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The Hebrew Communicative Development Inventory: language specific properties and cross-linguistic generalizations*

SHARONE L. MAITAL
University of Haifa

ESTHER DROMI
Tel Aviv University and the University of Texas at Dallas

ABRAHAM SAGI
University of Haifa

MARC H. BORNSTEIN
National Institute of Child Health and Human Development

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ABSTRACT

Cultural, linguistic, and developmental evidence was taken into consideration in constructing the HCDI, a Hebrew adaptation of the MCDI. The HCDI was then administered to a stratified sample of

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Israeli mothers of 253 toddlers aged 1;6 to 2;0 (M = 1;8·18). Hebrew results are presented and compared with scores from the original MCDI sample (Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994). The HCDI is a reliable and sensitive measure of lexical development and emergent grammar, capturing wide variability among Israeli toddlers. In comparison with English, the relation between vocabulary size and age, as well as the shape of the growth curves for nouns, predicate terms, and closed class words relative to size of lexicon, were strikingly similar. These results indicate that conclusions concerning cross-linguistic similarities can be best documented by using parallel methods of measurement. The HCDI results support the claim that early lexical development in Hebrew and in English follow remarkably similar development patterns, despite the typological differences between the two target languages.

INTRODUCTION

The empirical investigation of early lexical development in Hebrew speaking toddlers has been limited until now to several qualitative studies of small numbers of children (Dromi & Fishelzon, 1986; Dromi 1987/1996; Berman & Armon-Lotem, 1997). Results of these studies have led to the proposal that prior to the emergence of productive morphological and syntactic abilities, young Hebrew-speaking children do not demonstrate language-specific patterns of vocabulary growth (Berman, 1997; Dromi, in press). Early lexicons of young Hebrew speakers consist largely of nouns that are later accompanied by predicate terms. A noticeable addition of functional terms is observed only towards the beginning of productive grammar. This distribution of words into lexical classes is in accordance with reports for English, Italian, and Spanish (Jackson-Maldonado, Thal, Marchman, Bates & Gutierrez-Clellan, 1993; Bates, Marchman, Thal, Fenson, Dale, Reznick, Reilly & Hartung, 1994; Caselli, Bates, Casadio, J. Fenson, L. Fenson, Sanderl & Weir, 1995), and contrasts with recent accounts concerning the composition of early vocabularies in Korean and Mandarin (Gopnik & Choi, 1990, 1995; Tardif, 1996; Tardif, Shatz & Naigles, 1997).

Information about vocabulary composition in typologically different languages will shed light on discussions about the generalizability of claims based on English alone. Hebrew is a Semitic language with rich, bound derivational and inflectional morphology. Verbs, nouns, and adjectives are constructed in Hebrew from [tri- or quadri-] consonantal roots which are embedded within patterns of vocalic infixes and syllabic prefixes or suffixes. In the verb system, the consonantal root (which can not be pronounced outside of the lexical item) often carries the core meaning of the word and the patterns (termed *binyanim*) convey with partial regularity semantic notions

such as transitivity, causativeness, passive, reflexiveness, and inchoativeness. Nouns and adjectives may occur in several patterns (termed *mishkalim*) which carry a variety of nominal meanings such as agent, location, instrument and abstract. The nominal patterns are much less regular in Hebrew than the patterns of verbs and hence are less detected by naive speakers of the language. Hebrew verbs mark tense distinctions (i.e. past, present, and future) and agreement. Verbs agree with the subject of the sentence in number, gender, and in person. Adjectives and demonstratives agree with their head nouns within noun phrases in gender, number, and definiteness.

The basic word order in Hebrew is SVO as it is in English, but word order in Hebrew is relatively free. Verb initial constructions are allowed and are frequently used in everyday conversations. Verb-subject and verb-object structures are optional in Hebrew when the main verb appears in past or future tense and are always used to express possession or presentation. Impersonal or 'dummy' sentences that use the subject 'it' in English may take the form of subjectless sentences in Hebrew. Thus, Hebrew shows many properties associated with verb initial languages: prepropositions mark case relations; the genitive order is possessed- possessor; all noun modifiers (e.g. adjectives, demonstratives, and relative clauses) follow the head noun; and within verb phrases, auxiliaries and modals precede the main verb but complements follow the verb. The ordering of the main syntactic constituents in Hebrew is determined by pragmatic considerations such as fronting for discourse purposes (Levy, 1983, 1988; Berman, 1985, 1997; Ravid, 1995). With respect to the relative salience of the different word classes in the input, as well as the richness and variability in morphological alternations, verbs may be more prominent in Hebrew than they are in English.

The hypothesis that early patterns of lexical growth do not reflect the distinctive morphological and syntactic characteristics of Hebrew grammar requires additional investigation. Data on a large sample of Hebrew-speaking toddlers at the beginning of speech and prior to the emergence of productive grammar are needed to further test this hypothesis. The primary goal of this study is to fill the gap in our knowledge about normative growth curves and individual differences in early lexical development with respect to vocabulary composition and growth in Hebrew. Pine, Lieven & Rowland (1996) presented convincing evidence that different relative and absolute proportions of nouns and predicate terms in children's early vocabularies in a single language may result from different methods of data collection. Thus, particularly with respect to cross-linguistic comparisons, valid conclusions concerning universal and language specific patterns in early lexical development require careful construction of parallel measures and use of similar procedures across cultures (e.g. van de Vijver & Leung, 1997).

In recent years there has been a growing reliance on the MacArthur Communicative Development Inventory (MCDI) for the study of vo-

cabulary development in English (e.g. Bates *et al.*, 1994; Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994), as well as in other languages such as Italian (Caselli *et al.*, 1995), Spanish (Jackson-Maldonado *et al.*, 1993), and Icelandic (Thordardottir & Ellis Weismer, 1996). A growing body of research indicates that the MCDI is a well normed, reliable, and valid tool. Concurrent and predictive correlations have been reported between MCDI scores and home observations, as well as with other language measures such as the Peabody Picture Vocabulary Test, observed vocabulary composition, and MLU measures at 28 months of age (Dale, Bates, Reznick & Morisset, 1989; Reznick & Goldsmith, 1989; Fenson *et al.*, 1994; Reznick & Goldfield, 1994; Pine *et al.*, 1996). The view that parents from diverse Western cultures and a range of educational backgrounds can provide faithful accounts of their young child's productive vocabulary and early grammatical development has become widely accepted in child language studies.

A second goal of this study was to develop a Hebrew adaptation of the MCDI-Toddler Form, and to administer it to a relatively large, stratified, cross-sectional sample of Hebrew-speaking toddlers. The complete MCDI has two versions: an Infant Form (for ages 0;8 to 1;4) and a Toddler Form (for ages 1;4 to 2;6). The Hebrew Communicative Development Inventory (HCDI) was constructed on the basis of the MCDI-Toddler form because the inventory at this level assesses lexical composition throughout the one-word stage and during the early phases of grammatical development. In this paper we first describe the procedures employed in constructing the HCDI; we examine its reliability and validity, and the contribution of the socio-demographic characteristics of the Israeli sample. We then compare the patterns of early lexical growth among Hebrew-speaking toddlers with that of English speakers from the US MCDI norming sample.

METHOD

Procedure for constructing the HCDI vocabulary checklist

The CDI was adapted to Hebrew in several stages in order to arrive at a representative vocabulary list. At each point, we relied on back-translation or comparisons of multiple independent translations of the English list by bilingual experts as well as use of explicit, shared rules for accommodating non-equivalent words and constructs (Dana, 1993). These methods were used to insure that the HCDI would be sufficiently authentic to provide a sensitive tool for evaluating early lexical knowledge of Hebrew speakers, while also maximizing construct and psychometric comparability of the Hebrew and English inventories.

Hebrew translation of the ELI. As a first step, a list of 643 English words appearing in the 1984 version of the Early Language Inventory (ELI, Bates

et al., 1984; Dale *et al.*, 1989), a precursor of the MCDI, was translated from English to Hebrew and then independently back translated by two bilinguals to insure accurate translation. Next, 20 trained Israeli caregivers working in early childcare settings were asked to evaluate the cultural appropriateness of the words in the translated Hebrew list. Based on caregiver feedback, some words that were most clearly related to North American culture were excluded from the list, and other more culturally appropriate words were added. The resulting Hebrew list included 699 words organized in 19 categories following the same structure as the ELI. This initial list was administered to a pilot sample of 42 second generation, middle class, Hebrew-speaking mothers of first born children when their child was age 1;8 (M = 1;8·14, S.D. = 0·83). In their responses, mothers were encouraged to include any words that their children uttered at that time, and that did not appear on the list. On the basis of this pilot study, word frequencies were calculated for each item on the Hebrew ELI checklist and a list of added words was compiled. These pilot ELI data were used in establishing the current HCDI vocabulary list.

The HCDI vocabulary list. A panel of five child language experts collaborated to develop the vocabulary list for the Hebrew Communicative Development Inventory (HCDI). The Toddler MCDI was used as the basis for the HCDI. (Extensive descriptions of the items and considerations in constructing the MCDI appear in Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993; Fenson *et al.*, 1994.) Each of the experts independently translated the MCDI list from English to Hebrew. The panel then compared the different translations and consulted word frequency data from the ELI pilot study. In formulating the final consensus regarding the HCDI word list, we were guided by three main principles: (1) Evidence concerning frequency of word use in Israeli child-directed speech and Hebrew child language; (2) consideration of culture specific terms; and (3) language-specific considerations such as the inclusion of a single lexical entry for related word forms that are constructed on the basis of the same root and differ only in morphological markings.

Non-discriminating words as indicated by the Hebrew ELI pilot data were omitted from the HCDI list. Extremely high frequency words were excluded because such words would not contribute to the measurement of individual differences in the normal range of lexical abilities. For example, the words *ima* 'mother' and *aba* 'father'[1] are acquired so unanimously by Israeli

[1] Hebrew words and sentences appear in broad phonemic transcription and they are italicized throughout the manuscript. Words in the HCDI appear in alphabetic order in broad Hebrew orthography in order to avoid overload of linguistic information. Stress (which unless marked on penultimate, appear on the final syllable) is not indicated in the manuscript nor was stress marked on the Hebrew parent questionnaire forms due to pragmatic considerations. Such information would negatively affect the ability of parents

toddlers, that they would add little information about a child's relative lexical level. Words that had very low frequency counts (less than three in the Hebrew ELI sample) also were omitted. However, there was consensus among panel members that some low frequency words were important for assessing early lexical development (e.g. all question words). These words were retained in the list because such words were expected to capture important individual differences in development.

Linguistic and cultural considerations led to some structural differences between the HCDI and the MCDI. All the changes were made in the interest of compiling a word list that would be sufficiently representative of the early Hebrew lexicon, without making the list overly long and difficult for parents. Words describing culturally distinctive American objects and events such as 'bat', 'snowman' and 'peanut butter' were omitted. They were replaced with words that are more frequently used by Hebrew-speaking toddlers or their mothers, for example, names for typical Israeli clothing items and foods, such as *sandalim* 'sandals', *pita* 'pita', *txina* 'tahini', *klemantina* 'tangerine', *melafefon* 'cucumber', as well as common Israeli children's routines, such as *lalexet letayel* 'go for a walk' and *day* 'enough'. Also, some words were moved from their original category in the MCDI to another category in the HCDI to reflect culture-specific use of that word. For example, the word *xaruzim* 'beads' was included in the Toys category, rather the Clothing category, because beads are regarded as common toy objects in Israeli preschools. In instances where Hebrew has more than one word for the same referent, the words were listed together in the HCDI, forming a single lexical entry (e.g. *helikopter/masok* 'helicopter', *matos/aviron* 'airplane', *raashan/kashkeshan* 'a noise maker', *barbacek/plastilina* 'playdough', *bifnim/betox* 'inside').

In accounting for structural aspects of Hebrew that impact on vocabulary, we followed similar guidelines to those set forth in adapting other foreign language versions of the CDI (Caselli *et al*., 1995; Fenson *et al*., 1994). Nouns based on the same root and that differ from one another in morphological markings of gender or number were included only once in the Hebrew list (e.g. 'rooster' and 'hen' in English appears as *tarnegol* (m) in the Hebrew list). Nouns that are acquired in plural form were listed only in plural form (e.g. *garbayim* 'socks', *itriot* 'pasta', *etsbaot* 'fingers'). Adjectives were listed in the HCDI only in their masculine form (e.g. *arox* 'long', *ra* 'bad', *raze* 'thin', *maluax* 'salty'). Verbs were listed only once in the infinitive form (e.g. *litsboa* 'to paint', *lishmoa* 'to hear', *laredet* 'to get off').

to respond to the questionnaire. English gloss of all Hebrew examples used in this paper appear between single quotation marks. Free translation to English is provided in order to avoid too many grammatical details that could have placed too much burden on the readers of this article.

Parents were instructed to mark a word as existing in the child's vocabulary if it occurs in identical or derived morphological form. In the Action Words category parents were instructed to mark a lexical entry as existing in the child's vocabulary when the child uses either nonfinite or finite (tensed) forms of the same verb. States and Events were listed in infinitival phrases or as single words (e.g. *ledaber batelephon* 'to talk on the phone', *laasot ambatia* 'to take a bath', *toda*, 'thank you').

The categories of grammatical functors in English were shortened or omitted because in Hebrew many functors do not appear as separate lexical items. Many of the semantic notions that are expressed by single words in English are expressed in Hebrew through bound morphemes that are prepositioned to the NPs. In the categories Prepositions & Locations and Quantifiers & Articles, we retained 23 words (see Table 1). The MCDI categories, Helping Verbs and Connecting Words were excluded from the HCDI checklist. A few words from these latter categories were included in the States & Events category of the Hebrew inventory (e.g. *yesh li* 'I have', *tsarix* 'need, have to, got to', *yaxol* 'can, could', *rotse* 'want to', *ten li* 'give me').

The resulting HCDI vocabulary list consists of 602 words presented in 20 categories. Table 1 compares the number of items included in each category of the HCDI and MCDI lists. As indicated in Table 1, the proportions of nouns and predicates in the HCDI are relatively similar to the proportions in the MCDI (i.e. 47·2% and 41·3% nouns, 24·8% and 24·4% predicates, respectively). The primary difference between the composition of the HCDI and MCDI lists is in the relative proportion of closed class words – In Hebrew, the relative proportion of closed class words is only 7·5%, whereas in English it is 15·1%.

Procedures for developing a measure of early Hebrew grammar

In general, cross-linguistic adaptations of measures of early grammar present a particular methodological challenge and require more language-specific changes than vocabulary lists (Fenson *et al.*, 1994). The grammatical part of the MCDI was developed as a representative sample of selected and discrete emergent morphological functions specific to English acquisition (Fenson *et al.*, 1994). Hebrew morphology is richer than English and is also non-linear. Therefore, the Sentences and Grammar section of the HCDI required developing original items especially suited to the analysis of the synthetic, bound morphology of Hebrew. In constructing this part of the HCDI, we followed the same general guidelines for enhancing the validity and reliability of parent reports that were used in constructing the original MCDI measures (Dale *et al.*, 1989). In particular, we sought to assess only current behaviours; we used a recognition format rather than open questions; and we en-

TABLE 1. *Lexical items in the HCDI compared with the MCDI*

	Hebrew (HCDI)		English (MCDI)	
Total vocabulary	602		680	
Items by category				
1. Sound effects & animal sounds	15		12	
2. Animals	46		43	
3. Vehicles	15		15	
4. Toys	22		18	
5. Food & drink	68		68	
6. Clothing	29		28	
7. Body parts	26		27	
8. Small household items	47		50	
9. Furniture & rooms	31		33	
10. Outside things	29		31	
11. Places to go	19		22	
12. People	17		29	
13. Games & routines	30		25	
14. Action words	103		103	
15. Descriptive words	46		63	
16. Words about time	14		12	
17. Pronouns	12		25	
18. Question words	10		7	
19. Prepositions & locations	13		26	
20. Quantifiers & articles	10		17	
21. Helping verbs	Omitted in Hebrew		21	
22. Connecting words	Omitted in Hebrew		6	
Part-of-Speech Types	Hebrew	Total list (%)	English	Total list (%)
Total nouns	284	(47·2%)	280[1]	(41·3%)
(Animal names, vehicles, toys, food & drink, clothing, body parts, small household items, and furniture & rooms)				
Total predicates	149	(24·8%)	166	(24·4%)
(Verbs and adjectives)				
Total closed class words	45	(7·5%)	102	(15·1%)
(Pronouns, question words, prepositions & locations, and quantifiers, for Hebrew)				

[1] Numbers of items for English are taken from Bates *et al.*, 1994.

deavoured to maintain a balance between a large enough set of items to insure validity, and a sufficiently short and simple measure that would maximize parent cooperation and valid responses.

Part II of the HCDI has two sections. The morphosyntactic section presents a list of eight one-proposition descriptions of typical situations in the daily lives of young Israeli children, such as 'requesting to go out for a walk', 'refusing to eat or sleep', or 'requesting a desired object that is out of reach'. Each proposition is followed by the question: 'What does your child say in this (or a similar) situation?' The question is followed by four examples of possible child answers, each representing an increasing level of

morphosyntactic complexity in Hebrew. For each situation, parents are asked to choose the response that most closely resembles the kind of utterances their child produces in such contexts. For example, following the question about what the child says when she/he wants to go for a walk, parents can check one of four responses that vary with respect to grammatical complexity: (1) the child produces a single word (e.g. *haxuca* 'outside' or *lo* 'no'); (2) the child produces a two-word combination (e.g. *holxim letayel* 'we go for a walk' or *lo roce* 'I do not want'); (3) the child produces a simple grammatical sentence (e.g. *ani roce haxuca* 'I want to go outside' or *lo roce lalexet* 'I don't want to go out'); or (4) the child produces a complex sentence containing a complex VP or more than a single VP (e.g. *ima bo'i nelex letayel* 'Mom, let's go for a walk'; *Dani axshav lo roce lalexet lishon* 'Dani doesn't want to go to sleep now'; or *ani rotse lalexet letayel kmo etmol* 'I want to go out as we did yesterday').

The second section of the grammatical part of the HCDI is directly comparable to the parallel part of the MCDI. Parents are asked to record three examples of the longest utterances which they had recently heard their child say. The Hebrew Sentences and Grammar sections did not attempt to assess specific morphological or syntactic attainments. Rather, the results of these sections are used in examining relations between age, lexical level, and overall morphosyntactic abilities.

Scoring and data reduction

Vocabulary production scores for each child were derived by summing the total number of items mothers checked across all word categories. The maximum possible score for Part I of the HCDI is 602 words. In the interest of comparability of results across different studies, we followed the same operational definitions used by Bates *et al*. (1994) to examine the composition of children's vocabulary by calculating the sum of COMMON NOUNS (animal names, vehicles, toys, food & drink, clothing, body parts, small household items, and furniture & rooms, maximum score 284 words); the sum of PREDICATE terms (verbs and adjectives, maximum score 149 words); and the sum of CLOSED CLASS words (pronouns, question words, prepositions and locations, and quantifiers, maximum score 45 words).

In Part II of the Hebrew inventory, answers to each of the eight questions were scored on a scale from 1 through 4, reflecting the increasing levels of the overall morphosyntactic complexity. A score of 1, reflects predominant use of single word utterances; 2, reflects use of word combinations; 3, refers to production of simple sentences, and 4, refers to production of a variety of syntactic forms including complex sentences. As in the procedures used for the MCDI, unanswered questions were counted as zero (Fenson *et al*., 1993). In a few cases (where none of the eight questions was answered) the protocol

was omitted from analyses of this section. (This was done because it was unclear whether lack of response reflected child language level or a parent's difficulty in responding to questions presented at the end of the inventory and that required additional effort.) For each child we calculated an average grammatical complexity score based on the eight items.

Parents' reports of their child's three longest spontaneous speech productions were scored by computing the total number of morphemes per each utterance and calculating an average MPU score for these three productions. Dromi & Berman's (1982) model for calculating MPU in Hebrew was followed. This model is based on the classical MLU measure that is often used to calculate a general language score for subjects in early language studies of English-speaking children. The set of morphemes specified in the MPU model are specific to Hebrew and account for language-specific differences in morphological productivity. Brown (1973) has pointed out that MLU scores are representative of one's overall language level only if the scores are calculated on the basis of about 400 spontaneous utterances. However, in most research practices MLU is computed for much shorter spontaneous speech samples of 50–100 utterances. It is important to note that the MPU scores in the present study can not be taken to reflect overall language abilities. This measure was included in the HCDI to insure maximum methodological comparability with the MCDI in which MLU was used. In this study the MPU scores were used only for testing correlations among vocabulary scores and responses on the two grammar sections of the HCDI.

Procedures

The HCDI forms were distributed to 400 mothers from a longitudinal early child care study when their children were between the ages of 1;6 and 2;0. Each mother received instructions for responding to the HCDI during a laboratory visit. Mothers then completed the inventory on their own, and the forms were collected at a later date. Usable HCDI forms were returned by 63 % of the mothers ($N = 253$). This compares favourably with return rates reported for other samples (e.g. Fenson *et al.*, 1994).

Participants

The HCDI was completed by 253 Israeli mothers of term healthy infants ranging in age from 1;6 to 2;0 ($M = 1;8{\cdot}18$) and balanced with respect to gender (128 boys and 125 girls). The sample was divided further into 7 one-month age intervals (see Table 2). A χ^2 test for distribution of toddlers across these age groups by gender was not significant ($\chi^2(6, N = 253) = 8{\cdot}99$, n.s.). All the mothers were fluent Hebrew speakers who were either native-born or raised and educated in Israel from early ages. The mothers' mean educational

level was 13·5 years (S.D. = 2·1). Fathers' mean educational level was 13·4 years (S.D. = 2·5). The distribution of the HCDI sample with respect to gender, age, parent education, family size, and child care arrangements appears in Table 2. The families were approximately equally distributed in terms of number of one, two, or three or more children (maximum number of children was 5). Family size correlated negatively with SES ($r(241) = -0{\cdot}22$, $p \leqslant 0{\cdot}001$), but was not related to maternal education ($r(253) = -0{\cdot}10$, n.s.). With respect to childcare arrangements, nearly two thirds of the sample received non-maternal care: 43·6% attended group care, and 21·6% received individual, non-maternal care at home or in the home of a relative. The remaining 34·8% was cared for primarily by their own mother at home.

The HCDI respondents were part of a larger, representative sample of mothers and toddlers ($N = 709$) from the Haifa area, participating in a longitudinal early child care study. The overall sample was carefully selected to reflect the full range of SES in the population of metropolitan Haifa, which is one of the three main urban areas in Israel. This suggests that the Early Child Care Study sample may represent the larger urban Israeli population. The SES measure we used is a standardized score calculated as a composite of maternal education and residential location and density. In Israel, parent educational levels, density of living quarters, and neighbourhood are considered a better reflection of SES than income. Neighbourhoods are routinely ranked by the Israeli Census Bureau to reflect variation in SES.

The sociodemographic characteristics of those who completed HCDI forms were compared with the characteristics of participants from the original full sample who did not respond to the language inventory. The proportions of boys and girls in the respective samples was similar ($\chi^2(1, N = 709) = 0{\cdot}005$, n.s.). Overall, the SES level of each group was the same ($M = 0{\cdot}034$, S.D. = 0·65 for the HCDI group, and $M = 0{\cdot}11$, S.D. = 0·71 for the non-participants, $t(695) = -1{\cdot}36$, n.s.). Likewise, there were no differences in educational level for mothers in the HCDI sample ($M = 13{\cdot}5$, S.D. = 2·1) and the non-participating mothers ($M = 13{\cdot}6$, S.D. = 2·3, $t(707) = -0{\cdot}42$, n.s.). The average family size in the HCDI group ($M = 2{\cdot}03$, S.D. = 0·93) and for the non-participating group ($M = 2{\cdot}11$, S.D. = 1·04) also were similar ($t(574{\cdot}52) = -0{\cdot}99$, n.s.). Thus the language data reported here may be viewed as representative of the larger stratified early child care study sample, and may be considered preliminary norms for the HCDI.

In order to make valid comparisons between results for the Hebrew-speaking sample and those for English speakers in the U.S. who were assessed using the MCDI (Fenson *et al.*, 1994), a subgroup of the MCDI sample was established by matching the children with the Israeli sample by age, In all, responses for 561 English speakers were included. As with the Hebrew speaking sample, the numbers of boys and girls in the matched U.S.

TABLE 2. *Demographic characteristics of the Israeli and U.S. samples*[a]

	Hebrew speakers (Israel)				English speakers (U.S.)			
Gender × age	Girls	Boys	Total	Sample (%)	Girls	Boys	Total	Sample (%)
18 months	11	5	16	6·3	41	38	79	14·1
19 months	23	23	46	18·2	34	42	76	13·5
20 months	40	35	75	29·6	44	40	84	15·0
21 months	27	23	50	19·8	29	47	76	13·5
22 months	10	20	30	11·9	39	29	68	12·1
23 months	8	16	24	9·5	34	33	67	11·9
24 months	6	6	12	4·7	58	53	111	19·8
Total *N*	125	128	253		279	282	561	
	M age = 1;8·18 (1·5)				*M* age = 1;9·6 (2·1)			

	Israel				U.S.			
Parent education	Mothers		Fathers		Mothers		Fathers	
8–11 years	23	(9·1%)	37	(14·6%)	18	(4·5%)	28	(5·0%)
12 years (high school)	106	(41·9%)	93	(36·8%)	101	(18·0%)	90	(16·0%)
13–15 years	82	(32·4%)	57	(22·5%)	138	(24·6%)	120	(21·4%)
16+ years	42	(16·6%)	66	(26·1%)	304	(54·2%)	323	(57·6%)
	M = 13·5 (2·1)		*M* = 13·4 (2·5)		*M* = 14·9 (2·4)		*M* = 14·9 (3·3)	

	Israel		U.S.	
Family size (Number of children)	*N*	Sample (%)	*N*	Sample (%)
One child	85	33·6	312	55·4
Two children	93	36·8	175	31·0
Three to five	75	29·6	76	13·3
Mean family size	*M* = 2·03 (0·93)		*M* = 1·60 (0·80)	
Child care status				
Group child care	109	43·6	(daycare and family daycare)	
Individual non-maternal care	54	21·6	(caregiver or relative care at home)	
Maternal care	87	34·8		

[a] The numbers represent a sub-sample of the U.S. norming sample matched for age to the Israeli sample. U.S. data were provided by L. Fenson.

sample were evenly distributed across the age groups ($\chi^2(6, N = 561) = 7{\cdot}11$, n.s.). Sociodemographic characteristics of the English speaking MCDI group as compared with the Hebrew speaking HCDI sample appear in Table 2. The U.S. group has a higher proportion of parents with at least college education, and U.S. family size is somewhat smaller on average.

RESULTS

Properties of the HCDI

Reliability of the HCDI checklist. Reliability of the final 602 word checklist was examined for the entire sample based on the internal consistency of scores for each of the semantic categories. Calculations of Cronbach's alpha yielded a coefficient of 0·98 overall. The only category for which the HCDI category-total correlations fell below 0·75 was Sound Effects (0·64). The reliability coefficients are quite similar to those reported for the MCDI vocabulary list (Fenson *et al.*, 1993).

Relations among the component parts of the HCDI. Concurrent relations among vocabulary, grammatical complexity, and MPU of the three longest utterances reported by parents appear in Table 3. The correlation coefficients

TABLE 3. *Intercorrelations among HCDI vocabulary and grammar scores*

	Total vocabulary	Grammatical complexity
Grammatical complexity	0·77*** ($N = 249$)	—
MPU	0·52*** ($N = 238$)	0·60*** ($N = 234$)

*** $p < 0{\cdot}0001$.

are uniformly high. These findings indicate strong associations among the different parts of the HCDI suggesting that, at the toddler stage, vocabulary growth and early grammar are highly related. These results are also similar to those reported for the original MCDI (Fenson *et al.*, 1994).

Israeli sociodemographic characteristics and HCDI scores. Before considering developmental trends for the Hebrew language sample, sociodemographic sources of individual differences are considered. A (7) age groups × (2) gender ANOVA for the Hebrew language sample alone indicated that gender contributed only marginally to variation in vocabulary across the age range 1;6 to 2;0, $F(1, 252) = 2{\cdot}85$, $p \leqslant 0{\cdot}09$, as compared with the highly significant contribution of child age, $F(6, 252) = 6{\cdot}88$, $p \leqslant 0{\cdot}0001$. There was no interaction. This finding is similar to other studies suggesting that small but consistent gender effects (favouring girls) emerge particularly when comparing large samples, although these differences may attenuate when considering smaller samples and individual age groups (Jackson-Maldonado *et al.*, 1993; Fenson *et al.*, 1994; Bornstein, Haynes & Painter, 1998).

Of the sociodemographic measures, only family size was moderately related to total vocabulary for this sample. The number of children in the family correlated negatively with size of the child's vocabulary,

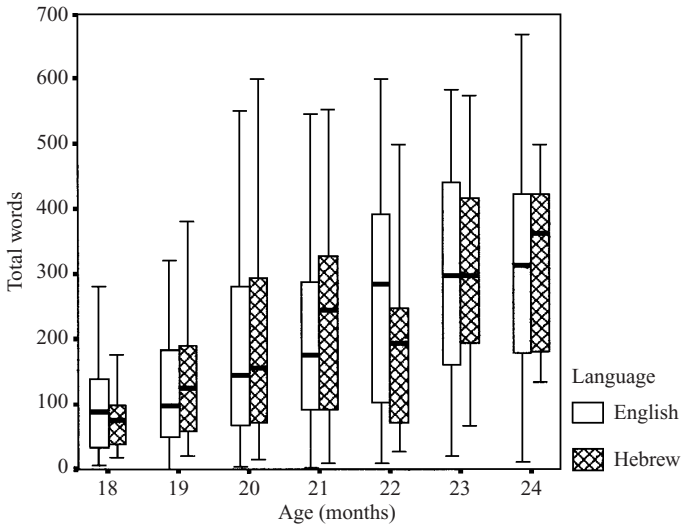

Fig. 1. A comparison of vocabulary ranges by age and by language.

$r(253) = -0{\cdot}13$, $p \leqslant 0{\cdot}05$, but not with the relative percentage of nouns in the child's vocabulary, $r(253) = -0{\cdot}01$, n.s. This is in keeping with repeated findings of a slight but reliable advantage in early word production among first born children (e.g. Bates, Bretherton & Snyder, 1988; Fenson *et al.*, 1994). HCDI total vocabulary scores did not relate significantly to the other Israeli sociodemographic measures for parent educational level and a composite SES score. An ANOVA comparing toddler age groups (7) × child care arrangements (3 groups) also indicated that child care arrangements did not contribute significantly to the variance in vocabulary growth, $F(2, 249) = 1{\cdot}10$, n.s.

Sociodemographic variables and the HCDI measures of early grammatical development were unrelated. Grammatical complexity scores and MPU respectively were unrelated to gender, parent educational level, family size, and SES. These findings correspond with the results for lexical development.

Growth in productive vocabulary by age

Figure 1 presents the range of vocabulary size for the Hebrew language sample by age as compared with the MCDI results for the matched English speaking sample. The heavy horizontal line represents the median, the box indicates quartile ranges from the 25–75th percentile, and the extended lines the extremes. Results from the Hebrew inventory indicate that between ages 1;6 and 2;0, Hebrew-speaking toddlers have a total production vocabulary that ranges in size from 10 to 599 different words with an overall median of 173 and a mean of 204 words (S.D. = 147). The overall median vocabulary

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size for the English-speaking toddlers was 182 words, with a mean of 218 words (S.D. = 163·17). At age 1;6 the median number of words for the Hebrew speakers was 75 with a range of 18 to 343 words and at age 2;0 the median number of words has risen to 362 with a range from 134 to 500 words. At age 1;6 the median number of words for the English speakers was 89 words with a range of 7 to 508 words and at age 2;0 the median was 314 words with a range from 314 to 668 words.

The correlation of HCDI vocabulary size and age indicates an increase with age amidst wide variability, $r(253) = 0{\cdot}35$, $p = 0{\cdot}0001$. The correlation of vocabulary size and age for the comparable English speaking group was $r(561) = 0{\cdot}44$, $p \leqslant 0{\cdot}0001$. Figure 1 shows growth in absolute vocabulary size with age for Hebrew-speaking toddlers as compared to the English speakers expressed in total words.

In order to accommodate differences in length of the English and the Hebrew lists when comparing children from each language group, a word opportunity score was calculated as the percentage of words checked at each age level relative to the total number of words in the checklist (see Fig. 2). A

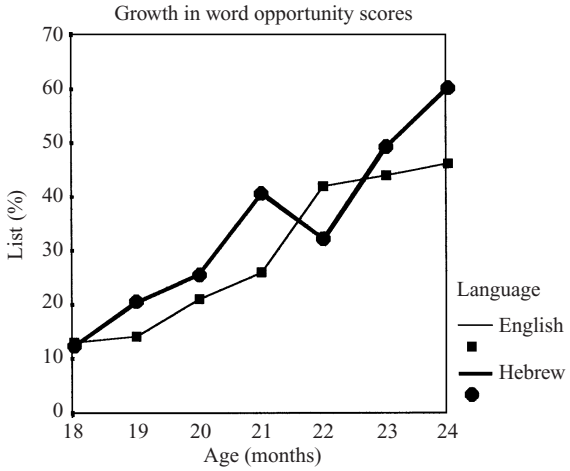

Fig. 2. Growth of vocabulary by age and language group.

comparison of word opportunity scores across the age groups indicates that through the age of 1;8 scores for the Hebrew and English lists represent similar proportions of the respective total list. Among the older age groups there are larger differences between the two languages in the proportion of the word list acquired. Nevertheless, the median HCDI opportunity score of 60% at age 2;0 indicates that there is still sufficient range in the Hebrew checklist to detect developmental differences. This finding attests to the

sensitivity of the HCDI in detecting developmental differences in vocabulary size at the age ranges that we studied.

A (2) language × (7) age group ANOVA with gender as a covariate was conducted both for total size of the child's productive vocabulary in absolute number of words and for lexicon production expressed as a word opportunity score. Only age showed a significant main effect for total word scores and for percentage scores, Fs(6, 813) = 18·77 and 19·79 respectively, ps ⩽ 0·0001). There was also a significant effect of the gender covariate, Fs(1, 813) = 14·61 and 15·07 for absolute number of total words and for percentage scores respectively, ps ⩽ 0·0001. Language did not contribute significantly to the variance in total vocabulary size, $F(1, 813) = 0·05$, n.s. However, some differences in word opportunity scores were attributable to language, $F(1, 813) = 3·76$, $p \leqslant 0·05$. This latter finding may reflect differences in the size of the respective inventory check lists in each language.

Growth of productive vocabulary by lexicon size

Because vocabulary size varies so widely with age among toddlers, relative vocabulary size is a better indicator of lexical development than chronological age (e.g. Bates *et al.*, 1994; Fenson *et al.*, 1994; Camaioni & Longobardi, 1995). The analysis of Hebrew lexical composition relative to overall vocabulary size was compared with the data for English speakers. Children were grouped according to seven levels of total production vocabulary size: (1) 0–50 words, (2) 51–100 words, (3) 101–200 words, (4) 201–300 words, (5) 301–400 words, (6) 401–500 words, and (7) 501 or more words. A χ^2 test to compare the relative number of Hebrew and English speaking toddlers at each level of vocabulary production indicated that both language samples were similarly distributed across vocabulary levels, χ^2 $(6, N = 814) = 5·59$, n.s.

Subsequent analyses focused on the distribution of words in the three main parts-of-speech categories of common nouns, predicates, and closed-class terms (Bates *et al.*, 1994; Pine *et al.*, 1996). An examination of Fig. 3 shows that in Hebrew as in English there are similar distinctive growth functions for each part-of-speech category. Nouns form the largest category of terms used in both groups (50–60 % of all words used) when lexical levels range from 50–500 words (Fig. 3*a*). Despite some structural differences between the HCDI and MCDI, nouns were predominant in lexicons of children producing up to 200 words after which their proportion relative to the complete productive vocabulary gradually decreased. The proportion of nouns for Hebrew-speaking toddlers peaks at a mean of 58·9 % in children with 101–200 word vocabularies. This finding is strikingly similar to the peak of 55·2 % at the same 101–200 word vocabulary level for English speakers. For both groups in this study, the growth function for common nouns formed an inverted-U. For the Hebrew language group, as reported for the

English speakers (Bates *et al.*, 1994), only the quadratic solution to the regression of the proportion of nouns on vocabulary level was significant, $F(2, 250) = 14{\cdot}33$, $p < 0{\cdot}0001$.

In order to further compare vocabulary composition by language, a (2) language × (7) vocabulary level ANOVA was computed for each part of speech type. Both vocabulary level and language contributed significantly to the variance in the percentage of nouns that comprise the toddler lexicon, $F(6, 812) = 27{\cdot}35$, $p \leqslant 0{\cdot}001$ for vocabulary level and $F(1, 812) = 20{\cdot}82$ for language, $p \leqslant 0{\cdot}0001$. There was also a smaller but significant language by vocabulary interaction effect, $F(6, 812) = 3{\cdot}03$, $p \leqslant 0{\cdot}01$. Examination of the means at each vocabulary level for each language (as illustrated in Fig. 3*a*) indicates that the Israeli toddlers' advantage in noun production is more noticeable at lower lexical levels – up to a vocabulary of 300 words. At the higher levels of lexicon size there is little difference between the groups, despite differences in the checklist length.

Predicate terms represented a much smaller proportion of the early lexicon than nouns both in Hebrew and in English (Fig. 3*b*). Children with vocabularies of less than 50 words on the HCDI produced few lexical verbs and adjectives. At the 50-word level, Predicate terms constituted about 4% of the Hebrew lexicon and 8% of the English lexicon. There was an increase to approximately equal proportions (25%) for both Hebrew and English speakers at lexical levels of 400 words or more, at which point the groups converged. In Hebrew, as reported for Italian and English (Caselli *et al.*, 1995; Caselli, Casadio & Bates, 1997), predicates begin to emerge primarily between the lexical levels of 50 and 100 words. There is a large linear increase in the proportion of predicates with the growth in total lexical size, $F(1, 251) = 243{\cdot}07$, and $F(2, 250) = 121{\cdot}09$, ps $\leqslant 0{\cdot}0001$ for the linear and quadratic terms, respectively, for the regression of predicate proportions on vocabulary level. Our results indicate that, as children's vocabularies approach 400 words or more, and the proportion of predicates produced reaches the absolute proportion of these terms in the HCDI checklist, the growth curve levels off (see Fig. 3*b*). This accounts for the significant non-linear component. The (2) language × (7) Vocabulary level ANOVA for the percentage of predicates indicated that both vocabulary level, $F(6, 812) = 116{\cdot}87$, $p \leqslant 0{\cdot}001$, and language group, $F(1, 812) = 13{\cdot}75$, $p \leqslant 0{\cdot}0001$, significantly contributed to the variance. There was no significant interaction term. At most vocabulary levels, predicate terms comprized a higher proportion of the lexicon for the English-speaking toddlers compared with the Hebrew speaking group. The advantage of English over Hebrew with respect to acquisition of predicates is consistent with findings of an English advantage compared with Italian (Caselli *et al.*, 1997). However, unlike the English-Italian contrast, a separate (2) language × (7) vocabulary level ANOVA for the proportions of Hebrew and English verbs alone indicated that there were

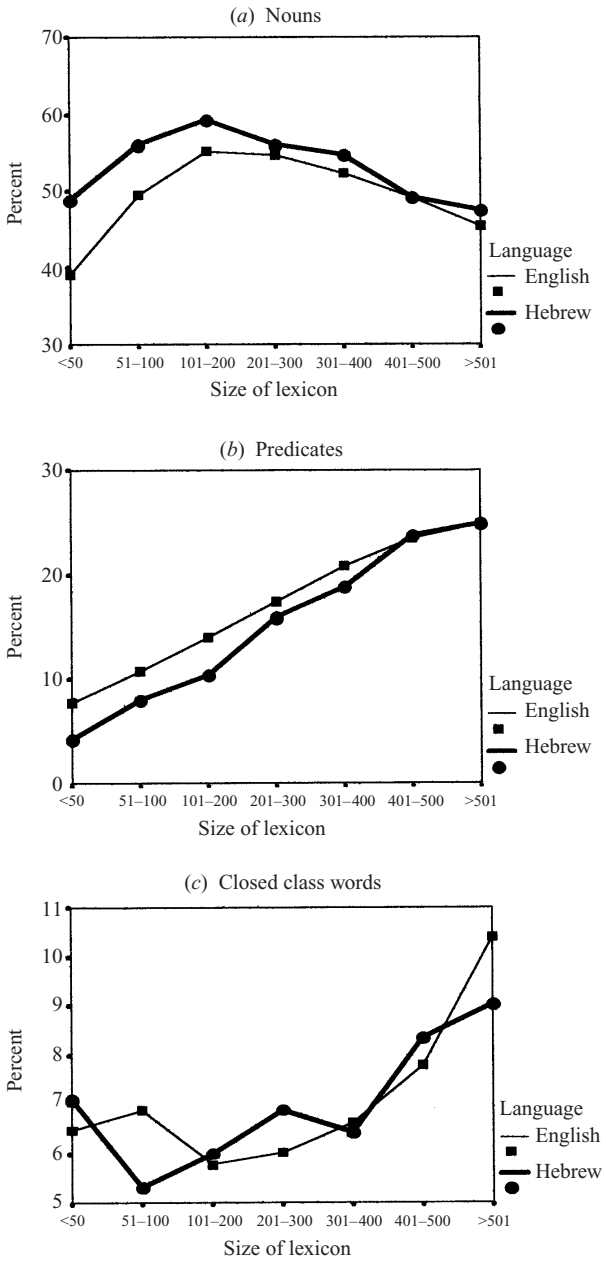

Fig. 3. Composition of lexicon in Hebrew and English.

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no significant language differences, $F(1, 812) = 0{\cdot}36$, n.s. This suggests that for Hebrew the primary source of difference is related to the acquisition of adjectives.

Finally, the relative proportion of HCDI closed class words is low ($M = 6{\cdot}59\,\%$, S.D. $= 3{\cdot}78$) and fluctuates throughout the lexical range studied (Fig. 3*c*). Notably, as reported for English (Bates *et al.*, 1994) the growth function of Hebrew closed class words includes a moderate but significant linear term, $F(1, 251) = 3{\cdot}77$, $p \leqslant 0{\cdot}05$ and a significant quadratic component, $F(2, 250) = 5{\cdot}29$, $p \leqslant 0{\cdot}01$. Hebrew speaking toddlers appear to acquire a few Closed Class items very early in their vocabulary production, and the main increase in these terms comes at a later phase of language development, concurrent with the emergence of word combinations. A (2) language × (7) Vocabulary level ANOVA for closed class terms indicated that only vocabulary level contributed to differences ($F(6, 812) = 6{\cdot}05$, $p \leqslant 0{\cdot}0001$).

The similarities in growth functions, as well as lack of any effect for language group for closed class terms should be interpreted with caution due to considerable structural differences between Hebrew and English that led to the elimination of many grammatical functors from the Hebrew list. The mean proportion of closed class terms found for the HCDI sample approaches the overall proportion of these terms in the checklist; for the MCDI the same proportion of closed class terms represents only half of such items in the checklist.

Early grammatical development

Hebrew Grammar scores were examined with respect to changes in age and vocabulary growth. The correlation of age and grammatical complexity was $r(249) = 0{\cdot}36$, $p < 0{\cdot}0001$, and the relation between age and MPU was $r(238) = 0{\cdot}18$, $p < 0{\cdot}005$. The modest, but highly significant relations between the HCDI vocabulary and grammar scores suggest that our original measure of grammatical complexity in Hebrew is sensitive to age. Figure 4*a* illustrates the average grammatical complexity level by age. Scores ranged from 1 through 4, reflecting the increasing levels of morphosyntactic complexity, from predominant use of single word utterances (score of 1) to production of a variety of syntactic forms including complex sentences (score of 4). At 1;6 the majority of children produced only one-word utterances and only those above the 90th percentile had begun to produce some two-word combinations. At 1;8 children at the 75th percentile used two-word utterances, and by the 90th percentile there were at least some children who produced simple three-word subject-verb-object sentences. By age 2;0, the majority of toddlers reportedly produced at least two-word combinations and at the 75th percentile children were producing simple three-word sentences. In the age range covered, none of the toddlers showed consistent use of more complex grammar that involves the use of expanded NPS (including

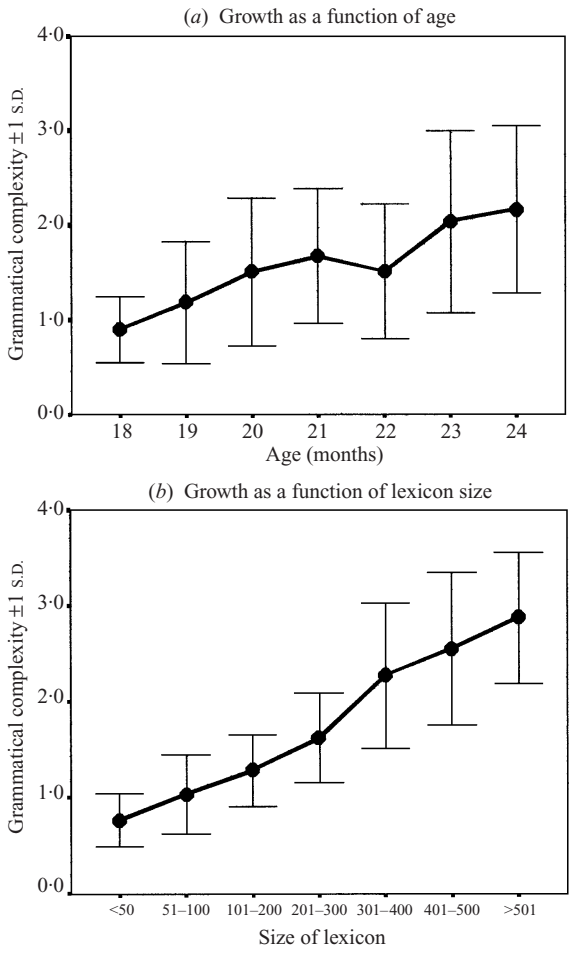

Fig. 4. Growth in Hebrew grammatical complexity.

morphological marking) as well as coordinated or embedded sentences. A comparison of mean sentence complexity by age based on a one-way ANOVA indicated a significant effect of age, $F(6, 242) = 7{\cdot}25$, $p \leqslant 0{\cdot}0001$.

Lexical level is a more sensitive index than age for early language development. Thus, an analysis of the relations between average grammatical complexity scores and lexical levels was conducted. Our findings indicated a steady increase in grammatical complexity as well as variability as a function of growth in lexicon size. In other words, individual differences with respect to the emergence of grammatical structures are more noticeable among children with larger lexicons. This is illustrated in Fig. 4*b*. Through the 100-

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word vocabulary level, the mean complexity level at the 50th percentile is one (ranging from 0·25 to 2·5), indicating that the majority of the children at that vocabulary level produce only single-word expressions. By the time toddlers have a production vocabulary of 400 words, at least 50% are reported to be using two-word combinations. Use of some simple sentences is reported for a majority of the children only when the lexicon exceeds 500 words.

A one-way ANOVA indicated a highly significant effect of vocabulary level on sentence complexity, $F(6, 242) = 58{\cdot}86$, $p \leqslant 0{\cdot}0001$. Moreover, there is a remarkable similarity among the correlations between grammatical complexity and each of the three parts-of-speech categories, $r(249) = 0{\cdot}74$ with nouns, $r(249) = 0{\cdot}74$ with predicate terms, and $r(249) = 0{\cdot}71$ with closed class words, respectively. This suggests that early emergence of grammar is supported by vocabulary growth in all the three parts-of-speech categories (see Bloom, Tinker & Margulis, 1993; Dromi, in press). Because the MCDI and HCDI measures of grammatical complexity are different, it is not possible to make direct comparisons of this part of the two inventories. Nevertheless, the relation between lexical and grammatical growth observed here supports the claim that differences in the grammatical structure of the target language have little effect during the early emergence of grammatical structures (Berman & Armon-Lotem, 1997; Berman, 1997; Caselli *et al.*, 1997).

DISCUSSION

The HCDI findings based on parent reports extend earlier diary and observational reports on the composition of early vocabularies in Hebrew-speaking children. Our data, from a large, representative sample, firmly support the position that the size of productive lexicons and the distribution of words in different grammatical categories in the productive lexicons are strikingly similar for Hebrew and English speaking toddlers at the same ages. Notably, the HCDI results indicate that despite the Semitic characteristics of the target language (i.e. its rich bound morphology and relatively free word order), Hebrew-speaking toddlers do not follow language-specific trends in constructing their lexicons during the pre-grammatical stage (e.g. Berman, 1985, 1997; Dromi, 1987/1996, 1999).

We found no significant differences between Israeli and U.S. toddlers with respect to the size and the shape of the growth functions for each part of speech category. In Hebrew as in English, nouns predominated over predicate terms and the distinctive shapes of the growth curves relative to vocabulary size followed parallel developmental trajectories. The HCDI data did not support the premise that because Hebrew shows many properties associated with verb initial languages, verbs might predominate nominal terms or emerge earlier than in English. The relative proportion of predicate terms was actually lower for Hebrew speaking toddlers than it was for the

English speakers, although the difference attenuated when verbs alone were considered.

Berman & Armon-Lotem (1997) reported on the remarkable similarity in the content as well as structure of the 20 first verbs acquired by six Hebrew speaking toddlers aged 1;2–2;1. The finding that many early verbs in Hebrew initially take non-finite forms led these researchers to conclude that during the pre-grammatical stage there are minimal effects of the rich morphological structure of the Hebrew lexicon on its acquisition. The direct cross-linguistic comparison of Hebrew and English data from a large sample provides converging evidence for this conclusion. Between the ages of 1;6 and 2;0, Hebrew speaking children only acquire several dozen verbs. These results point up a need for more detailed studies of verb acquisition in Hebrew that examine influences of lexical meanings of the different verbs, as well as variations and changes over time in their morphological forms. Such studies require a close grammatical analysis of rich spontaneous and experimentally elicited data. Parent questionnaires are limited with respect to the amount of structural detail they can include, and therefore are not suited for detailed analyses of verb acquisition. Moreover, we submit that future studies of verb acquisition in Hebrew speakers should be extended to include children who are older and who function at a more developed grammatical level than the toddlers who participated in the current study.

We agree with Tardif and her colleagues (Tardif, 1996; Tardif *et al*., 1997) that developmental parallels should not always be exclusively attributed to universal constraints on language learning. Several factors inherent to child-directed speech, such as the relative frequency of specific items in input, variations on sentence position, morphological simplicity, and culturally derived interaction features of the language learning game, could also be invoked to explain similar developmental outcomes in structurally different languages. The resemblance in patterns of vocabulary growth among Israeli Hebrew-speaking and U.S. English-speaking children could be related to similarities in sociocultural factors and the pragmatics of adult–child communication patterns in these two cultures. Berman (1997) noted that, although Hebrew permits flexible word order, parents typically use fixed SVO sentences in the input to children. With respect to basic patterns of mother–child interaction, both in Israel and in the U.S. mothers tend to engage in similar dyadic activities with their young children that emphasize attention to objects in the environment (Ninio, 1980; Bornstein, Maital, Tal & Barras, 1995). The findings of the present study point up the need to investigate child-directed Hebrew speech occurring in mother–child interactions. Such research would broaden our understanding of relations between the structural consistencies in input and patterns observed in early language development.

Another goal of the present study was to develop a parent report measure of early lexical development for Hebrew speaking toddlers, comparable to the MCDI. In any cross-linguistic or cross-cultural comparisons, there is a need for measures that at once reflect language and culture specific realities while also maintaining the same coherence of psychometric structure (Berry, Poortinga, Segall & Dasen, 1992; Dana, 1993; van de Vijver & Leung, 1997). Such inventories are needed to insure methodological rigour in making valid comparisons based on corresponding measures. The construction of the HCDI required adaptation of the MCDI word list as well as more substantial changes in the development of the measure of early grammatical complexity.

Our results, based on a large sample of Israeli toddlers, showed a high degree of internal consistency for each of the categories in the HCDI vocabulary checklist. Relations among the several sections of the HCDI attest to the validity of the Hebrew inventory as a developmentally sensitive measure of lexical growth. Mean vocabulary size and variability among children, as well as word opportunity scores for the Hebrew checklist, clearly indicate that for the ages that we studied (1;6–2;0), the inventory captures individual differences in a satisfactory way. In creating the HCDI early grammatical measure, our aim was to construct a set of representative items to which parents could easily respond. Results indicate that this measure of grammatical growth is sensitive to age differences as well as to differences in vocabulary size. Although grammatical complexity was measured differently in the HCDI and MCDI, the relations between early grammar scores and vocabulary growth in Hebrew were similar to those reported for English (Fenson *et al.*, 1994).

On the whole, age, rather than sociodemographic factors, accounted for HCDI scores. This finding accords with reports on Mandarin Chinese (Tardif, 1996) and on Spanish (Jackson-Maldonado *et al.*, 1993), and contrasts with findings that both size and composition of the lexicon (particularly with respect to the proportion of nouns) were related to sociodemographic factors among English speaking children in the U.S. (e.g. Bates *et al.*, 1994; Fenson *et al.*, 1994; Hoff-Ginsberg & Tardif, 1995; Bornstein *et al.*, 1998). Differences in sample size and composition, as well as the culture-specific formulations of SES scores, might account for the different results. Future-in-depth, cross-cultural studies should be planned to further explicate this issue.

In sum, the remarkable similarity of results for the HCDI and the MCDI attest to generalizable patterns of early lexical development between these two languages. The psychometric results of the present investigation advocate the use of the HCDI as an efficient tool for evaluating Israeli toddler vocabulary both in future research and for clinical screening. The isomorphism of the HCDI and MCDI measures demonstrated in this study

clearly establishes its suitability as a tool for use in future cross-linguistic research.

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