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Emergence and early development of lexicon and morphology

Abstract: This chapter examines the emergence and development of lexicon and morphology in children's first three years of life. It provides a novel perspective on this dynamic and intense period of language learning by integrating different viewpoints on children's cognitive development with insights from empirical studies and theoretical properties of learning systems. The chapter is organized around seven focal points, which discuss the following: the limitations of linguistic terminology in the study of child language development; the relation between word learning and concept learning; typological influences on morpho-lexical development; the role of context; the co-development of lexicon and grammar; the importance of word class; and finally, the central role of development. Throughout the chapter, discussion of the focal points is supported by existing and novel empirical evidence from Hebrew and other languages.

Keywords: morpho-lexicon, early language acquisition, dynamic systems, typology, developmental processes, lexicon in context

1 Introduction

The examination of morpho-lexical acquisition and development in this chapter focuses on the well-researched period of the first three years of life. This is because most researchers would agree that children growing up in a monolingual environment have access to the vast majority of morphological and syntactic structures of their language before they reach school age. But questions about the nature and processes of morpho-lexical development are particularly relevant for the first three years of life as the most dynamic and intense period of language learning, which constitutes the basis for adult processing (Bonin et al. 2004; Johnston and Barry 2006). This is when the links between concepts and thought are first forged (Arunachalam and Waxman 2010a; Ferguson and Waxman 2017; Imai and Gentner

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1997), and when the foundations of lexicon and grammar are laid (Devescovi et al. 2005; Trudeau and Sutton 2011; Noble et al. 2016) and are put to use in early conversation (Abbot-Smith et al. 2016; Graf and Davies 2014). Moreover, the young lexicon reflects and in fact magnifies the core morphological and lexical features of the language being learned (Ravid et al. 2008), so that any foray into early lexical learning can teach us much about lexical development in general.

For an overall perspective on the path of early lexical development, consider the account presented in Caselli, Casadio and Bates (2001). While we do not necessarily adhere to this model in our presentation of morpho-lexical acquisition, it can provide readers who are not acquainted with the developmental psycholinguistic literature with a top-down picture of the growth of the lexicon in young children. The Caselli, Casadio and Bates account starts with a *Routine and Word Games* phase with a small (1–50 words) vocabulary, consisting mostly of communicative/social words (sound effects, social routines, onomatopoeic words, and names of favorite people) (Dromi 1987; Fenson et al. 1994; Kauschke and Hofmeister 2002). This phase is followed by a *Reference* phase (50–200 words), when the majority of words in the lexicon are nominals; when the core lexicon reaches about 100 words, it evolves into the third phase of *Predication*, characterized by increasing numbers of verbs, followed by adjectives, coinciding with first word combinations, and involving the ability to encode relational meanings (Thibaut and Witt 2015). Finally, when lexical size reaches about 300–500 words, the fourth phase of *Grammar* kicks in, correlated with indices of grammatical productivity such as MLU (mean length of utterance) and MSP (mean size of paradigm) (Xanthos et al. 2011). At this time, the lexicon contains a considerable number of function words in addition to content words. This is the arena our chapter aims to characterize and explain.

2 Focal assumptions

Seven focal assumptions provide the narrative and organizational framework of this chapter. They are as follows:

- Linguistic terminology must be contextualized
- Development is key
- Word learning is conceptual learning
- Language typology affects word learning
- Words are learned in context
- Lexicon and grammar co-develop
- Lexical learning is paced by word class.

2.1 Linguistic terminology must be contextualized

The literature on child language development uses formal linguistic terminology as a matter of course. When we read that children have a lexicon or that children acquire morphology, we can easily get the impression that the way language is structured in a child's mind is accurately reflected by the structure of language assumed by formal linguistics. However, the linguistic terminology used in the field of child language acquisition long predates the development of the field itself.

Therefore, in writing this chapter about the emergence and development of lexicon and morphology, we found it important to point out that the linguistic terminology we use should be seen as a convention rather than as a reflection of a child's mind. We think that in studying how children gain command of communication in their language, the usage of linguistic terminology should be contextualized. We will therefore briefly discuss three core linguistic concepts used throughout this chapter: language acquisition, lexicon and morphology.

The term *language acquisition* represents a linguistics-centered view on how children learn to communicate. It presupposes an abstract goal, *language*, that the child is unaware of, and that must be *acquired*. Young language learners, however, cannot be described as algorithms attempting to discover the structures and functions that linguists have defined. Rather, children are motivated to understand their environment, to express their desires and needs, and to achieve their goals. One way in which a child can do this is by observing communication and attempting to communicate with others. Successful communication is the standard by which a child learns the shared conventions used by people in her environment.

Like other linguistic terminology, the notions of *lexicon* and *morphology* do not originate in the study of children's communicative development. The term *lexicon* is rooted in the philological interpretation of Greek poetic texts, where it is generally used to refer to a list of words that a writer uses or, more generally, an exhaustive compilation of word usage. The term *morphology* originated with Goethe, who used it in the context of biological taxonomy, which in turn inspired its use in linguistics.

In the second half of the 20th century, in the wake of the cognitive revolution (Miller 2003), scholars started to draw direct parallels between linguistic terms and mental constructs, with Chomsky (1957) explicitly claiming grammar to be a cognitive faculty and later giving the lexicon a place in his theory (Chomsky 1965). In the literature, the term *mental lexicon* became used in reference to Chomsky's concept of lexicon (e.g., Lieberman 1969), finding its way into mainstream textbooks on psycholinguistics (Clark and Clark 1977; Foss and Hakes

1978). Around the same time, Taft and Forster (1975) started to draw parallels between linguistic morphology and the mental processing of morphologically complex words. Later, Pinker (1998, 1999) popularized the idea that the linguistic distinction between regular and irregular morphology corresponds with distinct cognitive processing systems.

In studying the development of children's communicative abilities, attributing a mental status to the linguistic notions of lexicon and morphology seems attractive. However, the systematic ways in which linguists use lexicon and morphology do not imply that children's knowledge or performance rely on a similar systematic organization. We must be aware that these concepts do not reside in the child; rather, they should be seen as conventions according to which scholars describe and classify children's communicative abilities, taking their description of adult lexicon and morphology as model. But older children, adolescents and adults reanalyze young children's acquisition outcomes. When we say that children *know* certain words or that their lexicon *contains* certain words, we do so according to a given linguistic definition of what a word is and according to a list of words matching this definition. Similarly, when we say that children have certain morphological abilities, we do so according to a pre-defined notion of morphology and of morphological categories. Likewise, these pre-defined linguistic concepts are used to construct stimuli for experimental tasks in which children's responses are elicited. The terminology we use also constrains what is considered relevant to observation and how observations are classified. For example, when we say that children have *correctly* acquired a word or a morphological category, the judgement of correctness is based on what is in the adult inventory instead of what constitutes communicative success.

Therefore, studying children's communicative development within a linguistic framework is useful because it allows us to describe part of children's linguistic development in a conventional way. However, we should also be aware that many aspects of child language are difficult to grasp or even misconstrued in using these conventions.

2.2 Development is key

From a linguist or language teacher's bird's eye perspective, morphological systems may be hugely complex and often opaque in terms of both meaning and structure, with immense variations across languages (Ackerman and Malouf 2013). The same question can be asked regarding the path to acquisition of the rich lexical semantics of words in adult language. For example, when Hebrew-acquiring children in their third year of life were asked (in the context of a

music lesson) *le-histovev ba-xéder* 'to-wander in (=around)-the-room', many of them instead started turning around and around, following a basic interpretation of this instruction. Innate, abstract knowledge and universal maturational constraints have been invoked (Chomsky 1988) to explain the discrepancy between complex, rich and automatic morpho-lexical usage in adults, on the one hand, and children's limited cognitive abilities and the purported absence of negative evidence in language learning, on the other. One of the main problems with this view is that it conceives of morpho-lexical development as a straight line. Children must incessantly acquire more words and more morphological processes on their road to become ideal language users. However, any type of learning that progresses only in one way is doomed to fail in a noisy environment, as is illustrated by the classical hill climbing problem. Mountain climbers can use a strategy in which they start climbing and keep on going until there is no more up. Unless the mountain has a straight one-way slope, this strategy will almost surely fail. The climber must be able to backtrack from a local peak to be able to find the top of the mountain. A mountain with one straight slope to the top corresponds to a non-noisy environment. However, the situations in which language learning occurs are definitely noisy. Children are confronted with mountains of data and must make temporary assumptions about how to communicate successfully. The ability to let go of those assumptions, i.e., *non-monotonic learning*, eventually leads to a more successful way of communication.

Straight-line conceptions of language acquisition do not account for non-monotonic learning. On the other hand, there are models in which learning is central (see, for instance, Section 2.5.1). Because these models are constantly driven by the data, they are non-monotonic by design. Several strands of research on lexical and grammatical acquisition show that dynamic non-monotonic learning is key for morpho-lexical development. There is mounting evidence that children do require, receive and make use of efficacious positive and negative, direct and indirect feedback on their language productions over a long period of time (Chouinard and Clark 2003; Clark 2010; MacWhinney 2004; Moerk 1991). Elman (2003) formulated the idea that development in naturally noisy environments is the driving force in language learning, drawing attention to the important notion of "starting small" (Elman 1993), which means that young children are aided rather than hindered by limited cognitive resources. They start out with limited memory resources that only gradually improve and are at first exposed to only a limited number of frequent core examples of a language category. More complex but less representative sub-categories and items join in to construct categories over time.

We thus assume that morpho-lexical development occurs under constant pressure from the changing nature of the language input and the ability to

predict relationships based on current stochastic knowledge. Knowledge structures emerge as a result of increased discrimination caused by learning over many different events. And morpho-lexical development is a gradual, uneven developmental process in which learners integrate different pieces of evidence to establish more and more relationships and regularities. Two studies illustrate this generalization. A study of Spanish acquisition (Mariscal 2009) showed that children construct abstract agreement categories based on a dynamically changing confluence of sources in the input, such as noun phonology and the shape of determiners, pronouns, and adjectives. A study on Lithuanian agreement (Savickienė, Kempe and Brooks 2009) found that children make use of the mediating factor of diminutive morphology in learning to mark adjective agreement and to ease acquisition of number and case in general (Savickienė and Dressler 2007). Both studies interpreted their results as showing that children store representations of units of various sizes and form generalizations at differing degrees of abstraction – rather than applying a rule to all members of a symbolic category. The same seems to be true of adult second language learners (Brooks, Kempe and Donachie 2011, on Russian).

To illustrate this path, take the example of Hebrew monosyllabic masculine nouns patterned as *CeC* (with Cs standing for root consonants) such as *ec* 'tree', *ken* 'nest', *cel* 'shadow', or *lev* 'heart'. Learning how to pluralize such nouns is a study in the work of frequency, transparency, regularity, and consistency. Young children tend to attach the regular masculine *-im* suffix to a non-changed stem, yielding correct *ecim* 'trees' but incorrect *kenim* 'nests', *celim* 'shadows' or *levim* 'hearts'. Gaining morpho-lexical experience about the distributions of categories of Hebrew plurals from encounters with numerous singular and plural nouns (Ravid and Schiff 2009) will result in a set of different, and more specific, expectations regarding *CeC* nouns. They tend to change their vowels as in *ken/kinim* 'nest/s' or to reveal a "double" root, as in, *cel/clalim* 'shadow/s'. Moreover, final voiced consonants tend to attract the irregular *-ot* on masculine nouns (Ravid and Schiff 2012), and hence, *lev/levavot* 'heart/s'. The property that *CeC* nouns share with other plural categories – changing vowels in the stem and irregular suffix – will emerge first, whereas greater exposure to more monosyllabic nouns will result in doubling consonants. Increased success on pluralizing nouns will reflect emerging generalizations based on type and token frequency and consistency of plural forms.

Another example of an uneven non-monotonic developmental process, which has been called a blind-alley development (Bittner, Dressler and Kilani-Schoch 2003), is characterized by children constructing, for a short transitional period, patterns which present a developmental direction away from adult targets. A case in point is, in the German compound development of two Viennese

children, the over-generalization of a schwa (written *-e-*) at the end of the first compound constituent which represents descriptively both the overgeneralization of an *-e-* interfix and the lack of having an *-n-* interfix after a stem-final schwa. For example, from 2;2 onwards, Lena produced, for a few months, more incorrect than correct *-e-* interfixes, e.g. *Kinnesette* for *Kind+er+kassette* 'child-cassette', *Ralewasser* for *Mineral+wasser* 'mineral water', while omitting the *-n-* interfix in *Plattespieler* for *Platte+n+spieler* 'record-player'. The insertion of an *-n-* interfix in German *Platte+n+spieler* 'record-player' renders the identification of the first compound member *Platte* more difficult and thus diminishes morphotactic (also called: phonological) transparency of the compound. This obstacle for acquisition can explain why German children acquire interfixed compounding later than purely concatenative, i.e. interfixless compounding, as exemplified by *Polizei+auto* 'police car' (Dressler et al. 2010), although both patterns are productive and very frequent in ADS (adult directed speech) and CDS (child directed speech).

2.3 Word learning is conceptual learning

Cognitive science regards the human brain as the most powerful learning device shaped by evolution (Griffiths et al. 2010). A major task carried out by the human brain is mapping out the external and internal world in terms of objects, people, places, states, properties, ideas, actions, events, and processes (Sperber and Wilson 1998). These are encoded across an array of forms, from overt lexical units to periphrastic constructions (Goldberg, 1995). Our interest in the current context lies in the crossroads of language and conceptual development at a time when the foundations of individual human knowledge are established (Tooby, Cosmides and Barrett 2005; Wellman and Gelman 1998). We adopt here Evans' (2009) notion of *lexical concepts* as sense units inferred from the ambient language and stored as part of language knowledge, providing access to encyclopaedic knowledge structures, often encapsulating complex and informationally diffuse ideas (Langacker 1987). Importantly, Evans regards lexical concepts as knowledge structures specialized for symbolic representation.

Children begin linguistic acquisition with strong conceptual capacities and a tendency to encode lexical concepts in linguistic units (Clark 2004; Mandler 2000; Spelke 2000). Early on, infants are able to distinguish between different people, objects and events by noticing their perceptual properties, the ways they move and interact, and the changes they undergo (Arunachalan and Waxman 2010b; Clark and Lindsey 2015; Gentner and Boroditsky 2001). Across the learning years, children sharpen these abilities, enhanced by their socio-

cognitive and linguistic development, by the emergence of categories from items used, learned and repeated, by the changing linguistic and communicative contexts in which they occur, and by feedback extracted from the ambient language – from both older and more experienced language users, as well as from the children themselves (Blackwell 2005; Clark 2015; Houston-Price, Plunkett and Duffy 2006). Following the ultimate achievement of exhaustive categorization in infants – discovering that every object can be named (Booth and Waxman 2002; Nazzi and Bertoncini 2003) – children obtain an increasing lexicon of words guided by principles such as Conventionality (well established words have conventional meanings) and Contrast (words differ in meaning[1]) (Clark 1993). Words breed concepts, and concepts lay the ground for new words (Waxman and Leddon 2011).

Based on these abilities, children's vocabulary will grow and diversify in both breadth and depth in tandem with the increase in the range of situations, events, states and relationships encountered (Evans 2009), with a focus on literacy contexts and events (Anglin 1993; Ravid 2005; Ravid and Tolchinsky 2002). Later Language Development across the school years ushers in written language, forming the basis for the literate lexicon, which is embedded in academic fields and disciplines (Olson 1996). Thus, new lexical items, more meanings and word knowledge in general will come to reflect the conceptual knowledge of adult language users and their construal of the world. Against the backdrop of initial lexical learning and the long developmental route to the mature lexicon, the acquisition window adopted in the current chapter focuses on the core mental lexicon of children as a faithful reflection of their knowledge base about the world prior to the onset of written language (Berman 1997).

2.4 Language typology affects word learning

Much about the course of lexical learning is universal. Symbolic play, communicative gestures and word comprehension start in infants around their first birthday (Barbieri et al. 2009; Fasolo and D'Odorico 2012), platformed by shared cognitive and socio-cognitive skills (Tomasello 2003). Moreover, the semantic-pragmatic contents of children's early lexicons are strikingly similar across different languages and cultures, based on perceptual salience, frequency and

1 But that does not hold for pragmatically used diminutives and hypocoristics. Thus, in Italian, diminutives from English *vip* do not block each other: *vipp-ino, vipp-etto, vipp-uccio* + three others, plus 24 more examples of diminutive suffixation rivalry, more in Dressler et al. 2019.

communicative relevance (Clark 1993; Golinkoff and Hirsh-Pasek 2008; Pruden et al. 2006; Slobin 1985). However, languages differ dramatically in how semantic concepts such as space, number or time are formally encoded (Bowerman and Choi 2001; Lucy and Gaskins 2001). The typological impact of morphological richness is especially compelling in the course of lexical learning. This is because comparable lexical meaning can be expressed with varying degrees of morphological complexity in different languages (Koptjevskaja-Tamm 2012). For example, verb semantics follows verb morphology, taking into account the meaning of each derivational component, so that an unanalyzed form correlates with a simple meaning, while a complex, derived form correlates with a likewise complex meaning (Kibrik 2012; Talmy 2007).

This means that in acquiring a vocabulary, children learning a morphology-rich language will have to pay particular attention to the internal structure of words in order to learn to extract and express meaning. The literature indeed shows that the role of morphology in lexical acquisition varies with its richness and prominence in the language. Morphological development is faster when the input language is morphologically richer (Dressler 2007; Xanthos et al. 2011). Thus, Turkish children acquire their very rich inflectional morphology earlier than English children acquire their relatively morphologically poor one (Dressler 2010). In languages with a rich morphology, lexical growth interfaces with morphology earlier on and in more ways (Ravid 2012) in both typically developing and disordered populations (Bavin 1998; Dromi, Leonard and Shteiman 1993; Levie, Ben-Zvi and Ravid 2017). For example, for Hebrew- and Arabic-speaking children, verb learning is necessarily bound with learning the two non-linear morphological components of Semitic root and pattern. Thus, young Hebrew-speaking children rely on tri-consonantal roots as the most accessible option in their lexical innovations (Berman 1985; Clark 1993). Children as young as three years of age are able to interpret novel root-based nouns, indicating their ability to extract the root from the given test item. By age four, they are able to coin semantically appropriate novel verbs from other verbs in a form consistent with the structural stipulations of their grammar (Berman 1990; Berman 1999; Clark and Berman 1984). In fact, non-linear root-and-pattern affixation precedes linear suffixation in the acquisition of Hebrew adjectives (Berman 1994; Berman 1997; Ravid, Bar-On, et al. 2016; Ravid and Nir 2000). Likewise, children acquiring spoken Palestinian Arabic are able to manipulate “broken” root-and-pattern noun plurals such as *shubba:k/shabbabi:k* ‘window/s’, as early as age three-four years (Ravid and Hayek 2003; Ravid and Farah 1999; Saiegh-Haddad, Hadieh and Ravid 2012).

2.5 Words are learned in context

The linguistic literature has long recognized that words are creatures of their communicative environments (Medina et al. 2011). Lexical meaning is generally derived directly from how language is actually used (Clark and Wong 2002; Croft 2000; Langacker 2000), consistent with Wittgenstein's dictum that "For a *large* class of cases – though not for all – in which we employ the word 'meaning' it can be defined thus: the meaning of a word is its use in the language" (Wittgenstein 1953, 43).

The syntactic, discursive, pragmatic and environmental contexts in which words are encountered are not merely helpful in lexical acquisition and processing, they are in fact inherent to determining the nature of a word's meaning, including context-specific shifts in senses (Evans 2009; Pustejovsky 1995). To gain the breadth and depth of word knowledge, words must be experienced frequently in their contexts (Ambridge et al. 2015; Hulme et al. 1997; Sandoval and Gómez 2013). That is, numerous, variegated encounters with words are critical for them to be interpreted, organized into categories (Ferguson and Waxman 2017) and learned, including the creation of long-range relationships between similar environments to sustain new-word acquisition (Clark, 2016; Landauer and Dumais, 1997).

This insight promotes the examination of children's productions in their natural context. Cross-sectional testing, a long tradition in child language investigation, is somewhat problematic as it overlooks the different developmental paths of different children, based on formal tests that often use adult-directed adult language as a yardstick instead of the input of the investigated children, and probe children's metalinguistic knowledge instead of their spontaneous usage in natural interactions. While we do not debate the importance of cross-sectional investigations, some of which providing evidence in the current study, this underscores the importance of collecting and analyzing longitudinal corpora of children's spontaneous interactions with care-takers and their environment (Bittner et al. 2003; Dressler et al. 2017; Savickienė and Dressler 2007; Slobin 1985; Stephany and Voeikova 2009).

2.5.1 Frequency, information, and learning

To fully understand the contextual learning of words, it is necessary to understand how mere frequency influences word learning. Frequency, or the number of occurrences of a word in the environment, is one of the most important factors in adult lexical processing, so that the speed with which adults can identify

words is sensitive to minute differences in frequency of occurrence of those words (Keuleers, Brysbaert and Diependaele 2010). When considering the role of frequency in acquisition, a first thing to note is that encounters with words are, first and foremost, opportunities for lexical learning. All else being equal, the frequency of a word in CDS is proportional to learning opportunity. A second fact worth underscoring is that the role of a word's frequency before it has been learned is different from its role after it has been learned. While greater frequency initially corresponds to greater opportunity for learning, once a word has been acquired, greater frequency reinforces its acquisition by easing processing and serving to bootstrap the learning of other words.

A simple but naive view of acquisition would suggest that words that are more frequent are also acquired earlier. However, if the child were indeed to develop her lexicon based on frequency distributions alone, she would start by learning some very frequent function words and pronouns. Morphemes, especially affixes, which are also very frequent in speech, would also be acquired very early. But this is not the case: Lexical learning starts with referential rather than grammatical elements. There are several reasons why the relation between frequency and acquisition is not so straightforward. First, frequent words are often not related to things that are salient, that is, of importance to the child. Second, frequent words such as articles, and function words are often irrelevant in achieving communicative success, especially early on. Moreover, they are usually very abstract, representing relations rather than objects, people and events. Finally, words that are used often and across contexts are not informative about a particular situation, and therefore they are less likely to draw a child's attention (cf. Section 2.5.2).

Information theory (Shannon and Weaver 1949) offers a mathematical basis for understanding the learning of words in context. Consider a situation in which a parent and child are playing with a ball while suddenly a cat walks in. Let's assume that the child hears a few sentences in which *the ball* occurs, while in one situation it hears *the cat*. Frequency information only tells us that the word *the* has been encountered 5 times, the word *ball* has been encountered 4 times and the word *cat* just once. Therefore, we would expect the child to learn the word *the* before it learns the words *ball* and *cat* – which is never the case. Information theory allows us to go beyond this simple frequency information by evaluating how informative each word is. First, we need to establish that a word that occurs with equal frequency in any situation is not informative about any of those situations in particular. On the other end of a spectrum, a word that occurs in a single situation is probably informative about that situation. Information theory calls the unpredictability of an event its *entropy*. The

lower the entropy of a word, the more informative a word is about a particular situation. Entropy can be computed according to the formula:

$$H = -\sum_{i} p_i log_2(p_i)$$

In our example, this gives the following results:

$$H_{the} = -5 \times 0.2 log_2(0.2) = 2.32$$

$$H_{ball} = -4 \times 0.25 log_2(0.25) + 1 \times 0 log_2(0) = 2.00$$

$$H_{cat} = -1 \times 1 log_2(1) + 4 \times 0 log_2(0) = 0$$

Thus, while *the* occurs often, it is not predictive of any situation. The entropy of *ball* is slightly lower, and therefore it is more informative about the situations *ball* occurs in. Finally, there is no uncertainty about the situation that *cat* occurred in. Although the frequency of *cat* is just one, its absence in other situations means that it was almost certainly relevant to the situation it occurred in. Information theory therefore shows that while each occurrence of a word presents a child with learning opportunities, the distribution of those learning opportunities across contexts also plays an important role in acquisition.

The intuitions that information theory provides about learning occurring against a background of contextual events are also present in the discriminative learning model (Rescorla and Wagner 1972) which has been successfully applied to language learning tasks. The Rescorla-Wagner model is a general learning model that can be applied to any task where the occurrence of a certain type of events happens in connection with another type of events. In the context of language acquisition, the model has been applied to word learning (Ramscar, Dye and Klein 2013), showing that when learning new words, children's judgements about what is most informative about those words is predicted by their co-occurrence with objects and events in the environment, relative to how well other words match those objects and events. A central feature of the model is that it attends to whether events occur together (positive evidence) as well as whether they do not occur together (negative evidence). In this view, also called *discriminative learning*, children can work out the meaning of words by calculating whether the positive evidence for a word is larger than the negative evidence. For instance, if a child hears the phrase *the ball* three times accompanied by a picture of a ball, and *the cat* two times, associated with a picture of a cat, it will be clear that there is positive evidence for an association between the word *cat* and something in the picture of the cat and for an association between the word *ball* and something in the picture of the ball. However, the set of events would also have provided information to discriminate

between the parts of the pictures tied to the words *cat* and *ball,* because positive evidence for one was also negative evidence for the other. Second, there has been absolutely no learning of the word *the* as there was only positive evidence connecting it to every outcome.

2.5.2 Parental input and word learning

In child language, the connection between how often a word occurs in the environment and the time at which it is learned can be elusive, so that care should be taken to use valid measures. Word frequency in corpora correlates with age of acquisition (AoA) when these corpora consist of CDS or children's own output, Child Speech (CS) (Ashkenazi, Ravid and Gillis 2016; Kidd, Lieven and Tomasello 2010; Matthews et al. 2005), but not when this frequency is derived from written language (Goodman, Dale and Li 2008; Hansen 2017). Child lexical development is thus highly reliant on the quantity and quality of the ambient language and while later on in development peer input becomes more important (Labov 2014; Ravid, Olshtain and Ze'elon 2003), early child lexical development depends most notably on the linguistic input provided by parents.

The study of the relation between CDS and CS has long been absent from the scientific inquiry into language acquisition, largely due to nativistic assumptions and to the excessive reliance on experimental results where CDS has not been available. But this study has gained momentum in the last decades under data-driven, usage-based accounts, as reviewed in Behrens (2006). Studies indicate that CDS is the main source available to the child regarding the patterning of words and morphemes in her language (Hoff-Ginsberg 1985; Maslen et al. 2004), presenting children with the core, most frequent and consistent aspects of linguistic systems (Ravid et al., 2008; Ravid, Ashkenazi, et al. 2016). CDS moreover mediates word learning by presenting words in short utterances (Bergeson, Miller and McCune 2006) and at a slower rate of speech when children start using words and combining them (Ko 2012). Mediated language input enables young learners to analyze the distributional properties of the speech they hear and induce linguistic categories based on distributional and frequency information through pattern detection (Tomasello 2006). Child-adult conversations allow word learning to take place in situations characterized by mutual attention and responsiveness, in constant interaction with adults' corrections, reformulations and expansions and children's own uptake and imitations (Clark 2007; Clark and Bernicot 2008; Veneziano and Parisse 2010). To take a specific example, in languages with rich and variegated compounding devices, the degree of richness of compounding in CDS is a predictor for the age of compounds becoming productive

in CS. As shown in Dressler et al. (2017), this takes place earlier in children acquiring Danish, Estonian, Finnish, German and Saami (before two years of age) than in children acquiring French, Greek, Hebrew and Russian, where compounding is a less prevalent device (Berman 2009; Clark and Berman 1984; Ravid and Zilberbuch 2003).

The relationship between children's ambient language and their own speech has been demonstrated using different research methods such as computer simulations, artificial language learning, naturalistic corpus analysis, and elicitation procedures for all aspects of native language learning (Behrens, 2008). Particularly relevant to the topic at hand, these relations impact lexical learning: higher frequency words in CDS are acquired earlier on in CS (Hansen 2017; Huttenlocher et al. 1991; Kidd, Lieven and Tomasello 2010). Moreover, children's production of specific structures has been shown to correlate highly with parents' frequent and variegated usage of these structures (Brodsky, Waterfall and Edelman 2007; Naigles and Hoff-Ginsberg 1998). It is not only token frequency that drives lexical learning, as high type frequency of a certain category will lead to earlier productivity of this category in the child's speech (Bybee 2001, 2006; Lieven 2010; Maslen, Theakston and Tomasello 2004). As type frequency increases, a category is formed, which can be deployed to produce and understand items that were not present in the input (Borovsky and Elman 2006; Boyd and Goldberg 2009). Note, however, that while acknowledging these strong relationships, the input is not a direct representation of the child's actual intake and the output is not a direct representation of the uptake. Prosodically and positionally more salient structures have a higher chance of being perceived and thus taken in by children than less salient structures; and what children attend to and take up is a black box for the observer, who has to reconstruct children's uptake by a close study of input-output relations (Goldschneider and DeKeyser 2001; Harris 1992; Stemberger and Chávez-Peón 2014).

2.5.3 Hebrew verb roots: A case study in the CDS-CS relation

A recent study of Hebrew verb development (Ashkenazi 2015; Ashkenazi et al. 2016) demonstrates CDS – CS relations, focusing on the Semitic roots of verbs, a critical morpho-lexical component in Hebrew (Ben Zvi and Levie 2016; Berman 1985; Ravid 1995). Most Hebrew words participate in morphological families based on a single root and varying in the non-linear vocalic patterns that shape different words (Berman 1987; Bolozky 1999; Ravid 1990; Schwarzwald 2002). For example, the morphological family related by root *m-s-r* 'deliver, convey' contains the verbs *masar* 'deliver', *nimsar* 'be delivered', *hitmaser* 'devote

oneself', the adjective *masur* 'devoted', and the nouns *mesira* 'delivery', *hitmasrut* 'dedication', *mesirut* 'devotion', *méser* 'message', *mimsar* 'relay', *tamsir* 'handout', *timsóret* 'transmission', and *misron* 'text message'. Abundant evidence points to the Semitic root as the most accessible Hebrew morpheme across different age groups and populations (Levie, Ben Zvi and Ravid 2017; Ravid 2003). Root-and-pattern structure organizes lexical processing and learning in Hebrew speech, reading and writing (Bar-On and Ravid 2011; Frost 2012; Frost, Deutsch and Forster 2000; Gillis and Ravid 2006; Ravid 2001, 2005, 2012; Ravid and Bar-On 2005; Ravid and Schiff 2006a; Velan et al. 2005). Hebrew verbs constitute the prototypical habitat of this non-linear structure as an early-acquired content-word class composed solely of roots and patterns in both derivation and temporal inflection (Berman, 1994; Ravid et al. 2016a). Thus, verb acquisition is highly dependent on learning to identify relations among verbs sharing the same root, that is, sharing similar basic lexical content, with different vocalic patterns (termed *binyanim* lit. 'buildings') encoding transitivity and Aktionsart relations. For example, *nirdam/hirdim* 'fall asleep/put to sleep' or *lavash/hilbish/hitlabesh* 'wear/dress someone/dress oneself' share roots *r-d-m* 'sleep' and *l-b-š* 'wear' respectively in verbs with different vocalic patterns.

Ashkenazi (2015) showed that verb and root types produced by the two children (aged 1;8–2;2) in her densely recorded database (Table 1) were a subset of their parents' usage. That is, the children did not produce any verb form or verb root that did not appear in their parents' recorded usage, although they were evidently exposed to a larger set of language by them and by other caregivers. This finding illustrates the critical influence lexical input exerts on lexical uptake and output, and in a wider perspective, points to a core lexical inventory that is probably shared across caregivers and children. She also showed that parental verb types and tokens and children's verb types and tokens were highly correlated: Not only was each parent's root inventory and

Table 1: Words, verbs and roots in Ashkenazi (2015).

Numbers	CHILD SPEECH (CS)			CHILD DIRECTED SPEECH (CDS)		
	Total	Girl	Boy	Total	To Girl	To Boy
Word tokens	72,086	39,717	32,369	299,461	158,679	140,782
Verb tokens	7711	4610	3101	55,109	31,279	23,830
Verb types	259	204	172	684	531	503
Root types	224	204	172	534	437	426

total root input highly correlated with the child's root inventory and total root input, the root productions of the parents of the different children were highly correlated in types, structural (regular and irregular) root categories, and tokens. Likewise, the root productions of the different children were highly correlated; and the root productions of the first set of parents were highly correlated with the root productions of the toddler of the other parents. As roots are the basic lexical unit in Hebrew verbs, this indicates that the structure of the core verb lexicon in parents and children is highly similar (Ashkenazi, Gillis and Ravid 2019).

2.5.4 SES and maternal input profoundly influence morpho-lexical abilities

The robust relationship between parents' and children's lexicons leads to the question whether poor lexical input can deprive children of maximizing their language abilities. Differences in Socio-Economic Status (SES) have been linked to linguistic domains critical to early language learning, including sensitivity to the phonetic structure of words, morpho-phonology, and Theory of Mind (Blachman et al. 1999; Cutting and Dunn 1999; Korecky-Kröll and Dressler 2015; Nittrouer, 1996; Shatz et al. 2003; Ravid 1995). Lexical development is particularly affected by SES background (Arriaga et al. 1998; Qi et al. 2006). From infancy, the lexical repertoire of low-SES children lags behind that of more advantaged peers (Black, Peppé and Gibbon, 2008), with slower growth of both oral and written vocabulary (Farkas and Beron 2004; Walker et al. 1994). These SES-related effects on language abilities emerge early on (Betancourt, Brodsky and Hurt 2015; Fernald, Marchman and Weisleder 2013; Fish and Pinkerman 2003), involving the development of crucial brain regions (Kishiyama et al. 2009; Noble, Norman and Farah 2005), and important cognitive functions (D'Angiulli et al. 2008; Engel, Santos and Gathercole 2008; Farah et al. 2006; Fazio 1997).

To demonstrate the impact of SES on morpho-lexical knowledge in school age, Ravid and Schiff (2006b) compared high-SES and low-SES Hebrew-speaking grade school children on their ability to analyze roots and patterns in morphologically complex written words. This was a task that required the completion of an analogy problem by picking the correct noun out of five alternatives. Out of the four distractors, three were morphological – two of them root-related and one pattern-related; the fourth distractor bore a semantic, but non-morphological relationship to the target noun.

Figure 1 shows that the low-SES children consistently lagged two years behind their high-SES peers in range of correct responses, indicating a lesser ability to analyze words into their root and pattern components – a skill that is

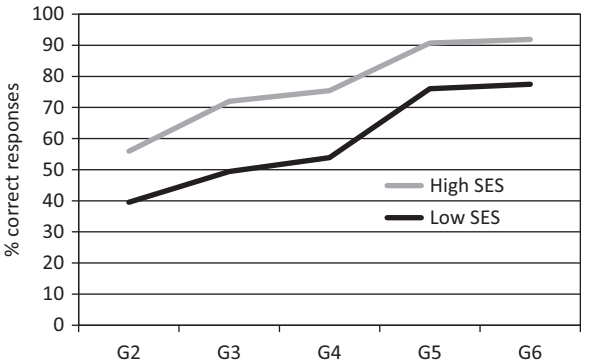

Figure 1: Correct responses on the Analogy Task in Hebrew-speaking grade schoolers from high- and low-SES backgrounds (Ravid & Schiff, 2006b).

both reliant on and supportive of lexical knowledge (Anglin 1993; Carlisle 2000).

Figures 2 and 3 indicate that the difference was not only quantitative. When high-SES children made an error, they overwhelmingly chose the Semitic root distractor in all age groups. In contrast, low-SES children in second grade chose other distractors more often, including non-morphological semantic distractors; in older age groups, they chose the root distractor more often. In a morphologically rich language such as Hebrew, where lexical learning is dependent on extracting structural and semantic connections between words,

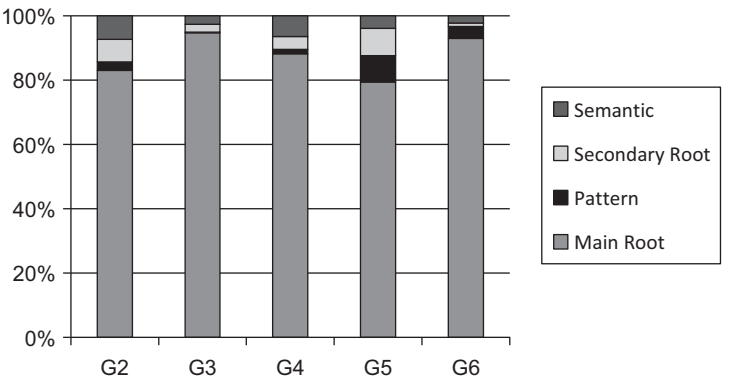

Figure 2: Erroneous responses based on types of distractors in the Analogy Task, high-SES grade schoolers (Ravid & Schiff, 2006b).

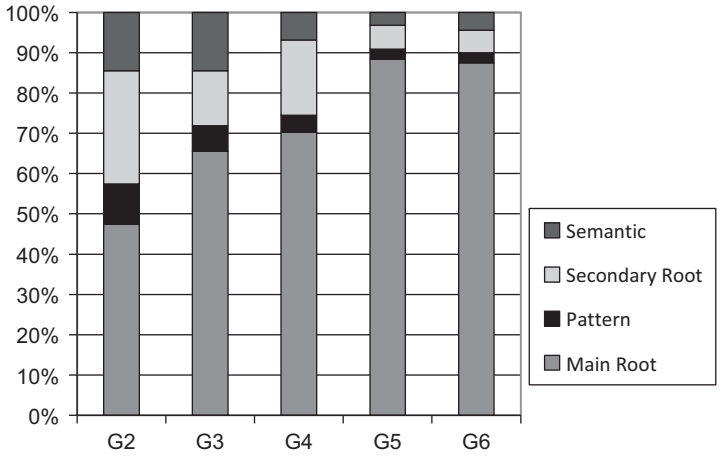

Figure 3: Erroneous responses based on types of distractors in the Analogy Task, low-SES grade schoolers (Ravid & Schiff, 2006b).

these discrepancies raise concerns regarding a reduced ability to understand and learn new words. Several other studies have shown that school-aged children from low SES struggle in relating words via their inflectional and derivational morphemes (Berman, Nayditz and Ravid 2011; Schiff and Lotem 2011; Schiff and Ravid 2012), with disturbing similarities to children with linguistic impairment (Levie, Ben-Zvi and Ravid 2017).

One major source of SES-related differences in schoolchildren is parental input and interaction in early childhood, with maternal education as a differentiating factor (Prevoo et al. 2014; Suizzo and Stapleton 2007). The literature shows that children from low-SES background are provided with less linguistic input, less scaffolding and fewer elaboration and commentary on their spoken production (Hart and Risley 1995; Hoff and Tian 2005). These differences are related to maternal sensitivity and cognitive stimulation, on the one hand, and to maternal speech and linguistic input to children, on the other (Hoff 2003; Hoff and Naigles 2002; Weizman and Snow 2001), with maternal engagement and parenting style mediating the relationship between SES and maternal language (Raviv, Kessenich and Morrison 2004; Song, Spier and Tamis-Lemonda 2014; Vernon-Feagans et al. 2008).

A recent study comparing the CDS of two native Hebrew-speaking mothers of toddler girls aged 1;6, one from high- and another from low-SES background, is a case in point (Ravid and Zimmerman 2017). This study found that at a time known for accelerated language development and subsequent increasing

complexity in CDS in many children and parents (Foursha-Stevenson et al. 2017; Lieven 2008; Ravid et al. 2008; Snow 1995), linguistic input to the toddler from low SES was scarcer based on all measures used. She experienced less speech input, mostly directive and non-elaborative, with a lower density and diversity of lexicon and morpho-syntax, and almost no object and activity naming. There was constant background noise accompanying the highly repetitive, sometimes incomprehensible input. Little linguistic interaction took place between mother and child, and the mother often did not follow up her daughter's interest in her surroundings.

A second study compared input from native Hebrew-speaking mothers of different SES backgrounds to two respective infants at 3, 6, 9 and 12 months of age (Peleg 2013). Across the study, there was more verbal input to the high-SES infant at all time points. The high-SES mother's speech was more variegated, and her pragmatic categories were fine-tuned to the child. In the recordings, she repeats, refers, elaborates, informs, encourages, names, and introduces new vocabulary at appropriate ages. Her speech was encouraging, and contained more nouns, more verbs, and more adjective types than in the low-SES mother. The latter talked much less, was less pragmatically tuned to the child, exhibited more vagueness, prohibited more, provided fewer opportunities for learning, and had a more restricted lexicon.

Two figures demonstrate these effects by comparing the numbers of words (tokens and types) and utterances (Figure 4), and the content word lexicon (tokens, inflected word types and lemmas of nouns, verbs and adjectives) the infants heard at 9 and 12 months by the high-SES mother and the low-SES mother respectively (Figure 5). The two findings demonstrated in these figures repeatedly echoed across this study. One, the consistent discrepancy in the number of linguistic units offered by the high-SES mother as compared to the mother from low SES in same-length recordings. And two, the fact that this number increased in the high-SES mother towards the first year of life, when children are in need of rich and variegated lexical input, whereas in the low-SES mother it actually declined. These findings join many other studies in linking the amount and quality of linguistic input addressed to children with SES background of parents in general and mothers in particular (Black, Peppé, and Gibbon 2008; Hoff 2003; Rowe 2008), with scarcer input resulting in children's slower and less effective rate of language acquisition (Ginsborg 2006; Korecky-Kröll et al. 2017). Again and again, this linkage proved to be a major stumbling block in low-SES children's linguistic and cognitive development (Rowe, Raudenbush and Goldin-Meadow 2012).

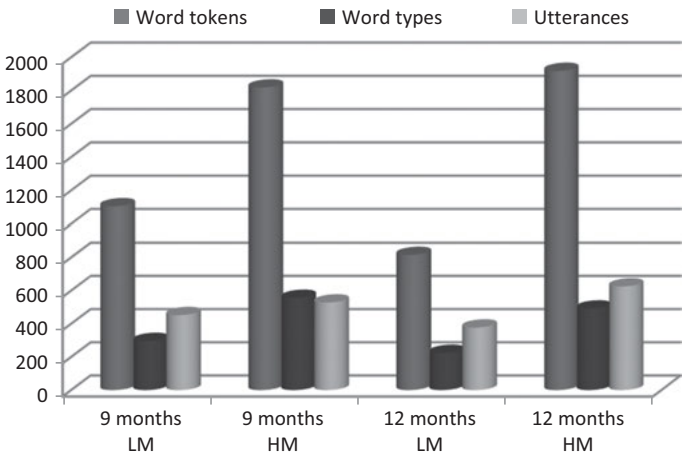

Figure 4: Numbers of word tokens, word types, and utterances in CDS by low SES and high SES mothers (respectively) to infants aged 9 and 12 months (Peleg, 2013).

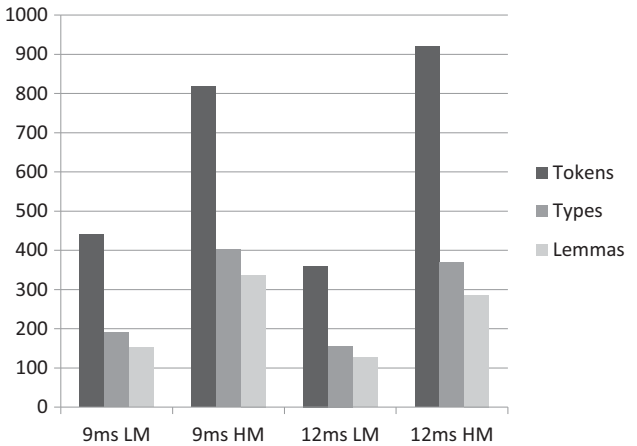

Figure 5: Numbers of content-word tokens, types, and lemmas in CDS by low-SES and high-SES mothers (respectively) to infants aged 9 and 12 months (Peleg, 2013).

2.6 Lexicon and grammar co-develop

The generative tradition views lexicon and grammar as essentially separate cognitive capacities (e.g., Clahsen and Veríssimo 2016; Pinker 1998), which would also suggest different temporal development. However, the acquisition literature

supports the view that children's grammatical development emerges in tandem with their lexical growth (Ashkenazi et al., 2019). One facet of this relationship is the close affinity between lexical frequency and the formation of grammatical generalizations (Ambridge et al. 2008; Borovsky, Elman and Fernald 2012; Matthews et al. 2005). Across languages, vocabulary size has been found to be the single most powerful predictor of children's grammatical development (Caselli et al. 2001; Devescovi et al. 2005). This makes sense, as content words fill designated syntactic positions in clauses and phrases, constitute the heads of syntactic phrases, and provide the stems for morphological inflection. The development of skills which allow children to organize words into morphological families and to form new words in word formation (derivation and compounding), and to express syntactic and pragmatic relations (inflection) are sustained and fed by the emergence and consolidation of syntactic abilities (Arnon and Clark 2011; Borovsky et al. 2016).

The inherent relationship between lexical and grammatical development is demonstrated in a study that investigated the growth of Hebrew temporal semantics, the structure of the Hebrew verb paradigm, and the emergence of communicative competence in conversation in mental verbs produced in the conversation of preschool children (Egoz-Liebstein 2010). Mental verbs, designating psychological events, states and concepts of desire, belief, and intention (e.g., *know, forget, lie, understand, plan*), occupy an important place in the construal of behavior and thus on the understanding of self and interpersonal relations (Montgomery 2002). Tables 2 and 3 and Figures 6 and 7 tell a developmental story that connects morphology, lexicon and semantics in a compelling way. From a distributional perspective, the sheer volume of mental verbs (in verb lemmas) increases across the preschool and early school years, with a prominent increase in new mental verb lemmas in the two oldest groups. An analysis of these lemmas (Table 2 and 3) indicates that the numbers of the *binyan* patterns that mental verbs take increase as children grow older; and that these verbs diversified in content and abstractness from toddlerhood to later childhood – from modal *want*

Table 2: Numbers and names of different *binyan* verb patterns of mental verb in children's Hebrew peer talk (Egoz-Liebstein 2010).

2-year olds	2;6-year olds	3-year olds	4-year olds	5-year olds	7-year olds
Qal	*Qal, Hif'il, Hitpa'el*	*Qal, Hif'il, Pi'el*	*Qal, Nif'al, Hif'il, Hitpa'el*	*Qal, Nif'al, Hif'il, Pi'el, Hitpa'el*	*Qal, Nif'al, Hif'il, Pi'el, Hitpa'el*

Table 3: New mental verb lemmas in each age group, baselined on the youngest group (Egoz-Liebstein 2010).

2-year olds	2;6-year olds	3-year olds	4-year olds	5-year olds	7-year olds
be able	think	upset	worry	choose	dream
love	be afraid	hope	remember	be chosen	investigate
want	forget	calm down,Tr	be angry	hate	feel concern
know	understand		be sure	be offended	mistake
	scare		enjoy	calm down,Int	be right
	interrupt		change	confuse	be happy
	allow		bore	give up	swear
	feel shame		believe	teach	interest
			decide	cheat	lie
			offend	terrify	plan
			get confused	invent	be willing
				agree	disgust
				feel	
				mean	
				insist	

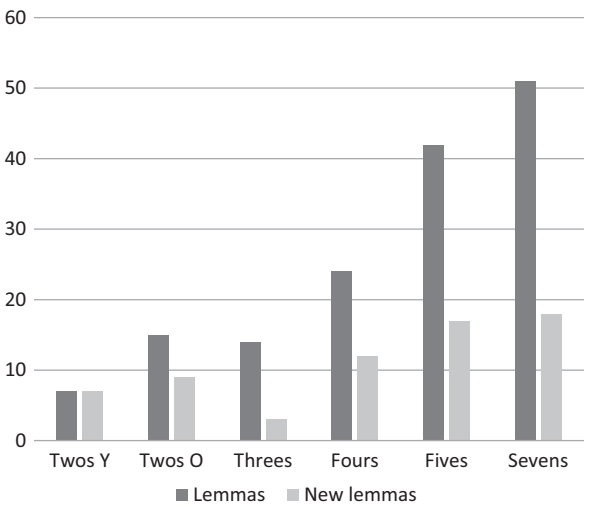

Figure 6: Increase in numbers of mental verb lemmas and new mental verb lemmas in children's peer talk (Egoz-Liebstein 2010). Children's age groups are, respectively 2;0, 2;6, 3, 4, 5 and 7.

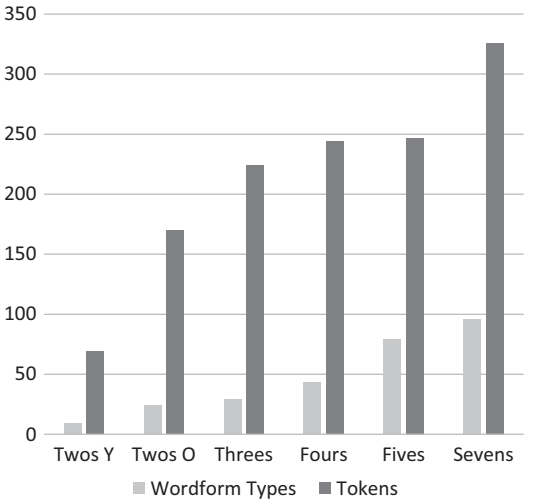

Figure 7: Increase in numbers of mental verb tokens and inflected mental verb types in children's peer talk (Egoz-Liebstein 2010). Children's age groups are, respectively 2;0, 2;6, 3, 4, 5 and 7.

and *be able*, the canonical cognitive *know* and canonical emotive *love* in the youngest age group, through basic concepts like *think* and *understand* in 2;6-year -olds, to mentalistic states and events like *worry, remember, confuse* and *mistake* and verbs involved in interpersonal "mind reading" such as *offend*, *agree* and *lie* in the older age groups. This is one basis for children's narrative abilities and hypothetical mental and interactional transactions.

Derivational morphology (Table 2) clearly supports this growth with a concurrent increase in the different *binyan* verb patterns of mental verbs, indicating the emergence of robust morphological abilities (Ravid, Ashkenazi, et al. 2016). While all mental verbs in the youngest group of toddlers were in *Qal*, the most basic and prevalent verb pattern in Modern Hebrew, 2;6- and three-year transcripts showed mental verbs in three different verb patterns, increasing to four in four-year-olds, and finally all five non-passive *binyan* verb patterns in the two oldest groups. Thus, both lexical frequency (in terms of verb lemmas and new lemmas) and lexical diversity (in terms of number of *binyan* verb patterns) increased in mental verbs in childhood.

Inflectional morphology (tense and mood, number, gender and person agreement) consolidated across the same period, especially towards school age, with a parallel growth of lexical and grammatical morphology supporting discursive abilities. In toddlers, the extremely limited expression of mental verbs also focused on

self in present tense, with no person inflections. The sheer volume of mental talk in tokens leaped in three-year-olds, with the emergence of person inflections and reference to past mental actions/states coming at the same time. The growing command of inflectional verb morphology and temporality promoted less concrete and immediate conversational foci in children by asking questions, addressing interlocutors with inquiries regarding others' mental states and processes, and narrative talk. The growth of this mental lexicon in verb lemmas in four- and five-year-olds was accompanied by diversifying inflections, underscoring the consolidation of verb paradigm and verb temporality, which support maintenance of conversation topic. Finally, second-grade seven-year-olds showed a great increase in word form types with all person, number and gender inflections, evenly distributed across tense and mood categories, with many large same-verb inflection clusters, accompanying the emergence of 'mental state reasoning' in children's conversations.

2.7 Lexical learning is paced by word class

The last point in our presentation of lexical and morphological development is that the semantics, syntax, and morpho-phonology of different word classes affect their accessibility to children as well as the rate of their uptake. Thus, for example, adjectives are the smallest (often absent) and most diverse lexical category in many languages (Dixon and Aikhenvald 2006; Schachter and Shopen 2007). As relational terms, adjectives show up later on in child speech than nouns and verbs (Salerni et al. 2007), and they constitute a low-frequency class compared to other content words in children's early lexicons (Tribushinina et al. 2015; Sandhofer, Smith, and Luo 2000). A full array of adjectival categories is far from present even in six-year-olds (Blackwell 2005; Blodgett and Cooper 1988), suggesting it coincides with the consolidation of a literate lexicon and its cognitive correlates (Dockrell and Messer 2004; Ravid, Bar-On et al. 2016). The size and makeup of the adjective category can therefore be taken as a yardstick for language development and proficiency across development (Ravid and Levie 2010).

Data from an unpublished doctoral dissertation (Herzberg 2010) on the lexical development of three typically-developing native Hebrew-speaking children from mid-high-SES background provide an illustration of the development of word classes across the second and third year of life. Herzberg (2010) examined the changing distributions of three classes of word tokens in the early lexicon – communicative/social words (including childish inventions and unintelligible communications), content words and function words. These distributions were examined longitudinally from two perspectives – based on children's chronological

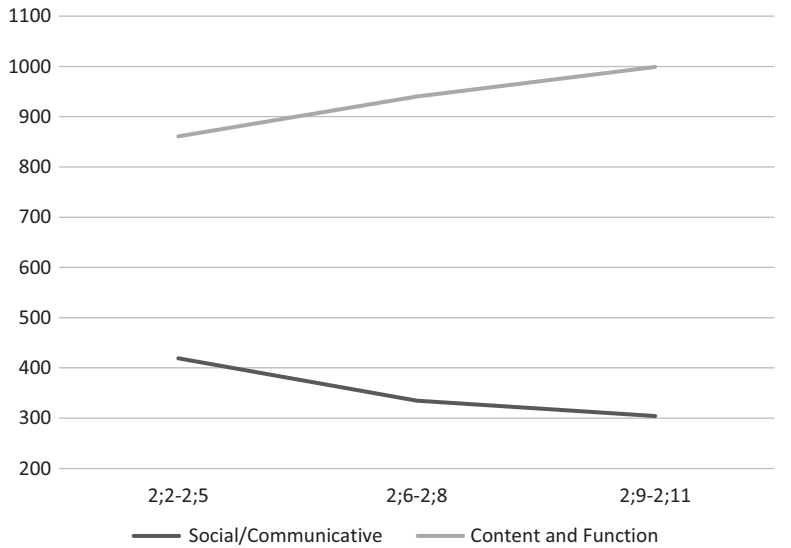

Figure 8: Median tokens of social/communicative and referential (content/function) words in three typically-developing Hebrew-speaking children, by chronological age (Herzberg, 2010).

age and on their MLU. Figure 8 shows the increase in the median tokens of referential (content/function words) versus the decline in social/communicative words across three time points in the third year of life. Figure 9 shows the same findings in medians across two MLU data points – at point 1, with speech samples ranging from 1–2 words per utterance, and at point 2 (MLU 2–3 words per utterance). Clearly, when children's speech became more syntactically organized towards age 3, their lexicons started to resemble those of older children, adolescents and adults in having mainly content and function words, the building blocks of syntactic units and the expressors of referential and relational meanings.

The analyses of the token distributions of the three major content word categories in Hebrew – nouns, verb, and adjectives – illustrate the impact of lexical class in terms of children's ages and their MLU. Figures 10 and 11 show that from both perspectives, the number of nouns declined, while the number of verbs increased. Adjectives, as well-known from the literature, were the smallest class in the lexicon, but it too increased with age and with the advent of syntactic constructions. Thus, when assessing the linguistic development of children, one cannot ignore the importance of different word classes.

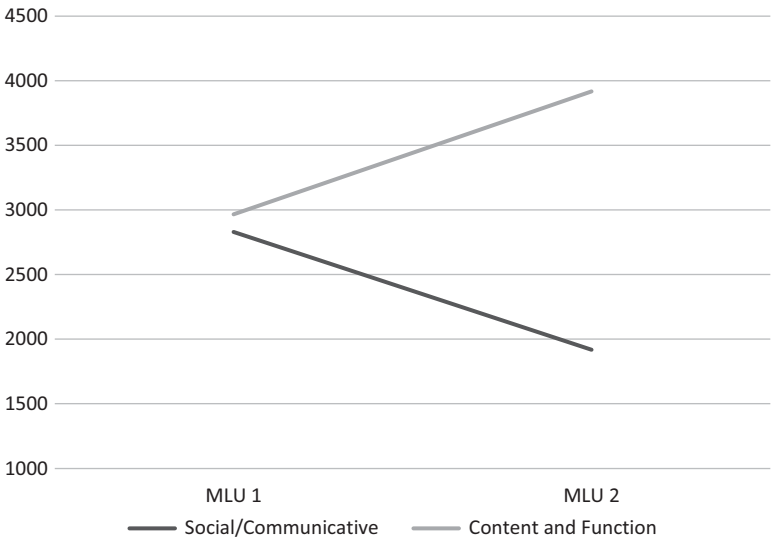

Figure 9: Median tokens of social / communicative and referential (content / function) words in three typically-developing Hebrew-speaking children, by MLU periods (Herzberg, 2010).

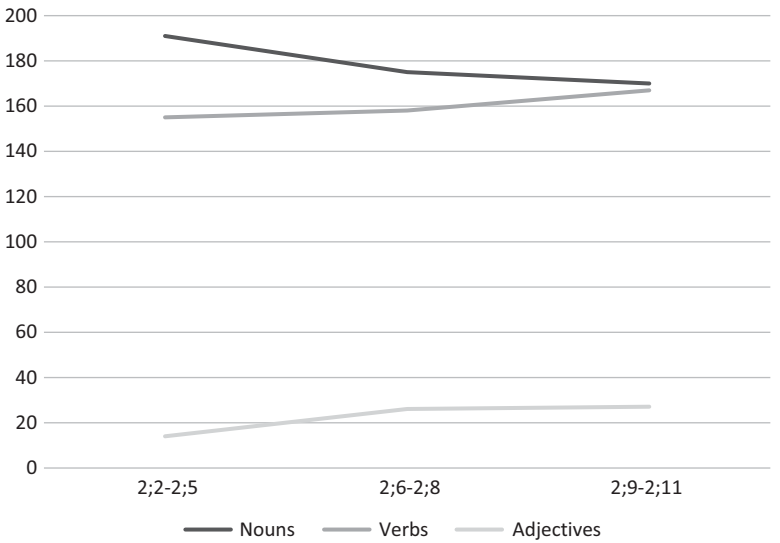

Figure 10: Median tokens of nouns, verbs and adjectives in three typically-developing Hebrew-speaking children, by chronological age (Herzberg, 2010).

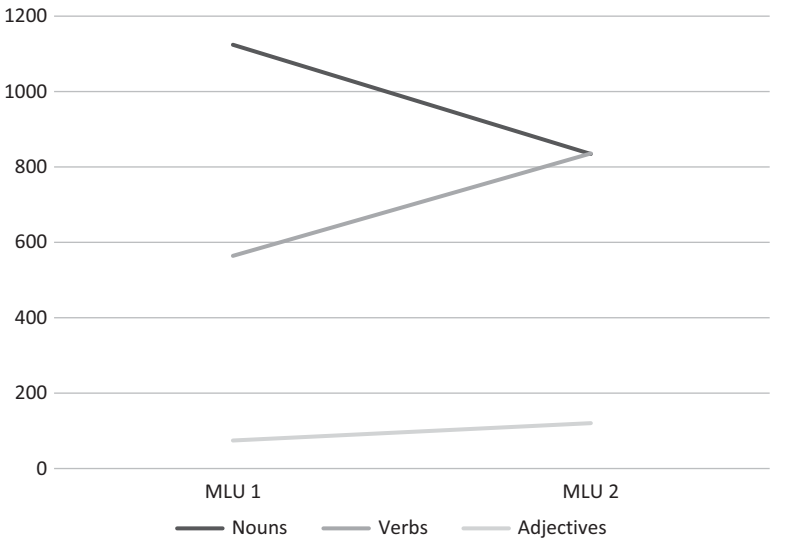

Figure 11: Median tokens of nouns, verbs and adjectives in three typically-developing Hebrew-speaking children, by MLU periods (Herzberg, 2010).

3 Conclusion

This chapter aimed at providing a broad perspective on morpho-lexical development during children's first three years of life. The chapter started by pointing out that linguistic terminology only provides descriptive conventions for structuring certain aspects of this development, but that the development process itself should not be understood simply as acquisition of linguistic structure. Instead, we formulated our examination of morpho-lexical development as a linguistic vantage point on a complex and dynamical development process.

Regarding the development process as central inevitably leads to understanding acquisition of morphology and lexicon in terms of dynamical learning systems that are data-driven, non-monotonic, and capable of operating in noisy environments. It further implies that the acquisition of morphology and lexicon cannot be isolated from learning in general. Instead, it is inseparable from the learning of concepts, categories, and relations. This interdependence is also reflected in the evidence that shows that lexical learning is paced by word class: adjectives are learned later than nouns and verbs and command of function words comes much later than their individual frequency would predict.

Although the semantic-pragmatic contents of children's lexicons are similar across languages and cultures, morpho-lexical development in typologically

different languages offers us insight on the relation between information and acquisition. Specifically, morphology is learned early on in environments where crucial information is expressed through morphology. For instance, Arabic and Hebrew speaking children acquire the ability to understand and use complicated root patterns early on. On the other hand, children struggle with the acquisition of morphological relics that carry little information, such as the irregular past tense and plural in English.

The pervasive role of information in lexical development is further addressed by the perspective that word learning is essentially context learning. Empirical evidence shows that children must frequently experience words in their context before they are acquired. Both information theory and discriminative learning are approaches that can address contextual learning. In the same vein, distributional semantics models (e.g., Landauer and Dumais 1997; Lund and Burgess 1996; Mikolov et al. 2013) address the way in which lexical representations can be built from context.

The context in which children learn also includes the social environment. Specifically, parents have an important impact on the development process, leading to high correlations between the contents and structure of child-speech and the corresponding parental child-directed speech. But parents are not only a source of input; they also actively mediate in children's morpho-lexical development, facilitating learning through feedback and through modulation of their own language.

Parents' profound impact on children's morpho-lexical development process is further substantiated by studies that examine the influence of parental SES. Parents' linguistic proficiency is linked with their SES and this transfers to their children, leading to lags of up to two years in morpho-lexical development in children with a low-SES background compared to children with a high-SES background.

Studying the development of lexicon and morphology involves taking a linguistic perspective on children's general development process. Complex and dynamical learning systems that are able to capture the amount and variety of information children are exposed to can be useful in understanding linguistic development within the general development process. While existing frameworks such as information theory and discriminative learning offer us ways to model certain aspects of dynamical learning processes, they are also limited if they address children's environment as a monolithic source of information. The enormous influence of parental input and SES on the morpho-lexical development process means that, going forward, it will be very important to understand and model children's larger environment as a dynamical system, composed of many different actors and information sources.

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