychological Science, 17*, 684–691.

Gillette, J., Gleitman, H., Gleitman, L., & Lederer, A. (1999). Human simulation of vocabulary learning. *Cognition, 73*, 135–176.

Gindis, B. (2005). Cognitive, language, and educational issues of children adopted from overseas orphanages. *Journal of Cognitive Education and Psychology, 4*(3), 290–315.

Gleitman, L. (1990). Structural sources of verb learning. *Language Acquisition, 1*, 1–63.

Gleitman, L. R. (1981). Maturational determinants of language growth. *Cognition, 10*, 103–114.

Gleitman, L. R., Cassidy, K., Papafragou, A., Nappa, R., & Trueswell, J. T. (2005). Hard words. *Language Learning and Development, 1*(1), 23–64.

Glennen, S. (2002). Language development and delay in internationally adopted infants and toddlers: A review. *American Journal of Speech Language Pathology, 11*, 333–339.

Glennen, S. (2009). Speech and language guidelines for children adopted from abroad at older ages. *Topics in Language Disorders, 29*(1), 50–64.

Glennen, S., & Masters, M. G. (2002). Typical and atypical language development in infants and toddlers adopted from Eastern Europe. *American Journal of Speech-Language Pathology, 11*, 417–433.

Goldin-Meadow, S., & Feldman, H. (1977). The development of language-like communication without a language model. *Science, 197*, 401–403.

Golinkoff, R. M., Hirsh-Pasek, K., Cauley, K. M., & Gordon, L. (1987). The eyes have it: Lexical and syntactic comprehension in a new paradigm. *Journal of Child Language, 14*, 23–45.

Gombert, J. E. (1992). *Metalinguistic development*. Chicago: University of Chicago Press.

Greenfield, P. M. (1978). Developmental processes in the language learning of child and chimp. *Behavioral and Brain Sciences, 4*, 573–574.

Hart, B. (2004). What toddlers talk about. *First Language, 24*, 91–106.

Havasi, C. & Snedeker, J. (2004). The adaptability of language-specific verb lexicalization biases. Proceedings of the twenty-sixth annual conference of the cognitive science society. Mahwah, NJ, USA: Lawrence Erlbaum Associates, Inc.

Hoff, E. (2001). *Language development*. Belmont, CA: Wadsworth Thomson Learning.

Huttenlocher, J., Smiley, P., & Ratner, H. (1983). What do word meanings reveal about conceptual development? In T. Wannamacher & W. Seiler (Eds.), *The development of word meanings and concepts* (pp. 210–233). Berlin: Springer-Verlag.

Hwa-Froelich, D. A. (2009). Communication development in infants and toddlers adopted from abroad. *Topics in Language Disorders, 29*(1), 27–44.

Hyltenstam, K., Bylund, E., Abrahamsson, N., & Park, H.-S. (2009). Dominant language replacement: The case of international adoptees. Bilingualism: Language and. *Cognition, 12*, 121–140.

Kim, M., McGregor, K., & Thompson, C. (2000). Early lexical development in English- and Korean-speaking children: Language-general and language-specific patterns. *Journal of Child Language, 27*(2), 225–254.

Krakow, R., Tao, S., & Roberts, J. (2005). Adoption age effects on English language acquisition: Infants and toddlers from China. *Seminars in Speech and Language, 26*, 33–43.

Laing, E., Butterworth, G., Ansari, D., Gsödl, M., Longhi, E., Panagiotaki, G., et al (2002). Atypical development of language and social communication in toddlers with Williams syndrome. *Developmental Science, 5*, 233–246.

Landau, B., & Gleitman, L. R. (1985). *Language and experience. Evidence from the blind child*. Cambridge, MA: Harvard University Press.

Lenneberg, E. (1967). *Biological foundations of language*. New York: Wiley.

Levy, E., & Nelson, K. (1994). Words in discourse: A dialectical approach to the acquisition of meaning and use. *Journal of Child Language, 21*(2), 367–389.

Locke, J. L. (1997). A theory of neurolinguistic development. *Brain and Language, 58*, 265–326.

Lucariello, J., & Nelson, K. (1987). Remembering and planning talk between mothers and children. *Discourse Processes, 10*, 219–235.

Marchman, V., Martínez-Sussmann, C., & Dale, P. (2004). The language-specific nature of grammatical development: Evidence from bilingual language learners. *Developmental Science, 7*(2), 212–224.

McCall, R. B., Parke, R. D., & Kavanaugh, R. D. (1977). Imitation of live and televised models by children one to three years of age. *Monographs of the Society for Research in Child Development, 42*(5).

McCarthy, D. A. (1930). *The language development of the preschool child*. Minneapolis: University of Minnesota Press.

McMurray, B. (2007). Defusing the childhood vocabulary explosion. *Science, 317*(5838), 631.

Miller, L., & Hendrie, N. (2000). Health of children adopted from China. *Pediatrics, 105*(6), e76.

Morgan, J., Shi, R., & Allopena, P. (1996). Perceptual bases of rudimentary grammatical categories. In J. Morgan & K. Demuth (Eds.), *Signal to syntax* (pp. 263–287). Cambridge, MA: MIT Press.

Nelson, K. (1996). *Language in cognitive development: The emergence of the mediated mind*. New York: Cambridge University Press.

Newport, E. (1990). Maturational constraints on language learning. *Cognitive Science, 14*, 11–28.

Nice, M. (1925). Length of sentences as a criterion of child's progress in speech. *Journal of Educational Psychology, 16*, 370–379.

O'Grady, William. (1987). *Principles of grammar and learning*. Chicago: University of Chicago Press.

Pallier, C., Dehaene, S., Poline, J., LeBihan, D., Argenti, A., Dupoux, E., et al (2003). Brain imaging of language plasticity in adopted adults. *Cerebral Cortex, 13*, 155–161.

Pinker, S. (1984). *Language learnability and language development*. Cambridge, MA: Harvard University Press.

Pollock, K. (2005). Early language growth in children adopted from China: Issues and preliminary normative data. *Seminars in Speech and Language, 26*, 22–32.

Raudenbush, S. W., Bryk, A. S., & Congdon, R. (2005). *HLM6.03: Hierarchical linear and nonlinear modeling*. Chicago: Scientific Software International.

Redington, M., Chater, N., & Finch, S. (1998). Distributional information: A powerful cue for acquiring syntactic categories. *Cognitive Science, 22*, 425–469.

Roberts, J., Pollock, K., Krakow, R., Price, J., Fulmer, K., & Wang, P. (2005). Language development in preschool-age children adopted from China. *Journal of Speech, Language, and Hearing Research, 48*(1), 93–107.

Robinson, B. F., & Mervis, C. B. (1999). Comparing productive vocabulary measures from the CDI and a systematic diary study. *Journal of Child Language, 26*, 177–185.

Rondal, J. A. (2003). Atypical language development in individual with mental retardation. In L. Abbeduto (Ed.). *Language and communication in mental retardation* (Vol. 27, pp. 281–308). New York: Academic Press.

Sachs, J. (1983). Talking about the There and Then: The emergence of displaced reference in parent-child discourse. In K. E. Nelson (Ed.). *Children's Language* (Vol. 4, pp. 1–28). Hillsdale: Lawrence Erlbaum Associates.

Scott, K., Roberts, J., & Glennen, S. (2011). How well do children who are internationally adopted acquire language? A meta-analysis. *Journal of Speech, Language, & Hearing Research, 54*, 1–17.

Selkirk, E. O. (1996). The prosodic structure of function words. In J. L. Morgan & K. Demuth (Eds.), *Signal to syntax* (pp. 187–213). Mahwah, NJ: Lawrence Erlbaum.

Senghas, A. (2003). Intergenerational influence and ontogenetic development in the emergence of spatial grammar in Nicaraguan Sign Language. *Cognitive Development, 18*, 511–531.

Shore, C. (1986). Combinatorial play: Conceptual development and early multiword speech. *Developmental Psychology, 22*, 184–190.

Shore, C., O'Connell, B., & Bates, E. (1984). First sentences in language and symbolic play. *Developmental Psychology, 20*, 872–880.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* New York: Oxford University Press.

Singer-Harris, N., Bellugi, U., Bates, E., Rossen, M., & Jones, W. (1997). Emerging language in two genetically based neurodevelopmental disorders. In D. Thal, J. Reilly (Eds.), Special issue on origins of communication disorders, developmental neuropsychology (Vol. 13, no. 3, pp. 345–370).

Sloutsky, V. M. (1997). Institutional care and developmental outcomes of 6- and 7-year-old children: A contextualist perspective. *International Journal of Behavioral Development, 20*(1), 131–151.

Snedeker, J., Li, P. & Yuan, S. (2003). Cross-cultural differences in the input to early word learning. Proceedings of the 25th annual cognitive science conference. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Snedeker, J., Geren, J., & Shafto, C. (2007). Starting over: International adoption as a natural experiment in language development. *Psychological Science, 18*(1), 79–87.

Snedeker, J., & Gleitman, L. (2004). Why it is hard to label our concepts. In G. Hall & S. Waxman (Eds.), *Weaving a Lexicon* (pp. 257–294). Cambridge, MA: MIT Press.

Sugarman, S. (1983). Developmental change in early representational intelligence. Evidence from spatial classification strategies and related verbal expressions. *Cognitive Psychology, 14*, 410–449.

Talmy, L. (2000). *Toward a cognitive semantics* (Vol. 2). Cambridge, MA: MIT.

Tan, T. X., & Yang, Y. (2005). Language development of Chinese adoptees 18 to 35 months old. *Early Childhood Research Quarterly, 20*(1), 57–68.

Tardif, T. (1996). Nouns are not always learned before verbs: Evidence from Mandarin speakers' early vocabularies. *Developmental Psychology, 32*(3), 492–504.

Tardif, T., Gelman, S., & Xu, F. (1999). Putting the 'noun bias' in context: A comparison of English and Mandarin. *Child Development, 70*, 620–635.

Tardif, T., Shatz, M., & Naigles, L. R. (1997). Caregiver speech and children's use of nouns versus verbs: A comparison of English, Italian, and Mandarin. *Journal of Child Language, 24*, 535–565.

Tare, M., & Shatz, M. (2005). Children's use and understanding of expressions of time. Paper presented at the biennial meeting of the society for research in child development, Atlanta, April 7–10.

Tare, M., Shatz, M., & Gilbertson, L. (2008). Maternal uses of non-object terms in child-directed speech: Color, number and time. *First Language, 28*(1), 87–100.

Thal, D., O'Hanlon, L., Clemmons, M., & Frailin, L. (1999). Validity of a parent report measure of vocabulary and syntax for preschool children with language impairment. *Journal of Speech, Language & Hearing Disorders, 42*, 482–496.

The St. Petersburg-USA Orphanage Research Team (2005). Characteristics of children, caregivers, and orphanages for young children in St. Petersburg, Russian Federation. *Journal of Applied Developmental Psychology, 26*(5), 477–506.

Tomasello, M. (1992). *First verbs: A case study of early lexical development.* Cambridge: Cambridge University Press.

U.S. Department of State (2011). Total Adoptions to the United States. <http://adoption.state.gov/about_us/statistics.php> Retrieved 30.12.11.

Vicari, S., Caselli, M. C., Gagliardi, C., Tonucci, F., & Volterra, V. (2002). Language acquisition in special populations: A comparison between Down and Williams syndromes. *Neuropsychologia, 40*, 2461–2470.

Wexler, K. (1999). Maturation and growth of grammar. In W. C. Ritchie & T. K. Bhatia (Eds.), *Handbook of child language acquisition* (pp. 55–110). San Diego: Academic Press.

Yagmurlu, B., Berument, S., & Celimli, S. (2005). The role of institution and home contexts in theory of mind development. *Journal of Applied Developmental Psychology, 26*(5), 521–537.