Acquisition of #sC clusters: universal grammar vs. language-specific grammar

Aquisição de sequências com ataque #sC: gramática universal versus gramática específica à língua

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Abstract: This study is a cross-linguistic examination of the patterns of acquisition of two-member /s/-clusters. Data from six languages (English, Dutch, Norwegian, Croatian, Hebrew, and Polish) gathered from the productions of typically developing children and from children with phonological disorders are analyzed. Correct renditions in the productions showed correlation with the change of C2 from [-continuant] to [+continuant] of the target clusters in Germanic languages, while there was no such correlation in the other languages. The differences in the two groups of languages give support to the specific-language grammar hypothesis which states that children acquire language based on the patterns in the input language, which drive children's acquisition of phonology; the input triggers the default settings to be set or reset.

Keywords: Acquisition of #sC clusters; Universal grammar; Language-specific grammar

Resumo: Este estudo trata de uma investigação translinguística dos padrões de aquisição de sequências de dois segmentos com ataque #sC . São analisados dados de seis línguas (Inglês, Holandês, Norueguês, Croata, Hebraico e Polonês), oriundos das produções de crianças com desenvolvimento normal e de crianças com desordem fonológica. As produções corretas demonstraram uma correlação com a mudança de C2 de [-contínuo] a [+contínuo] das sequências alvo nas línguas germânicas, ao passo que esta correlação nas outras línguas não ocorreu. As diferenças entre os dois grupos de línguas corroboram a hipótese de gramática específica à língua, que apregoa que as crianças adquirem a linguagem com base nos padrões da língua de input, os quais determinam a aquisição da fonologia entre as crianças; o input dispara os parâmetros default que serão ajustados ou reajustados.

Palavras-chave: Aquisição de sequências com ataque #sC; Gramática universal; Gramática específica à língua

Acquisition of consonant clusters has been a subject of frequent inquiry in developmental and clinical phonology literature. In any discussion of this topic 'sonority' has a central role, because the sonority indices of sounds play an important role in the sequencing of sounds in languages of the world. As stated in the Sonority Sequencing Principle (hereafter SSP), in any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values. In other words, as we advance from the beginning to the peak, the sonority level rises, and as we continue from the peak to the end, it falls.

The exact nature of sonority has been a prominent topic of discussion for a long time. Starting in the 19th century (LEPSIUS and WHITNEY, 1865; SIEVERS, 1881) and continuing into the present, the phonetic correlates of sonority have been subject to vigorous debate[1]. While the controversy surrounding it still continues, the global function of sonority in influencing how segments are arranged into syllables is well settled.

There have been several different sonority scales proposed in the literature[2]. They all seem to agree on the basic ordering of vowels at the top of sonority, sonorant consonants in the middle, and obstruents at the bottom. The basic difference seems to involve the details of discrimination among sound classes. In this paper, we will adopt Hogg and McCully's (1987) 10-point scale, as it makes finer distinctions than many others.

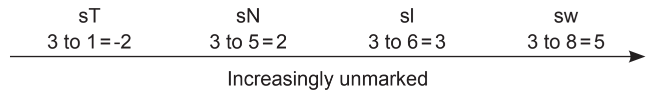
[1] For a detailed account of different explanations, see Parker (2002), where 98 different correlates of sonority are mentioned.
[2] Parker (2002) cites 100 distinct sonority scales in the literature.

Sounds	SI (sonority index)
Low vowels	10
Mid vowels	9
High vowels	8
Flaps	7
Laterals	6
Nasals	5
Vd. Fricatives	4
Vs. Fricatives	3
Vd. Stops	2
Vs. Stops	1

As mentioned above, the SSP requires that segments with higher sonority be found closer to the nucleus and those with lower sonority further away. As a result, in languages with complex onsets, words like plant [plænt] and frost [frɔst] are very common, whereas words which have the same sequence of sounds but with onsets and codas reversed, like [lpætn] and [rfɔts] are non-existent or extremely rare. It has also been established that sonority difference between the cluster members translates into their relative complexity (markedness). Clusters that have smaller sonority difference (hereafter SD) are more complex than those with a greater difference. A corollary of this, if a language allows clusters with a sonority difference of 2 (e.g. /fn-/), it will also permit clusters of all greater differences (e.g. /fl-/ with a difference of 3 and /bl-/ with a difference of 4) which are less marked. It should be noted, however, that while the SSP should be taken as a tendency, it is by no means exceptionless. For example, English double onsets generally obey the SSP, but there are also some clusters with falling sonority (e.g., /sp-/, /st-/, /sk-/). Other languages are more lenient with respect to the SSP; Russian, for example, allows such onset clusters as /lb, rt, mx/, even though these are less frequent than the clusters that obey the SSP.

There is considerable literature that discusses the correlation of sonority of consonants with production accuracy in First language acquisition (OHALA, 1999; PATER, 2004; BARLOW, 2005; YAVAŞ et al., 2008), Second language acquisition (BROSELOW and FINER, 1991; BROSELOW et al., 1998; BROSELOW and XU, 2004, YAVAŞ, 2011), Developmental phonological disorders (GIERUT, 1999; BARLOW, 2001; YAVAŞ, 2010), Aphasia (ROMANI and CALABRESE, 1998; STENNEKEN et al., 2005), Speech errors (STEMBERGER and TREIMAN, 1986), Word games (TREIMAN, 1984; TREIMAN and DANIS, 1988; FOWLER et. al., 1993; TREIMAN et al., 2002), and Reading tasks (LEVITT et al., 1991; ALONZO and TAFT, 2002).

As far as /s/ clusters are concerned, we see different sonority sequencing in different targets. More specifically /sp-/, /st-/, and /sk/, (i.e., /s/+stop', hereafter sT) clusters show a sonority fall, the others (/sm-/, /sn-/, hereafter /sN/, and, /sl-/, and /sw-/) has varying degrees of rising sonority from C1 to C2. Accordingly, we have the following markedness scale:



If the sonority distance between C1 and C2 is an indicator of markedness, it is not unreasonable to expect this reflected in the acquisition patterns of these targets. In the following, we are going to examine the cross-linguistics patterns of correct renditions of two member /s/ clusters. The data come from typically developing children and from children with phonological disorders in six languages including English (YAVAŞ and CORE, 2006; YAVAŞ and McLEOD, 2010), Dutch (GERRITS and ZUMACH, 2006; GERRITS, 2010), Hebrew (BEN-DAVID, 2006; BEN-DAVID, EZRATI and STULMAN, 2010), Norwegian (KRISTOFFERSEN and SIMONSEN, 2006; Croatian (MILDNER and TOMIC 2006); Polish (YAVAŞ and MARECKA, submitted), as well as a comparative study among English, Dutch, Norwegian and Hebrew (YAVAŞ et al., 2008). These studies investigated, among others, the patterns in correct renditions of two-member initial /s/ clusters. We give the results in Figure 1.

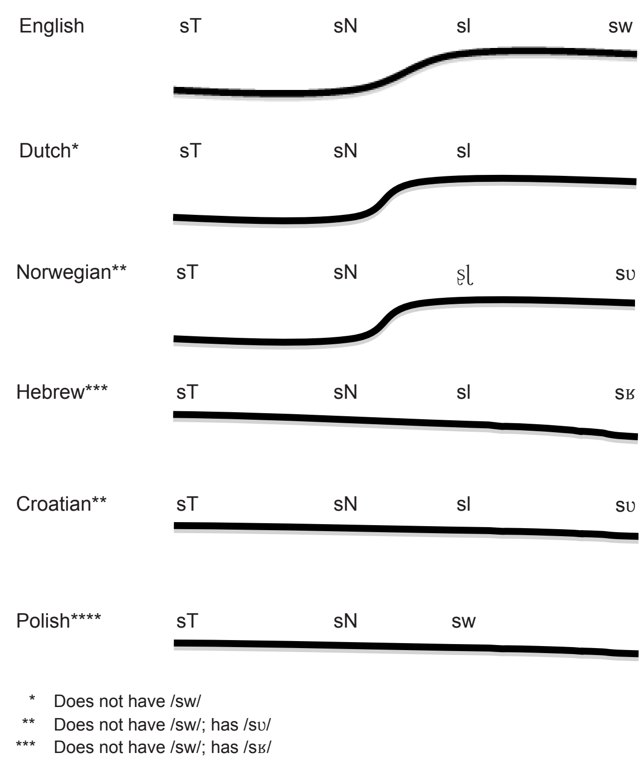


Figure 1. Correct renditions of /sC/ targets in six languages.

Looking at Figure 1, one can easily see two different patterns: in the three Germanic languages, displayed on top, we observe a rise in the correct renditions as we move from left to right, while there is no such movement in the bottom three languages. Although the rises are significant in the first three languages, they don't lend themselves to the simple explanation of the rise in sonority from C1 to C2. While we can say that the /sT/ targets with a sonority fall may be expected to show a low rate of correct production, we cannot suggest the same thing for /sN/ targets because they follow the SSP with a rise in sonority from C1 to C2. One can, of course, try to save the day by suggesting a formula which will state that the significant increase in correct renditions is observed when the SD between C1 and C2 is greater than 2. In other words, no significant increase is observed in /sN/ because the SD is 2, but observed in /sl/ where the SD is 3. This would automatically beg the question "why should there be a significant rise in correct renditions when the SD is changed from 2 to 3 (the difference of 1), when there was no significant rise when the change is from /sT/ (SD=-2) to /sN/ (SD=2) where the SD difference is 4.

Not having found any reasonable explanation between the sonority distance and the accuracy of productions with respect to rising or falling sonority, we now turn to the examination of the continuancy of C2. In the three Germanic languages (English, Dutch, and Norwegian), the rates for correct renditions were correlated with the quality of C2. In other words, the correct renditions were always higher in '/s/+[+continuant]' (i.e., /sl/ and /sw/) targets than in '/s/+[-continuant]' (/sT/ and /sN/) targets both in TD and PD children. The opposite tendencies are revealed by Hebrew, Croatian, and Polish data; in these three languages, '/s/+[-continuant]' clusters are either equal or more successfully rendered than '/s/+[+continuant]' clusters. Although Croatian and Polish belong to the same language family, Slavic, the similarity with Hebrew data cannot be explained with the same line of reasoning. However, if one considers the cluster inventories of these languages, similarities become rather obvious. These three languages (see Appendix B), in contrast with English, Dutch, and Norwegian (see Appendix A), have rather rich cluster inventories with more lenient attitudes toward the SSP, and that can explain the above mentioned similarities. The greater accuracy in '/s/+[-continuant]' clusters in these languages can be explained through frequency effects. The children that are raised in the ambience of such languages would probably produce the marked clusters more frequently. Frequent repetitions of these patterns result in automaticity and greater accuracy, since the neural pathways involved in these productions are strengthened and stabilized as a result of continuous activation (Hebb's Law – HEBB, 1949; LOGAN, 1988). This is borne out by the experimental studies of Beckman and Edwards (1999) and Zamuner et al. (2004), which showed that the more frequent a given sequence is in a given language, the more accurately it will be produced.

In this paper we looked at the cross-linguistic patterns of the acquisition of #sC clusters in six languages. Specifically, we examined the correct renditions of these targets by typically developing children and in children with phonological disorders and see if the patterns could be explained through the principles of sonority. The findings did not lend themselves to an explanation via sonority. Rather, in the three Germanic languages (English, Dutch, and Norwegian) which have limited inventory of #sC clusters with a very small number of SSP violations which come from 's+stop' combinations', there was a significant increase in the correct renditions by children when C2 is switched from [-continuant] to [+continuant]. On the other hand, the remaining three languages (Hebrew, Croatian, and Polish) which have a rich inventory of clusters and also are replete with non-rising sonority sequences (either in the form of level sonority clusters or sonority falling clusters), there was no significant difference in correct renditions for any subgroup of /s/ clusters. These differences in two groups of languages give support to the SLGH (Specific Language Grammar Hypothesis) in that children's acquisition patterns are based on the patterns in the input language, which drive children's acquisition of phonology; the input triggers the default settings to be set or reset.

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Appendix A

(Level sonority clusters are <u>underlined</u>; falling sonority clusters are in *italics*)

Inventory of **English** Consonants and Double Onsets

	Bilab.	Lab.-dent.	Int.-dent.	Alve.	Retro.	Pal.-alv.	Pala.	Vel.	Glot.
Stop	p b			t d				k g	
Fricative		f v	θ ð	s z		ʃ ʒ			h
Affricate						ʧ ʤ			
Nasal	m			n				ŋ	
Liquid				l	ɹ				
Glide	w						j	w	

CC clusters	pl, pr, pj, bl, br, bj, tr, tw, (tj), dr, dw, (dj), kl, kr, kj, gl, gr, gw
	fl, fr, fj, vj, θr, θw, hj
	mj, (nj), (lj)
	sp, ***st***, ***sk***, sm, sn, sl, sw, (sj), ʃr

( ) found in some speakers of American English.

Inventory of **Dutch** Consonants and Double Onsets

	Bilabial	Labio-dental	Alveolar	Palatal	Velar	Glottal
Plosives	p b		t d		k	
Fricatives		f v	s z		x	h
Nasals	m		n		ŋ	
Liquids			l r			
Glides		ʋ		j		

CC clusters	pl, pr, bl, br, tr, tw, dr, kl, hn, kw, (ps), (ts), (tj), (dw)
	fl, fr, xl, xr, (ft), (fn), (fj)
	sp, ***st***, <u>sx</u>, sm, sn, sl, zw, (***sk***), (sf), (sj)

( ) uncommonly found clusters.

Inventory of **Norwegian** Consonants and Double Onsets

	Bilabial	Labio-dental	Alveolar	Retroflex	Palatal	Velar	Glottal
Stop	p b		t d	ʈ ɖ		k g	
Fricative		f	s	ʂ	ç		h
Nasal	m		n	ɳ		ŋ	
Tap/flap				r ɽ			
Approximant		ʋ	l	ɭ	j		

CC clusters	pɭ, pr, pj, bɭ, br, bj, tr, (tj), tʋ, dr, (dj), dʋ, kn, kɭ, kr, kʋ, gn, gɭ, gr, fn, fɭ, fr, fj
	sp, ***st***, ***sk***, sm, sn, ʂɭ, sç

Appendix B

(Level sonority clusters are underlined; falling sonority clusters are in *italics*)

Inventory of **Hebrew** Consonants and Double Onsets

	Bilab.	Lab.-dent.	Alve.	Retro.	Pal.-alv.	Pala.	Vel.	Uvul.	Glot.
Stop	p b		t d				k g		
Fricative		f v	s z		ʃ ʒ			χ	h
Affricate			ʦ		ʧ ʤ				
Nasal	m		n						ŋ
Liquid			l					ʁ	
Glide						j			

We adopt the analysis of Bolozky (1997) and Laufer (1991) of Hebrew r-sound as a dorsal (velar or uvular) approximant.

CC clusters	bx, px, bʃ, pʃ, bs, ps, bz, pz, bts, pts, dv, df, tv, tf, ts, tz, dʃ, tʃ, dx, tx, gv, gf, kv, kf, gz, gs, kz, ks, gʃ, kʃ, gx, kx, tsf, tsx, tsʁ, sj, ʃj, ml, mn bn, pn, bl, pl, bʁ, pʁ, dm, tm, tn, dl, tl, dʁ, gm, km, gn, kn, gl, kl, gʁ, kʁ, dj, tj, vl, vʁ, fʁ, fj, zm, sm, ʃm, tsm, zn, sn, ʃn, tsn, zl, sl, ʃl, tsl, zʁ, sʁ, ʃʁ, tsf, tsv, zx **bg, bk, pg, pk, bd, bt, pd, pt, dg, dk, tg, tk, gd, kd, kt, kts, zv, sv, sf, ʃf, sx, ʃv, ʃx** ***sp, zb, ʃb, zd, sd, st, ʃd, ʃt, zg, sk, sg, sk, ʃg, ʃk, tsd***

Inventory of **Croatian** Consonants and Double Onsets

	Bilabial	Labio-dental	Dental	Alveolar	Postal-veolar	Palatal	Velar
Stop	p b		t d				k g
Affricate			ʦ		ʧ ʤ	ʨ ʥ	
Fricative		f	s z		ʃ ʒ		x
Nasal	m			n		ɲ	
Trill				r			
Approximant		ʋ				j	
Lateral Appr.				l		ʎ	

Clusters in normal type follow the SSP, in ***italics bold*** type violate the SSP, and in **underlined bold** have level sonority.

CC clusters	kʦ, pʧ, bz, ks, ps, pʃ, dm, dn, gm, gn, gɲ, km, kn, kɲ, pn, tm, ʦm, ʧ, sm, sn, ʃn, ʃn, ʃɲ, ʒm, ʒn, br, dr, gr, kr, pr, tr, bl, dl, gl, kl, pt, tl, ʧl, pʎ, kʎ, gʎ, sr, sl, sʎ, ʃʋ, ʃʎ, fr, f;, fj, xr, xl, xv, xʎ, mr, mj, ml, mʎ, rj, rʋ, ʋl, ʋr **bd, gd, kt, pt, tk, sf, sx, mn** ***zb, zd, zg, ʒb, ʒd, ʒg, ʃt, sk, sp, st, sʦ, ʃk, ʃp, ʃt, ʃʧ***

Appendix B (cont.)

Inventory of **Polish** Consonants and Double Onsets

	Bilab.	Lab.dent.	Dental	Alveolar	Retrof.	Alv.pal.	Palatal	Velar
Stop	p b		t d				c ɟ	k g
Fricative		f v	s z		ʃ ʒ	ɕ ʑ		x
Affricate			ʦ ʣ		ʧ ʤ	ʨ ʥ		
Nasal	m		n				ɲ	
Liquid				l r				
Glide							j	w

CC Clusters	pʃ, pr, pj, pw, pl, ps, pɲ, px, br, bj, bl, bw, bʒ, bz, tr, tl, tʃ, tf, tw, tj, tx, tɲ, dr, dm, dl, dv, dw, dɲ, dj, dʒ, dn, kj, kl, kf, kʃ, kɕ, kw, ks, kn, kr, gr, gw, gl, gʥ, gv, gɲ, gʒ, gn, gz, gm, gj, fr, fj, fl, vj, vw, vr, vɲ, vn, vl, vm, sm, sn, sr, sj, sl, sw, zn, zr, zj, zm, zw, zɲ, zl, ʃl, ʃw, ʃm, ʃl, ʒm, ʒw, ɕr, ɕl, ɕɲ, ʑm, ʑl, ʧw, ʧf, tsm, tsn, dzv,ʨf, ʥv, xw, xr, xj, xl, xm, mj, mw, ml, mr, nj, lj, wz **pt, db, tk, kt, gd, fs, fx, fʃ, fɕ, vz, vʒ, vv, sf, sx, sɕ, ss, vʑ, vʒ, zv, zz, zʒ, ʃf, ʒv, ɕfʑ, ʧʨ, xf, xʃ, mn, mɲ** ***fʨ, fts, ft, fʧ, fp, fk, vd, vb, st, sp, sk, sʧ,* sts, *zg, zb, zd, zʥ,ʃʧ, ʃk, ʃp, ʃt, ʒb,ɕʨ, ɕp, ʧt, xts, xʨrt, rv, lv, rdz***