Part 3:
Sonority and Language Acquisition

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The Sonority Dispersion Principle in the acquisition of Hebrew word final codas

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Abstract. Studies on language acquisition have shown that phonological development proceeds gradually from the less to the more marked structures. This tendency is addressed here with reference to the Sonority Dispersion Principle (SDP), which predicts that in coda position, sonorants will be acquired first. This prediction is not borne out when it comes to production data, which show that in various languages, including Hebrew, obstruent codas are produced before sonorant codas. Since Hebrew has more word final obstruents than sonorants, it is possible that the children attend to the language's relative frequency in their productions. However, the data from attempted targets presented in this paper reveal a higher relative rate of attempted sonorant codas than obstruent codas. Moreover, there was found to be a negative correlation between attempted targets and productions with reference to developmental pace: The slower the developmental pace the more obstruent codas in productions and sonorant codas in attempted targets. The study proposes a U-shaped development of word final codas, whereby the early dominance of obstruent codas (due to general markedness) is followed by a mild slope characterized by the dominance of sonorant codas (in accordance with the SDP), and then back to obstruent codas (as in the target language). The early production of obstruent codas is attributed to cumulative complexity, a combined effect of marked prosodic (codas) and segmental (sonorants) elements.

1. Introduction

The notion of sonority gained extensive attention in the phonetic and phonological literature, though its definition remains controversial (see Parker 2002 for a review of the various definitions). I follow here Laver's (1994) definition of sonority as "the inherent loudness of individual segment-types" (p. 156), which also emphasizes Ladefoged's (1975) assertion that this is "relative to other sounds with the same length, stress and pitch" (p. 219). Loudness is the perceptual property of intensity, which is a physical concept (Laver 1994). Acoustically, the greater the sonority (loudness) the higher the perceptual accessibility. Physically, the greater the sonority (intensity), the higher the effort. That is, sonorants are relatively easy to perceive but require more invested energy. Parker's (2002, 2008) recent studies provide experimental support to these phonetic properties of sonority (see also a review in Parker 2011); out of the five properties examined in the study (intensity, peak P_o, F1 frequency, total air flow, and segmental duration), intensity (or loudness) was found to have “the strongest correlation with the typical sonority hierarchy” (Parker 2008:106).

This negative correlation between the acoustic and physical properties of sonorants is at the heart of the present paper, where acoustic properties are relevant to perception and physical properties to production. The paper studies the acquisition of word final coda consonants in Hebrew, attending to the distinction between perception and articulation, which correlates with the distinction between attempted targets and produced forms respectively. This distinction facilitates the identification of the role of the universal Sonority Dispersion Principle (1).

The order in which children acquire phonological structure often correlates with markedness, such that the less marked structure is acquired before the corresponding more marked one. This proposal, attributed to Jakobson (1941), has been supported by various studies on language acquisition. For example, CV syllables are acquired before CVC syllables (Demuth and Fee 1995; Gnanadesikan 2004; Levelt, Schiller and Levelt 1999/2000 among many others) and the trochaic foot is acquired before the iambic foot, not only in trochaic languages like English (Allen and Hawkins 1978), but also in iambic ones like Hebrew where stress is predominantly final (Adam and Bat-El 2009). The order of acquisition also correlates with perceptual prominence and/or articulatory effort and complexity, though these factors may compete.

With reference to sonority, Clements (1990) proposed the Sonority Dispersion Principle, which associates degrees of sonority with sub-syllabic constituents (I ignore here Clements’ reference to demisyllables).

(1) Sonority Dispersion Principle (SDP)
Sonority is maximally dispersed between onset and nucleus and minimally dispersed between nucleus and coda.

The following sonority scale is assumed in Clements (1990), though some languages provide evidence for more detailed scales (Hankamer and Aissen 1974 among others). The relevant level of detail I assume is within the obstruent class, where fricatives are more sonorous than stops. This assumption gains a weak support in Hebrew phonology (see Hebrew complex onsets in section 2), but is required to account for the children’s data presented here. It is possible that children start with the most detailed scale and later on merge contrasts that are not supported by the ambient language.

(2) Sonority scale
Vowels > Glides > Liquids > Nasals > Obstruents (Fricatives > Stops)
← more sonorous (less sonorous →)

The SDP reflects the preference of languages for obstruents in onset position and sonorants in coda position. That is, a language that has obstruent codas necessarily also has sonorant codas, but not vice versa. However, the relative frequency of sonorant codas in languages that have both obstruent and sonorant codas, is not necessarily higher than that of obstruent codas. This is the case in Hebrew (see (3) below).

Parker (2011) addresses some theoretical problems with the SDP, in particular with reference to complex onsets (see Greenberg 1978 for typology). In particular, maximization of the sonority distance between C_1 and C_2 in a C_1C_2V syllable results in minimization of the distance between C_2 and V. Parker considers the option that the SDP refers only to C_1 obstruents, but dismisses it given its role in enhancing the sonority distance between the consonant and the vowel in CV syllables. Parker thus emphasizes that in onset position, sonority should be also evenly dispersed between C_1 & C_2 and C_2 & V, thus giving priority to obstruent-liquid complex onsets over obstruent-glide.

Sonority dispersion has various perceptual functions. It enhances the accessibility of the onset, which is most significant for word recognition, in particular in word initial position (Goodglass et al. 1997 among others). It also enhances the accessibility of syllable boundaries (the Syllable Contact Law; Murray and Vennemann 1983), as it maximizes the sonority distance between a coda and a following onset (see also Seo 2003b, 2011). Coda-onset contrast, with the help of other properties (e.g. stress), also facilitates word segmentation. In addition, sonorants in coda position expand the carrier of prosodic properties, such as stress, intonation, and tone (Clements 2009).

Studies on language development support the SDP with regard to onset position. Children produce more frequently obstruent onsets than sonorant onsets, whether they acquire Dutch (Fikkert 1994), English (Gnanadesikan 1996, Pater 1997), European Portuguese (Freitas 1996), Hebrew (Ben-David 2001) or Greek (Kappa 2002). Also during the babbling period, children produce stops in CV syllables (Vihman 1992). However, the prediction of the SDP with regard to onsets converges with the predictions of markedness regardless of syllabic position, since obstruents are universally less marked than sonorants.

It is thus the acquisition of codas that can tease apart position-specific SDP (sonorants > obstruents) from general segmental markedness (obstruents > sonorants). The results of most studies on the acquisition of codas do not support the SDP. The first segments appearing in word final codas are obstruents; either fricatives, as in Dutch (Fikkert 1994), Hebrew (Ben-David 2001), and Greek (Kappa 2002), or stops, as in Catalan (Prieto and Bosch-Baliarad 2006) and English (Salidis and Johnson 1997; Kehoe and Stoel-Gammon 2001). Moreover, in all these languages, liquids are the last to appear in coda position, again, in sharp contrast with the SDP. Goad and Brannen (2003) argue that the fact that the word final and word initial consonants have the same properties in early acquisition suggests that word final consonants are syllabified as onsets rather than codas. However, in Greek, as reported in Kappa (2002), word final *s* (the first consonant acquired in coda position) is produced faithfully (*márkos* 'proper name Nom.' → *mákos*) at the stage where word initial *s* is still produced as a stop (*síko* → *cíko* 'get up 2nd Imp.'). Kappa suggests that this may be due to the role of *s* as a suffix, and thus to the effect of morphology on phonological development, as in European Portuguese (Freitas, Miguel and Hub Faria 2001). Nevertheless, this case shows that early codas are not always identical to the onsets.

Given the SDP violation in the acquisition of codas, Zamuner (2003) and Zamuner, Gerkenb and Hammond (2005) argue against the role of universal principles in acquisition, attributing the high relative frequency of obstruent codas in the speech of English-acquiring children to language-specific frequency. However, Stites, Demuth and Kirk (2004) report on two English-acquiring children, one of whom acquired nasal codas before obstruents, complying with the SDP, while the other acquired obstruents before nasals, following the language's frequency (liquids were excluded from the study).

The present study on the acquisition of Hebrew codas also reveals inter-child variation. However, the variation is attributed to differences in developmental pace rather than to child-specific preference. It is argued that the faster the development the less evidence exists for the SDP (and in general, for any other universal principle that the ambient language does not support). Evidence for the development of word final codas is thus based here on the comparison among the children.

The data are drawn from a longitudinal study of three Hebrew-acquiring children, who differed in their developmental pace, as evident by the correlation between the size of their lexicon and their age. This difference enables the distinction among stages in the development of codas, where the slowest developing child provides evidence for the very initial stage, which supports the SDP. In addition, the present study examines not only the children's productions, but also their attempted targets. The latter type of data provides evidence for the role of the SDP in perception, since sonorant codas have, in general, a high frequency in attempted targets, relative to their frequency in the target language.

2. Universal principles vs. language-specific frequency

Recent studies on language acquisition have investigated the effect of lexical frequency in language acquisition and whether it overrides the effect of universal principles (see a review in Demuth 2007). I follow Demuth's (2007) claim that frequency is "only one of the factors that can influence when and how learners demonstrate knowledge of grammar" (p. 386). Moreover, I maintain that universal principles do play a role in early stages of acquisition, but their effect gradually fades in favor of frequency when the ambient language does not support them (Rose 2000, Adam and Bat-El 2009). This view paves the way to variation on several levels.

Inter-child variation within a language may arise due to developmental pace, whereby the effect of a universal principle is hardly visible in a fast learner, but evident in a slow one. For example, the sonority-based universal hierarchy *PEAK[high] ≫ *PEAK[low] (Prince and Smolensky 1993/2004), which implies that low vowels are better nuclei than high vowels, is supported by data from a slow learner but not from a typical learner (Adam and Bat-El 2008). In the present study, the effect of the SDP is visible in the attempted targets of the slow learner but not of the typical learner.

Intra-child variation may exist between attempted targets and productions. A universal principle grounded in perception, but not in articulation, may be visible in attempted targets but not in productions. In the present study, the effect of the SDP is found in attempted targets but not in productions.

Another type of variation may arise among languages. A high relative frequency of a particular structure in one language may overcast the role of the relevant universal principle, which is evident in another language, where the frequency of the structure is not as high. This variation is found in the acquisition of stress in French vs. Hebrew. In both languages, final stress is dominant, though to different degrees; in French, all words bear final stress while in Hebrew, most, but not all words bear final stress. Indeed, French-acquiring children do not show evidence for the universal preference for trochees, i.e. penultimate stress (Rose 2000), while Hebrew-acquiring children show the effect of the universal trochee, but only during early stages of acquisition (Adam and Bat-El 2009). Similarly, children acquiring languages with a high frequency of codas, such as English (Bernhardt and Stemberger 1998), German (Grijzenhout and Joppen 1998), and Hebrew (Ben-David 2001), produce codas relatively early, thus showing little effect of the constraint prohibiting codas (Prince and Smolensky 1993/2004). And children acquiring languages with a low frequency of codas, such as Spanish (Lleó 2003) and Japanese (Ota 2003), start producing codas relatively late.

In order to consider the role of frequency in the acquisition of word final codas, the distribution of Hebrew word final codas is provided below. The codas are classified into two major classes – obstruents vs. sonorants, where each major class is further divided into sonority-based subclasses. The frequency is drawn from Bolozky and Becker's (2006) dictionary, based on 7,124 nouns with word final codas, which constitute 70% of the entire noun list. Since the period under study here (see section 3 below) includes very few target verbs, the limitation to nouns is reasonable.

(3) Frequency of Hebrew word final codas (in nouns)

Obstruents – 60%		Sonorants – 40%	
Stops – 39%	Fricatives – 21%	Nasals – 21%	Approximants – 19%
t, d, ts͡, k, g	*f, v, s, z, ʃ, x*	*m, n*	*l, r, j*

Word final codas are not evenly divided between obstruents and sonorants; obstruents account for 60% of the 7,124 codas, which is significantly more than 50% (single sample chi-square test, $\chi^2(1) = 143$, $p < .0001$).

Approximants include the liquids and the glide /j/, where the glide constitutes only 2% of the word final codas.[1] The glide /w/ is not part of the Hebrew inventory (with the exception of a few loans such as *kíwi* 'kiwi' and *wíski* 'whisky', as well as some interjections like *waw* and *wala*). However, as shown in section 4.3 below, /w/ is sometimes used by children for substituting /r/ and /v/ in coda position.[2] Labial stops do not appear in word final position (again, with the exception of a few loans) due to post-vocalic spirantization, whereby /p/ and /b/ surface as [f] and [v] respectively (Adam 2002). It should be noted that 72% (2,112/2,921) of the coda stops in (3) are /t/, 81% (1,706/2,112) of which serve as the feminine singular marker. Nevertheless, the feminine /t/ is not excluded from the counting, because in most cases, the base of the feminine suffix is not an independent word (e.g. *ts͡aláxat* 'plate' **ts͡alax*), and it is thus unlikely that at this early stage the children identify the complex morphological structure of such words.[3]

Although the relative distribution of final codas in (3) does not support the SDP, Hebrew provides phonological validity to the notion of sonority. Most notable are Hebrew complex onsets, where their distribution and alternation

1. I assume that the glide resides in coda position because Hebrew does not allow tautosyllabic VV sequences.
2. Hebrew /r/ (phonetically [ʁ]) is a uvular approximant with certain frication (Bolozky and Kreitman 2007), and is lower in sonority than /l/.
3. Note that Hebrew has two feminine markers, /-Vt/ and /-a/. The latter is the first to appear productively in the children's speech.

reflect the effect of the Sonority Sequencing Principle (SSP): "Between any member of a syllable and the syllable peak, a sonority rise or plateau must occur" (Blevins 1995:210). Note that Hebrew complex onsets allow plateau (e.g. *gdola* 'big fm.sg.')[4], and thus this definition is the most appropriate one.

Hebrew nouns and adjectives exhibit a morpho-phonological vowel alternation in an initial stem open syllable. If the first consonant in the stem is an obstruent, the stem vowel is deleted (e.g. /k**a**tan-a/ → *ktana* 'small fm.sg.'). If, however, the first consonant in the stem is a sonorant, the stem vowel surfaces as /e/ (e.g. /l**a**van-a/ → *l**e**vana* (**lvana*) 'white fm.sg.').[5] The output of this process complies with the distributional restrictions on Hebrew complex onsets, which follow the SSP: obstruent-sonorant and obstruent-obstruent sequences are allowed, but sonorant-obstruent sequences are not. Within the class of obstruents, stop-fricative and stop-stop onset clusters are common (e.g. *tfila* 'prayer', *tkufa* 'period'), but fricative-stop onset clusters are limited, as in many other languages, to sibilant-stop sequences (e.g. *skira* 'overview', *ʃtixim* 'carpets'), with the exception of truncated imperatives (e.g. *ftax* 'open!'). Due to historical reasons, the labial fricatives are rare in word initial position and the velar /x/ does not appear as the first member in complex onsets. Another distinction between obstruents and sonorants in Hebrew is that plateau is common in complex onsets consisting of obstruents (e.g. *ptakim* 'notes') but rare in complex onsets consisting of sonorants. There is a general tendency to avoid complex onsets consisting of sonorants only, regardless of sonority, though there are a few examples of /m/-sonorant clusters, all complying with the SSP, i.e. with sonority rise (e.g. *mlaj* 'stock') and plateau (e.g. *mnaja* 'share/stock').

Further support for the notion of sonority is provided with reference to the Syllable Contact Law (SCL), which requires a maximal sonority fall from the coda to the following onset (see section 1). The role of the SCL emerges in Hebrew blends (Bat-El 1996), where it often determines the order of the base words. For example, the words *moʃav* 'cooperative settlement' and *kibuts* 'collective settlement' serve as a base for the blend *moʃbuts* 'a cooperative and collective settlement', rather than **kibʃav*, since the coda-onset cluster /ʃb/ fares better with respect to the SCL than /bʃ/. Note that there is no independent principle determining the order of the base words, since both words have the same semantic status and thus neither of them serves as a head (as in exocentric compounds, like English *smog* 'a mixture of *smoke* and *fog*').

4. Stress is final unless otherwise specified.
5. This process is limited to a lexically specified class (Bat-El 2008). Other stems preserve their vowel regardless of the quality of the first consonant (e.g. *gamada* 'dwarf fm.sg.').

While the notion of sonority is relevant for Hebrew phonology, the distribution of word final codas, given in (3) above, does not comply with the SDP in the major classes, as obstruents (60%) are more frequent than sonorants (40%). The same holds within the sub-classes, where the less sonorant consonants are more frequent codas than the more sonorant ones; stops (39%) more than fricatives (21%), and nasals (21%) more than approximants (19%). Since the distribution of word final codas in Hebrew does not conform to the SDP, the distinction between the effect of the SDP and frequency can be teased apart.

3. Research method

3.1. The children

Three Hebrew-acquiring children participated in the study, all from upper-middle class families in the center of Israel. Two were typically developing children, SR (a boy) and RM (a girl), and one was an atypically developing child, YV (a boy), diagnosed with mild Pervasive Developmental Disorders (PDD).[6] YV did not temper the data; on the contrary. Studies of his development of complex onsets (Karni 2011), word medial codas (Gishri 2009), and monosyllabic productions (Adam and Bat-El 2008) reveal an extremely slow development, where every stage lasts for a rather long time, thus providing an extensive amount of data. The study of the development of complex onsets can illustrate this point. Ben-David (2001) argues for an initial stage of onset development, in which children produce word initial onsetless syllables (in polysyllabic words) for targets with simple and complex onsets. This stage is rather short when it comes to targets with complex onsets, since children often refrain from complex structures by not attempting to produce words containing them, i.e. children are selective learners (Ferguson and Farwell 1975; Schwartz 1988; Becker 2007). Children's early attempts at producing targets with complex onsets, typically result in cluster simplification, rarely in deletion of the entire cluster. Indeed, Karni (2011) found that only 1% of SR's and 5.8% of RM's targets with initial complex onsets were produced without an onset, compared to 19.3% of YV's. That is, YV's slow development provides better support for stages that are rather brief in typically developing children. Indeed, as will be shown in the present study, while the data from all three children provide nu-

6. According to DSM-IV-TR (2000), "Pervasive Developmental Disorders are characterized by severe and pervasive impairment in several areas of development: reciprocal social interaction skills, communication skills, or the presence of stereotyped behavior, interests, and activities" (p. 69).

merical trends in the distinction between obstruent and sonorant codas, only YV's data reveals statistical significance.

3.2. Data collection

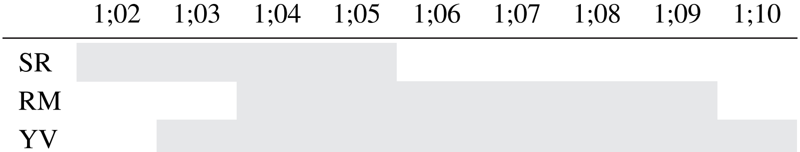
The data were drawn from natural speech and picture/object naming. All children were exposed to a similar set of objects and the same set of pictures. The set of pictures was specially designed to correspond to words with various phonological structures: words with a varying number of syllables (from mono- to quadrisyllabic) and different stress patterns (final, penultimate, and antepenultimate), syllables with different types of onsets (empty, simple, and complex) and different types of codas (empty and simple), and various segments in different prosodic positions.

The children were recorded once a week in their natural environment, and their productions were transcribed off-line by trained phoneticians (graduate linguistics students specialized in phonetics and phonology). The recording sessions started during the babbling period, in order to detect the emergence of the very first word (see Adam and Bat-El 2009 for the criteria used for identifying the first word). Of course, as the children grew, they attempted more words, but quite a few pictures and objects received no response, particularly during the early sessions.

3.3. Comparison tools

The three children differed in their developmental pace, measured by their production lexicon, i.e. the number of attempted target types (the lexicon records the age of the first attempt of a new word). SR, the fastest developing child, acquired a lexicon of about 150 words in less than 4 months (1;02.00–1;05.21). YV, the atypically developing child, and thus the slowest one, acquired a lexicon of about 150 words in 8 months (1;02.29–1;10.30). RM was between the two boys, acquiring a lexicon of about 150 words in almost 6 months (1;03.27–1;09.18). Notice, in particular, that YV lags behind SR in about a month for the first word but in five months for 150 words.

(4) Developmental pace: 150 attempted target types (production lexicon)



The lexicon-based scale was adopted as a comparison tool, relying on the relation between lexical and phonological development in early stages of acquisition (Stoel-Gammon 2011). The lexical scale is more suitable to the present study than the age scale because YV is a slow developer. The identical size of the production lexicon is used as a methodological tool for cross-subject comparison.

The lexicon-based pace differences (SR > RM > YV) correlate with differences in the development of other properties. Adam and Bat-El (2008) show that the rate of the first acquired vowel *a* in YV's attempted targets and productions was much higher than in SR's. The same was true for truncated monosyllabic productions, which sustained in YV's speech for a rather long time (almost a year), but disappeared relatively fast in SR's speech (his first ten words already included disyllabic productions). Another indication for pace differences is provided in Bat-El's (2010) study of the effect of coda development on the acquisition of verb inflectional suffixes. RM's coda development was slower than SR's, and she thus produced the vowel-final 1st person suffix /-ti/ before the consonant-final plural suffix /-im/. SR, like the Hebrew-acquiring children studied in Armon-Lotem (2006), acquired these suffixes in the opposite order, i.e. plural before 1st person, as predicted by morpho-syntactic theories. As shown in the current study, the same pace differences are found with respect to the development of word final codas, where sonority is taken into consideration.

Following Rose (2000) and Adam and Bat-El (2009), it is assumed that the effect of a universal principle that is not supported by the ambient language may arise during the very early stages of acquisition, before the children have accumulated sufficient data that do not support the principle. Indeed, Kirk and Demuth (2006) suggest that sonority plays a role only during the early stages of the acquisition of codas, as they found no effect of sonority on production accuracy among 2-year-old English-acquiring children. Therefore, the present study is limited to the early stages of acquisition, measured by a production lexicon of 150 cumulative attempted target words (see (4) above).

The data have been considered on two dimensions: (i) attempted targets, regardless of productions and (ii) productions, including substitutions. Many studies, like Stoel-Gammon (1985), consider (i) productions only and (ii) target-production faithfulness. The dimension studies here, i.e. the attempted targets, provides the crucial data supporting the role of the SDP in the acquisition of word final codas.

The quantitative data are based on type-per-session counting. Identical productions were counted only when produced during different sessions. The productions were considered with reference to the word final codas only, disregarding other structural properties. Multiple productions of the same target (within the same session) were counted once when the codas in the forms were identical (5a), from the same sonority class (5b), or absent all together (5c). Two productions of the same target were counted twice, when one was with a final vowel and the other with a coda (5d), or when the two codas were from different sonority classes (5e).

(5) Counting word final codas

		Target		Production		Child	Age
One count:	a.	tapúax	'apple'	ba**x**	púa**x**	SR	1;02.07
		adóm	'red'	da**m**	ató**m**	RM	1;09.18
	b.	cahóv	'yellow'	ha**v**	ho**f**	RM	1;05.29
		mazlég	'fork'	edé**t**	bedé**k**	RM	1;09.10
	c.	kadúr	'ball'	du	adu	RM	1;05.29
		meʃuláʃ	'triangle'	ʃa	ʃiʃá	YV	1;10.16
Two counts:	d.	igúl	'circle'	guu	go**k**	YV	1;08.09
		tapúax	'apple'	púxa	púa**x**	SR	1;02.24
	e.	garbáim	'socks'	abá**j**	abái**m**	RM	1;09.18
		af	'nose'	a**f**	a**p**	YV	1;10.30

Only target words with singleton codas in word-final positions were examined. Complex codas are rare in Hebrew, let alone in children's language. Word medial codas are acquired much later in Hebrew (Ben-David 2001, Gishri 2009), as is the case in languages like Dutch (Fikkert 1994), French (Rose 2000) and English (Goad and Brannen 2003; Kirk and Demuth 2006).

4. Quantitative data

This section provides the quantitative data with reference to codas in attempted targets, regardless of whether the coda was produced faithfully, deleted, or substituted (section 4.1) and productions (section 4.2); substitutions are considered as well (section 4.3), supporting the production data. The results of the attempted targets provide evidence for the role of the SDP, in particular with reference to developmental pace – the slower the pace, the higher the rate of sonorant codas. The results of the productions, as in earlier studies (see section 1), indicate a preference for obstruent codas, contrary to the SDP. However, in this case too, there is a correlation with developmental pace, though a rather surprising negative correlation – the slower the pace the higher the percentage of obstruent codas.

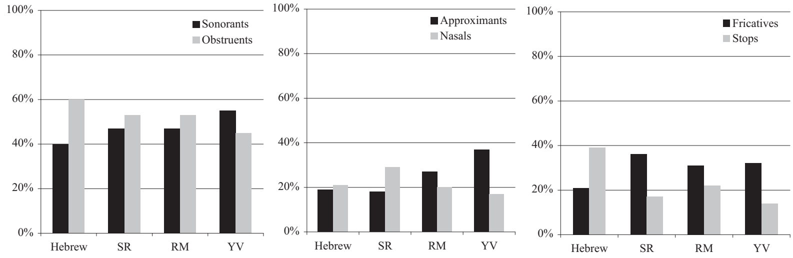
4.1. Attempted targets

The total number of attempted targets with codas was 182 for SR, 255 for RM, and 305 for YV. As a lexicon of 150 attempted target word types is constant (see section 3), the slower the development, the higher the number of sessions and thus the number of attempted targets.

The charts below provide the distribution of word final codas in the children's attempted targets, compared with the distribution in Hebrew.

(6) Attempted targets

a. Sonorants vs. Obstruents b. Approximants vs. Nasals c. Fricatives vs. Stops



All three children attempted a higher rate of sonorants than in the ambient language (6a), suggesting traces of an SDP effect. However, a comparison between the rate of attempted sonorants and obstruents reveals that the two typically developing children, SR and RM, attempted more obstruents (53%) than sonorants (47%). Only YV, the atypically developing child, still held on to the SDP, attempting more sonorants (55%) than obstruents (45%). With the expectation of the language's distribution of 40% final sonorant codas and 60% final obstruent codas, only YV's distribution was significant (two-tailed Fisher's test; $p = .0004$).

Within the sonorant class (6b), RM and YV, but not SR (the fastest developing child), had a higher rate of approximants than in Hebrew, again, suggesting traces of an SDP effect. A comparison between the rate of attempted approximants and nasals reveals that SR, the fastest developing child, attempted more nasals (29%) than approximants (18%), but the other two children still held on to the SDP, attempting more approximants than nasals; RM 27% vs. 20% and YV 37% vs. 17%. Note that the gap between approximants and nasals is greater in YV's attempted targets than in RM's, in accordance with their different pace of development (where YV is slower than RM).

Within the obstruent class (6c), all three children attempted more fricatives than stops, as expected by the SDP, and contrary to the language's relative rate;

SR 36% vs. 17%, RM 31% vs. 22%, and YV 32% vs. 14%. However, SR, the fastest developing child, unexpectedly had the highest rate of fricatives. This is probably due to his lexical favoritism towards the word *tapúax* 'apple', which was not only the first word he attempted, but also a word that appeared in all but one recording sessions (recall the type-per-session counting indicated in section 3).

In general, the children's attempted targets correlate with their pace of development, such that the slower the development, the larger the propensity for the SDP. The correlation between developmental pace (indicated on the top row from the slowest to the fastest) and the propensity for the SDP is illustrated below. For each pair in the left column, the member with the highest rate is provided (cf. (6)), and the more sonorous member is shaded.

(7) Correlation with developmental pace

	YV	<	**RM**	<	**SR**
Sonorants vs. Obstruents	Sonorants		Obstruents		Obstruents
Sonorants: Approx. vs. Nasals	Approximants		Approximants		Nasals
Obstruents: Fricatives vs. Stops	Fricatives		Fricatives		Fricatives

YV, the slowest developing child, adheres to the SDP in all three classes in (7), RM only in two, and SR, the fastest developing child, only in one.

The correlation between the developmental pace and the degree of the SDP effect suggests that the distinction between the children is not sporadic. Rather, I claim that the three children stand at different points in the developmental path of word final codas. This correlation supports the view that universal principles are active in early stages of acquisition, and gradually diminish when not supported by the ambient language.

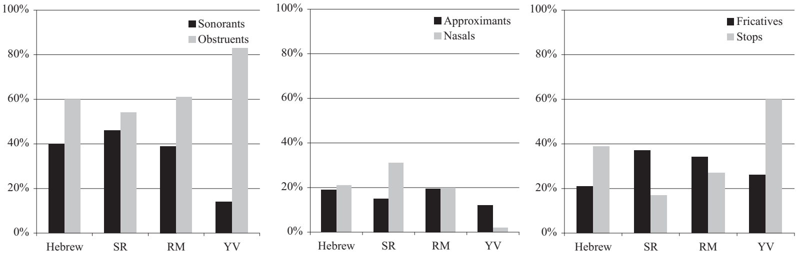
4.2. Productions

The children differed in the degree of the coda preservation, i.e. the number of target codas produced as faithful or substituted codas. The difference, again, correlates with their developmental pace – the faster the development, the higher the rate of coda preservation. SR preserved 77% (141/182) of the target word final codas, RM 64% (164/255), and YV only 14% (42/305). Vowel final productions of targets with codas were mostly due to coda deletion (e.g. *kofa* ← *koxa**v*** 'star', *kupu* ← *kumku**m*** 'kettle', *tadu* ← *kadu**r*** 'ball'). However, there were a few cases of vowel insertion (*pílu* ← *pil* 'elephant', *hóf**u*** ← *tsahóv* 'yellow'), consonant-vowel metathesis (e.g. *má**ni*** ← *máim* 'water', ***xa*** ← *péra**x*** 'flower'), and syllable deletion (e.g. *se* ← *sé**fer*** 'book', *za* ← *za**nav*** 'tail').

The following charts provide the distribution of codas in the children's productions according to the sonority classes compared with Hebrew.

(8) Productions

a. Sonorants vs. Obstruents b. Approximants vs. Nasals c. Fricatives vs. Stops



All children produced more obstruent codas than sonorant codas (8a), where the slowest developing child, YV, displayed the highest percentage of obstruents (86%) and the fastest developing child, SR, displayed the lowest percentage of obstruents (54%); RM, as usual, was in between (61%). With the expectation of the language's distribution of 40% sonorant codas and 60% obstruent codas, only YV's distribution was significant (two tailed Fisher's test; $p = .0134$)). When compared with the rate in Hebrew, YV is much above the target rate and SR is slightly below; RM's rate of obstruents and sonorants is almost identical to that in Hebrew. That is, contrary to the correlation obtained in the attempted targets, the slower the development, the smaller the effect of the SDP.

The same was found within the obstruent class (8c), where YV produced more stops (60%) than fricatives (26%), while the typically developing children produced more fricatives than stops; SR 36% vs. 17%, and RM 34% vs. 27%. Only within the sonorant class (8b) was there an SDP effect, correlating with the developmental pace, where the atypically developing child, YV, produced more approximants (10%) than nasals (2%), the fastest developing child, SR, produced more nasals (31%) than approximants (15%), and RM, again, was in between, producing an identical rate of nasals and approximants (19.5% each). It should be noted that most of YV's approximants were glides, including /w/ which is hardly found in Hebrew (see section 2). Thus, with the exception of YV's higher rate of approximants compared to nasals, the production data suggest the preference of low sonority obstruents, such that the slower the development, the greater the preference. The production data obtained in the present study add to that of earlier studies (see section 1), showing the preference of obstruent codas in early speech.

4.3. Substitutions

Some of the preserved codas were substituted across sonority classes, where the rate of substitution, as shown in (9), also corresponds to the pace of development – the slower the development, the higher the rate of substitutions. Here I also count substitutions of liquids for glides, both counted above within the approximant class due to the scarcity of glides.

(9) Targets of substitution

			SR	**RM**	**YV**
	Total substitutions		(6/141) 4%	(28/164) 17%	(21/42) 50%
a.	Sonorants:	Approximants	5	16	3
		Nasals	0	4	6
b.	Obstruents:	Fricatives	1	5	12
		Stops	0	3	0

The majority of substituted codas were liquids (approximants), but only for SR (83%) and RM (57%); YV deleted most of his liquids. For all children, stops are the most stable. This coincides with the production data (section 4.2), which suggests the preference of obstruents in coda position.

Most cases of substitution of word final codas involve replacement of a target segment with a new segment (e.g. *xor* → *xoj* 'hole'), sometimes via consonant harmony (e.g. *kos* → *kok* 'cup'). There were also rare cases of metathesis (e.g. *náal* → *an* 'shoe') and syllable truncation (*xamór* → *xam* 'donkey'), where the latter is rather unique, since the truncated syllable is stressed and final, exactly the properties that usually ensure preservation of a syllable (see Adam and Bat-El 2008 for segmental effects on syllable truncation). In the data below, identical productions (ignoring voice contrast) are presented once with the number of times in parentheses and the latest age.

(10) Substitutions

	Sonority increase				Sonority decrease			
		Target		**Production**		**Target**		**Production**
SR	1;04.03	panas	'torch'	padán	1;05.08	náal	'shoe'	an
	1;04.24	or	'light'	aw (x2)	1;05.08	pázel	'puzzle'	pázem
					1;05.08	gadol	'big'	gadid
RM	1;05.29	xipuʃit	'beetle'	pujʃ	1;05.14	xatul	'cat'	tooʃ
	1;06.12	dag	'fish'	dan	1;06.05	tov	'good'	top
	1;06.12	jad	'hand'	tjas	1;06.05	ʃaon	'clock'	eʃ
	1;08.01	xatul	'cat'	toj (x2)	1;06.19	táiʃ	'goat'	táit
	1;07.10	régel	'foot'	égej	1;06.26	tsahov	'yellow'	tʃjahuts
	1;08.07	kaxol	'blue'	xaj (x2)	1;06.26	tov	'good'	tot
	1;08.27	iparon	'pencil'	obój	1;07.03	of	'chicken'	od
	1;08.27	or	'light'	ow (x2)	1;07.10	sir	'pot'	ʃitiʃ
	1;08.27	xor	'hole'	xoj (x2)	1;07.24	makel	'stick'	ken
	1;09.10	galgal	'wheel'	gagáj	1;07.24	xatul	'cat'	tun
	1;09.18	garbáim	'socks'	abáj	1;08.27	lavan	'white'	abád
					1;08.27	kadur	'ball'	kut
					1;09.10	akol	'all'	kek
YV	1;08.09	yoav	Name	aw (x2)	1;05.01	xamor	'donkey'	xam
	1;10.02	dov	'bear'	kow	1;06.19	ʃir	'song'	dis
	1;10.09	zanav	'tail'	waw	1;08.09	igul	'circle'	gok
					1;09.04	tapúax	'apple'	bag (x5)
					1;10.30	kos	'cup'	kok
					1;10.30	kof	'monkey'	kok
					1;10.30	arnav	'rabbit'	ab
					1;10.30	katom	'orange'	kak (x6)

As shown below, SR and RM do not exhibit sonority-based substitution, as they have an almost identical number of forms with an increased sonority as with a decreased sonority. SR's productions, however, were more faithful than RM's, displaying fewer substitutions, and as noted at the top of section 4.2, also fewer instances of coda deletion. YV, however, had 81% (17/21) substitution with a sonority decrease, mostly towards stops.

(11) Substitutions by sonority decrease/increase

a. Sonority increase

	Total	**Liquid → Glide**	**Nasal → Glide**	**Fricative → Glide**	**Fricative → Nasal**	**Stop → Nasal**	**Stop → Fricative**
SR	3	2			1		
RM	15	10	2			1	2
YV	4			4			

b. Sonority decrease

Total	Liquid → Nasal	Liquid → Fricative	Liquid → Stop	Nasal → Fricative	Nasal → Stop	Fricative →Stop
SR 3	2		1			
RM 13	2	2	2	1	1	5
YV 17	1	1	1		6	8

4.4. Summary

The discussion above points out two types of factors: (i) developmental pace and (ii) distinction between attempted targets and productions. The scales of preference in (12) below highlights these two factors.

(12) Scales of preference

Sonority scale (universal):		**approx**	>	nasal	>	fricative	>	**stop**
Hebrew frequency:		**stop**	>	fricative	=	nasal	>	**approx**
SR	Attempted targets:	fricative	>	nasal	>	**approx**	>	**stop**
	Productions:	fricative	>	nasal	>	**stop**	>	**approx**
RM	Attempted targets:	fricative	>	**approx**	>	**stop**	>	nasal
	Productions:	fricative	>	**stop**	>	**approx**	=	nasal
YV	Attempted targets:	**approx**	>	fricative	>	nasal	>	**stop**
	Productions:	**stops**	>	fricative	>	**approx**	>	nasal

To highlight the contrast between attempted targets and productions, notice the relative position of stops and approximants, which stand at the opposite edges of the sonority scale (approximants > stops) and the Hebrew frequency scale (stops > approximants).

To highlight the role of the developmental pace (see boxed pairs), notice that the faster the development (SR > RM > YV), the lower the relative position of approximants in the attempted target scales and of the stops in the productions scale.

It looks as if YV's productions, i.e. those of the slowest developing child, are closer to the relative rate in the target language. However, as argued below, this is not the case; YV reflects more than the other two children the preference of the articulatory less marked consonants in production, i.e. obstruents, and the perceptually more accessible consonants in attempted targets, i.e. sonorants.

5. Competing factors

The quantitative results obtained in this study reflect a negative correlation in the degree of sonority between attempted targets and productions (section 5.1). This apparent contradiction is resolved with reference to cumulative complexity in language development (section 5.2) and the distinction between the acoustic and physical properties of sonorants (section 5.3).

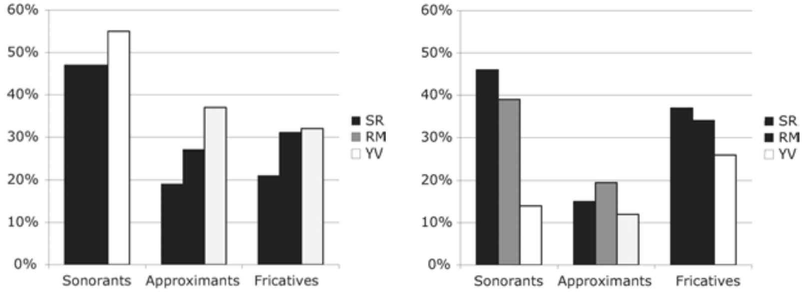
5.1. Attempted targets vs. productions

The diagrams in (13) below display a comparison among the children, with emphasis on the distinction between attempted targets and productions (regardless of whether the productions are faithful to the targets). In each diagram there are three sets of bars (parallel to the three groups in (6) above): The first (leftmost) set refers to the rate of sonorant codas (from sonorants vs. obstruents), the second to the rate of approximants (from approximants vs. nasals), and the third to the rate of fricatives (from fricatives vs. stops). That is, the rate of the more sonorous sub-class is provided.

Taking into consideration the developmental pace of the three children (SR > RM > YV), the two diagrams are almost a mirror image of each other; within each set of bars, there is a decline in the rate of the more sonorous sub-class from the slowest to the fastest developing child (right-to-left) in the attempted targets, but an incline in the productions (with the exception of the production of approximants).

(13) The rate of the more sonorous codas in each class

Attempted targets | Productions



The *slower* the development the higher the rate of the more sonorous sub-class
YV > RM > SR

The *faster* the development the higher the rate of the more sonorous sub-class
SR > RM > YV

In all three sets of bars, YV (the slowest developing child) has the highest rate of the more sonorous sub-class in attempted targets and the lowest in productions. SR (the fastest developing child) has, in general, the lowest rate of the more sonorous sub-class in attempted targets and the highest in productions. RM, as always, is in between. That is, when the pace of development is considered, the attempted targets and the productions display the same picture but in the reverse direction. The picture, however, is not perfect; deviation from the mirror image pattern appears in the distinction between SR and RM, the two typically developing children. Both had the same rate of sonorant codas in attempted targets (rather than SR's lower than RM's), and SR had a lower rate of approximant codas than RM (rather than the other way around). Statistical significance (two-tailed Fisher's test) between targets and productions appears, again, only in YV's data, between sonorants and obstruents ($p < .0001$) and fricatives and stops ($p = .0004$).

The mirror image pattern of the attempted targets and productions is puzzling. The attempted targets conform to the SDP, particularly in light of the correlation with the developmental pace. That is, the SDP plays a role in early stages of acquisition (which start prior to speech), and gradually fades if the target language does not support it. The slower the developmental pace, the greater the effect of the SDP in the attempted targets.

While the attempted targets support the role of the SDP in acquisition, it is still necessary to account for the preference for obstruent codas in productions, contrary to the SDP. This, as I argue below, is due to cumulative complexity.

5.2. Cumulative complexity in production

As shown above, the production rate of sonorants was lower than that of obstruents for all three children. Although the data were obtained from three children only, there are at least two reasons to conclude that the first codas appearing in children's productions are obstruents. First, the data were obtained from the very early stage of acquisition, starting with the first word (recording began prior to the first word). Second, the slowest developing child, YV, had the highest rate of obstruents (86%) and other studies of the phonological development of these children reveal that his developmental stages are prolonged, providing extensive amount of data for each stage, particularly in the early stages (see section 3).

As noted in section 2, children's early speech is expected to show evidence for universal principles, before they accumulate sufficient evidence for their target grammar. So why do early coda productions, in Hebrew as in other languages, not conform to the SDP?

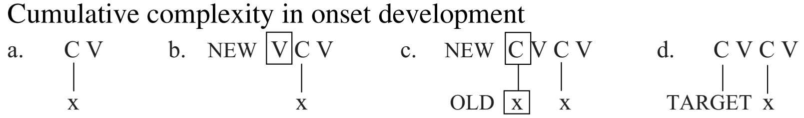
I propose that this is due to cumulative complexity, i.e. to the increase of complexity in combined structures. The term “cumulative complexity,” used in the context of syntactic development (Brown and Hanlon 1970) and discourse (Evers-Vermeul and Sanders 2009), closely relates to the terms “trade off” in Garnica and Edwards (1977) and “backgrounding” in Ferguson and Farwell (1975), used in the context of phonological development. When a new structure starts appearing in the children’s speech, the old structure may show regression. For example, when codas start emerging, an earlier produced onset may delete (Ferguson and Farwell 1975), and during the stage at which monosyllabic productions may include a coda, disyllabic productions consist of CV syllables only (Waterson 1978). For example, during the same session (1;10.28) RM produced *mái* and *báim* for the word *máim* ‘water’. In *mái*, faithfulness (Max) is violated in coda position, to satisfy *Coda, but respected in onset position, where the SDP is violated. In *báim*, faithfulness (Max and Ident) is respected in coda position, but violated in onset position (Ident), where the SDP is respected.

(14) Cumulative complexity in word development

	Faithfulness		**Markedness**	
máim ‘water’	**Coda (Max)**	**Onset (Ident)**	**Coda (*Coda)**	**Onset (SDP)**
mái	*	√	√	*
báim	√	*	*	√

In the above-mentioned combined structures the domain is the word. However, assuming a non-linear phonological representation, every segment by itself is a combined structure, consisting of a prosodic position (C-slot) and a segmental element. This is the approach adopted in Ben-David (2001) to account for word initial onsetless syllables in children’s polysyllabic productions. In the course of development of the prosodic word, for example, from mono- to disyllabic words, the nucleus is first added, thus yielding a word initial onsetless syllable (*du* → *adu* for *kadur* ‘ball’). When the onset is added to the new syllable, its segmental content is often identical to that of the following segment (*adu* → *dadu*) before it reaches its target form. That is, not only the syllable (in polysyllabic words) is developed in steps (15b–c), but also the onset (15c–d).

(15) Cumulative complexity in onset development



The same goes for coda development. At the beginning of speech, the children produce mostly codaless CV syllables, where the majority of the segments in the onset are obstruents. The absence of codas in early speech can be attributed to the perceptual weakness of coda position relative to onset position. As shown in Parker (2002, 2008), consonants in coda position (with the exception of stops) have lower relative sound level (intensity) than their counterparts in onset position.

When they start producing codas, the children have to add "two new" phonological elements: a coda position and a sonorant segment, where the latter is in accordance with the SDP. The development of the coda thus involves cumulative complexity – a combination of prosodic (coda position) and segmental (sonorant) elements.

Given the early production of obstruent codas, contrary to the SDP, I propose that children untangle this complexity by breaking the development of the coda into two steps, as in the case of onset development. To the early CV syllables with obstruent onsets (16a), they add a "new" prosodic position, i.e. the coda. This position is filled with "old" segments, those used in onset position, i.e. obstruents (16b). In the next step, they start increasing the complexity by producing sonorant codas, in accordance with the SDP (16c). The final step is the target coda (16d). The step in (16b) reflects the children's preference of obstruents.

(16) Cumulative complexity in coda development (o = obstruent, s = sonorant)

a. C V | o   b. C V [C] NEW | o [o] OLD   c. C V C | o [s] NEW   d. C V C | o TARGET

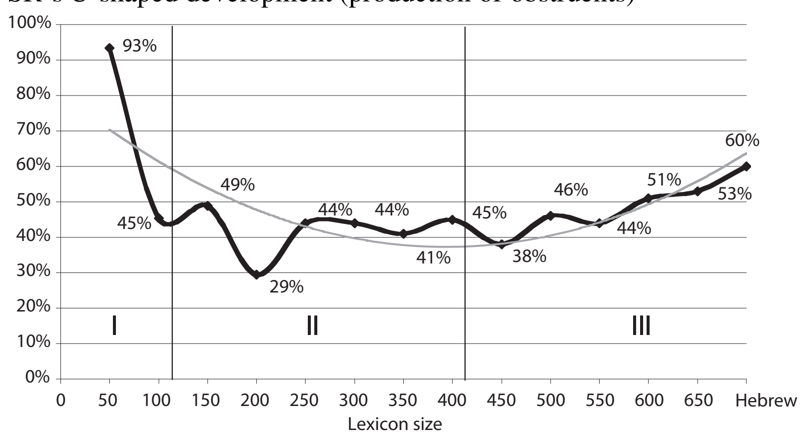
It should be noted that the rate of obstruent production in word initial onset position was high for all three children: 86% (229/267) for SR, 93% (303/326) for RM, and 86% (567/659) for YV.[7] These rates are significantly higher ($p <$ .0001) than the 67% (6154/9249) of word initial obstruents in Hebrew (based on Bolozky and Becker's 2006 dictionary). In particular, YV had the same rate of obstruents in coda and onset positions (86%), while SR and RM had a higher rate in onset than in coda (SR 86% vs. 54%, RM 93% vs. 61%) suggesting a more advanced stage.

7. This rate excludes YV's peculiar productions with NC onsets (which are probably due to hesitation), as in *mba* for *ába* 'father', *sába* 'grandfather', *bubá* 'doll', and *ribúa* 'square'; *nda* for *migdál* 'tower'; *mpa* for *pará* 'cow'; and *mpe* for *pílpel* 'pepper'). His rate of obstruent onsets including these words is 83% (567/685).

As the Hebrew-acquiring children are exposed to a language with more obstruent codas than sonorant codas, in the initial stage of coda development (16b) they are actually closer to this target than in the pre-final stage (16c), where the SPD plays a role. Nevertheless, the discussion above suggests that they do not skip the stage in which the SDP is active, though they may go through it rather rapidly. Following the proposal in (16), we expect to find a U-shaped development in coda position, but with a moderate slope: First, a majority of obstruent codas (16b) emerge, as these are the unmarked consonants, then, a majority of sonorant codas (16c), as predicted by the SDP, and, finally, back to a majority of obstruent codas (16d), reaching the target codas.

The graph below displays SR's U-shaped development up to the age of 2:00, where his lexicon consisted of about 650 words. This period is divided into three stages (marked with lines), with a significant difference in the rate of obstruents (two-tailed Fisher's test) between stages I and II ($p = 0.0008$) and between stages II and III ($p = 0.0076$). There was no significant difference between stages I and III ($p = 0.0894$).

(17) SR's U-shaped development (production of obstruents)



The U-shape expresses the development of the children's productions from a majority of obstruents to a majority of sonorants and then again to a majority of obstruents (as in the target language). That is, the slope in the production of obstruent codas, and thus the rise in the production of sonorant codas, indicates the effect of the SDP.

Within the classical model of Optimality Theory (Prince and Smolensky 1993/2004), the U-shaped development is accounted for with constraint reranking. Two universally ranked pairs of markedness constraints are relevant here (ignoring the general *CODA constraint for (16a)), which prohibits codas altogether):

(18) Relevant markedness constraints

a. General markedness: *SON ≫ *OBST
b. The SDP: $*\text{CODA}^{\text{OBST}} \gg *\text{CODA}^{\text{SON}}$

The ranking in (18a) expresses the markedness relations between obstruents and sonorants within the consonants class, i.e. that sonorant consonants are more marked than obstruents, regardless of their position in the syllable.[8] The ranking in (18b) expresses the SDP, whereby obstruent codas are more marked than sonorant codas. These two rankings are in conflict. Note that there is no conflict in onset position, where the position-specific ranking $*\text{ONSET}^{\text{SON}} \gg *\text{ONSET}^{\text{OBST}}$ is in line with the general markedness ranking *SON ≫ *OBST. Therefore, as noted earlier, the development of codas, but not of onsets, can provide evidence for the role of the SDP in acquisition.

During the initial stage, the general markedness constraints are dominant, thus allowing mostly obstruent codas. At a later stage, the SDP takes over, and sonorants are thus the preferred codas. The development from Stage I and Stage II is, of course, gradual, where during the intermediate stage there is inter- and intra-word variation.

(19) Development of coda production

a. Stage I (15b) – obstruent codas: $*\text{SON} \gg *\text{OBST} \gg *\text{CODA}^{\text{OBST}} \gg *\text{CODA}^{\text{SON}}$

	General Markedness		The SDP	
tal	*SON	*OBST	$*\text{CODA}^{\text{OBST}}$	$*\text{CODA}^{\text{SON}}$
tal	*!			*
→ tap		*	*	

b. Stage II (15c) – sonorant codas: $*\text{CODA}^{\text{OBST}} \gg *\text{CODA}^{\text{SON}} \gg *\text{SON} \gg *\text{OBST}$

	The SDP		General Markedness	
tal	$*\text{CODA}^{\text{OBST}}$	$*\text{CODA}^{\text{SON}}$	*SON	*OBST
→ tal		*	*	
tap	*!			*

8. The hierarchy in (18a) is limited to consonants in syllable margins. In syllable peaks, the higher the sonority the better the syllable peak. See Prince and Smolensky's (1993/2004) peak hierarchy.

The grammars in (18) assume that the markedness constraints have not yet demoted below the faithfulness constraint IDENT[son]. It is also assumed that the development from Stage I to Stage II proceeds by demoting the constraints one-by-one. As the ranking between the members of each pair of constraints is fixed, *OBST must be demoted first. However, as long as *SON is dominant, the output in (19a) is maintained, regardless of the position of *OBST in the hierarchy. The output in (19b) emerges only when *SON is demoted below *CODA^OBST^.

(20) Constraint demotion

tal → tap:	*SON	≫ ***OBST**	≫ *CODA^OBST^	≫ *CODA^SON^
	*SON	≫ *CODA ^*Obst*^	≫ ***OBST**	≫ *CODA^SON^
	*SON	≫ *CODA^OBST^	≫ *CODA^SON^	≫ ***OBST**
tal → tal:	*CODA^OBST^	≫ ***SON**	≫ *CODA^SON^	≫ *OBST
	*CODA^OBST^	≫ *CODA^SON^	≫ ***SON**	≫ *OBST

The notion of cumulative complexity can be expressed in terms of local constraint conjunction (Smolensky 1995a). The relevant conjoined constraint *CODA&*SON rules out the candidate violating its two members (sonorant codas), but not each one independently (sonorant onsets or obstruent codas). The ranking achieving this effect is *CODA&*SON ≫ FAITH ≫ *SON, *CODA.

5.3. Perception vs. articulation

I have alluded in this paper to a three-way correlation: {perception – attempted targets – sonorants} vs. {articulation – production – obstruents} respectively. I assume that attempted targets reflect perception, and since perception is more advanced than articulation, the preference of sonorants in attempted targets (most visible in YV's data) supports the role of the SDP in early acquisition.

However, sonorants have a blurring effect on the preceding vowels (Becker 2003), to the extent of VC cohesiveness, and thus reduced contrast (more so with liquids than with nasals). That is, although the presence of a sonorant coda is acoustically prominent, its segmentation is relatively difficult, for adults (Treiman 1989) as well as children (Yavas and Gogate 1999). This property, as Becker suggests, may delay its production. Moreover, sonorants are less favored than obstruents in production due to their higher intensity and thus articulatory energy.

The articulatory energy distinguishing between sonorants and obstruents (regardless of prosodic position) is represented in Rice (1992) in terms of structural complexity, where the greater the sonority of a segment the more complex its structure.

(21) Structural complexity

```
Liquids (l)   Nasals   Obstruents
   ROOT        ROOT       ROOT
    |           |
    SV          SV
    |
  Lateral
```

(SV stands for Sonorant Voice)

On the basis of this structural complexity, Rose (1997) accounts for the development of coda production in Dutch (based on data from Fikkert 1994), which corresponds to the growth in complexity. This approach coincides with the account provided above for the children's productions, but it is mute with regard to the attempted targets.

Note that due to the articulatory energy and thus the structural complexity, sonorants are also disfavored in onset position. However, in this case, as noted earlier, there is a convergence with the SDP, which also disfavors sonorants in onset position.

6. Conclusion

I have argued in this paper that the SDP does play a role in the acquisition of word final codas. The quantitative data did not allow straightforward interpretation, as there were differences (i) among the children and (ii) between attempted targets and productions (but not for all three children).

The differences, however, were not sporadic. There was a negative correlation in the relative rate of sonorants between attempted targets and productions, with reference to developmental pace. The slower the development, the higher the rate of obstruents in productions and sonorants in attempted targets.

I have proposed a U-shaped development of the production of word final codas. Obstruents are attempted first, due to cumulative complexity, and then the effect of the universal SDP emerges. Its effect is rather weak in Hebrew, as the children have to revert to producing more obstruents in this position, in order to meet the frequency in the language.

By attributing the early obstruent productions to cumulative complexity, the analysis predicts that obstruents will be the first codas also in languages where the rate of sonorant codas is higher than that of obstruents. However, obstruents are not expected to appear in the speech of children whose ambient language prohibits obstruent codas, since such regularity is obtained prior to speech (as in the case of final stress in French noted in section 2).

This study thus adds further support to the claim that universal principles play a role in early stages of acquisition. When the ambient language provides a weak support for a particular universal principle, its effect in child language gradually diminishes. The pace at which it diminishes, and thus the extent of the evidence obtained, depends on the pace of the child's development (the slower the pace, the greater the evidence) and the frequency of forms supporting it in the language (the lower the frequency, the lesser the evidence).

Abbreviations

2^{nd}	second person
fm.	feminine
Imp.	imperative
Nom.	nominative
SCL	Syllable Contact Law
SDP	Sonority Dispersion Principle
sg.	singular
SSP	Sonority Sequencing Principle
SV	sonorant voice

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