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Productiveness of the Sonority Sequencing Principle

The goal of this paper is to provide an analysis on the Sonority Sequencing Principle's productiveness when applied to consonant cluster onsets of syllables in English. The main focus of this paper is to find where the SSP is productive in application to consonant cluster onset allowances and constraints. It is important to provide a critical analysis on the Sonority Sequencing Principle because it is not a sufficient theory to account for all consonant clusters in English. We know that there are instances where the SSP is adequate in explaining consonant cluster onsets in English. However, there are also instances where the SSP is inadequate in explaining consonant cluster onsets in English.

The Sonority Sequencing Principle (SSP) has been introduced in phonology in order to function as a general guideline to explain how syllables are constructed. It is not the case that for all languages, syllable structure is not governed. For example, in English, syllables must have at least a nucleus which is either a vowel or possibly a syllabic consonant. They can also have onsets and codas. The focus of this paper will center around these syllable onsets. It is important to consider the idea of something governing the arrangement of consonants in the onset position of a syllable. For example, there are 23 possible consonants that can be in onset position of a syllable (this is excluding [ŋ]). If there was nothing governing how these consonants can be arranged in a CCV onset, then we would expect there to be 529 possible CC onsets in English syllables. We would expect an even greater number of possible ways in which CCC onsets could be arranged. However, Fig. 1 shows the CCV and CCCV onsets that are allowable in English.

Fig. 1.

CCV onsets												
[pC]	[tC]	[kC]	[bC]	[dC]	[gC]	[fC]	[ɵC]	[vC]	[zC]	[mC]	[ʃC]	[sC]
[pw]	[tw]	[kw]	[bw]	[dw]	[gw[	[fl]	[ɵr]	[vr]	[zw]	[my]	[ʃr]	[sp]
[pl]	[tr]	[kl]	[bl]	[dr]	[gl]	[fr]	[ɵw]	[vl]			[ʃt]	[st]
[pr]		[kr]	[br]		[gr]	[fy]		[vy]			[ʃm]	[sk]
[py]		[ky]	[by]			[fw]					[ʃl]	[sf]
												[sm]
												[sn]
												[sw]
												[sl]

CCCV onsets		
[spC]	[stC]	[skC]
[spl]	[str]	[skw]
[spr]		[skl]
		[skr]

Clearly, there are far less than 529 CC onsets, and even fewer CCCV onsets. Ultimately, this leaves us with the question of why we have the clusters we do, and if there is some type of underlying system that governs the ways onsets can be arranged.

One theory of what determines the arrangement of consonants in onset position is that they must be arranged according the Sonority Sequencing Principle. The Sonority Sequencing Principle (SSP) states that, “Segments are syllabified in such a way that sonority increases from the margin to the peak.”(Clements, 1999) Therefore, we can develop the hypothesis that the Sonority Sequencing Principle should be able to be applied to all of the CV and CCV onsets in English. The other aspect of this is that the SSP should not be able to be applied to the CV and CCV onsets that do not follow the principle. One thing to keep in mind is that CCCV onsets need to be treated separately from this hypothesis and the SSP in general. This will become clearer further into this analysis, but for now CCCV onsets will be excluded from this hypothesis.

In order to determine if the SSP can be applied to English syllable onsets, one must understand sonority. Trying to define sonority does not seem to be an easy task. There does not seem to be a universal agreement in exactly what sonority is. An older definition is that sonority is related to the general loudness and audibility, or the power of a speech sound. This definition is extremely vague, and it seems to rely too heavily on production of speech sounds being uniform across their sonority hierarchy. For example, this system ranks [z] as being slightly more sonorous than [v]. If these two are produced with the same manner than this might very well be true. However, if one produces [v] in a different manner than [z], perhaps one devoices [z] or simply produces a 'louder' [v], then would this sonority hierarchy not be altered? Clements offers a different definition of sonority which seems to exclude the possibility of altering the sonority hierarchy. Clements suggests that sonority is related to an intrinsic aspect of the speech sound. He states that sonority is not related to the loudness or audibility of a speech sound, but instead to the relative resonance of a speech sound. He explains that a resonant speech sound has inherent sonority which is repeated, prolonged or augmented in some way. A sound can be more resonant by having a more prominent, undampened formant structure.

The most common way to categorize the sonority of speech sounds is by constructing a sonority hierarchy which categorizes speech sounds according to their perceived sonority. Typically, the hierarchy is arranged from most sonorant to lowest in the following way: low > mid > high vowels and glides > liquids > nasals > obstruents.

With this knowledge of sonority, we can bring focus back to the hypothesis. We know that the SSP will always be able to be used to explain all CV onsets because a consonant will always be less sonorant than a vowel. Therefore, the margin of a CV syllable will always be less sonorant than its peak. To apply this to CCV onsets, we must state that the first consonant in the cluster must be less sonorant than the following consonant in the cluster. This would satisfy the SSP. We can establish a general rule that in a CCV onset, the first consonant, call it α, must be less sonorant than the second consonant in the cluster, call it β. Therefore, αβV satisfies the SSP whereas βαV should never satisfy the SSP, and should not be allowed as a consonant cluster onset in English. Taking this into consideration, we see how the existence of the [pr] cluster in the word [praɪs] is explained by the SSP. However, we run into problems quickly when we start to expand the SSP to clusters that we do not have in English. Clusters such as [ml], [ml], [nr], etc. do not exist in English even though they satisfy the Sonority Sequencing Principle. Because of this, a type of sonority scale has been introduced to this theory. Speech sounds are ranked on a scale of .5, (least sonorous) to 10 (most sonorous). The idea behind this is that given a consonant cluster, αβ must be a certain distance apart in order to satisfy the SSP. One adaptation of this ranking is given in Fig. 2.

Fig. 2.

Sonority			
	Vowels	Low	10
		Mid	9
	Glides	High	8
	Liquids	[r]	7
		[l]	6
	Nasals	[m],[n]	5
	Fricatives	[s]	4
		[v],[z],[ð]	3
		[f],[ɵ]	2
	Stops	[b],[d],[g]	1
		[p],[t],[k]	0.5

This scale can then be used to determine the distance between α consonants and β consonants by taking the difference between the two. For example, if one takes the word [praɪs] we see that the α consonant of the onset cluster is [p] which has a sonority value of 0.5. Then, we take the β consonant which is [r] and find that it has a sonority value of 7. Finally, once the consonants and their values have been established, we subtract the value of the α consonant from the value of the β consonant and end up with the sonority distance. Or put in formulaic terms, β-

α = d(istance). In this example we end up with 6.5. However, given a consonant cluster [bv] we find that it has a distance 2. This cluster does not exist in English, and the reason might have something to do with the distance in the sonority values being too short. However, it is not enough to claim that allowed clusters have a greater sonority distance and un-allowed clusters have a shorter distance. In order to test the hypothesis that the SSP can be applied for all CV and CCV onsets in English, we need to first figure out what would be an acceptable difference in sonority values. After doing so, we might be able to make the argument that CCV ($\alpha\beta$V) onsets must follow the SSP and satisfy a minimum distance between α and β on the sonority scale.

This paper utilizes Optimality Theory as a way to represent how distance on the sonority scale affects which consonants are allowed and not allowed in English. We know that in order to satisfy the Sonority Sequencing Principle, an onset cluster must rise in sonority from the margin of the syllable to the peak. Therefore, we can establish a constraint that says that a consonant cluster must satisfy the SSP, this would be called the SSP constraint. However, as noted earlier, this is not enough to rule out consonant clusters that, despite satisfying the SSP constraint, we do not have in English. Therefore, we develop a constraint system that will account for distance between the consonant clusters on the sonority scale. There are two basic constraints that are used. The first constraint is the SSP constraint. The constraint, SSP ≥ 0, says that the distance between α and β must be greater than or equal to zero. It is important to note that this is greater than or equal to zero and not greater than zero. This is because if there was a consonant cluster where both α and β shared the same sonority value, this would still satisfy the SSP as sonority would still peak at the nucleus and rise from the margin. The SSP does not specify that each segment must be higher in sonority than the segment immediately preceding it unless, of course, the segment is the peak of the syllable. This constraint can also be repeated with different values to express the actual distance of each cluster on the sonority scale. Thus, we have SSP ≥ 0, SSP ≥ 1, SSP ≥ 2, SSP ≥ 3, SSP ≥ 4, SSP ≥ 5, SSP ≥ 6, SSP ≥ 7, SSP ≥ 8, and SSP ≥ 9 as possible constraints.

SSP ≥ 0…9:

The distances between α and β is greater than or equal to 0…9.

There is one more constraint that is included in this analysis. This is a DEP constraint which prevents segments from being inserted in between α and β. The insertion of a vowel between α and β would cause the SSP to always be satisfied because GEN would be producing CV segments, which always rise in sonority. Table 1 shows the basic tableau template that CCV onsets will be applied to.

DEP:

Do not insert any segments.

Table 1.

	/αβV/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8	SSP ≥ 9
☞	(αβV)	✓										
	(βαV)	✳!										

If we apply all CCV clusters in English to this tableau, not only should we be able to determine if they satisfy the Sonority Sequencing Principle, but also we should be able figure out a general sonority distance between each consonant. Ideally, there should be a preferred minimum sonority distance for the allowed clusters in English. The first data presented will be voiceless stops, these are organized by α and β sonority values. Table 2 and Table 3 show voiceless stops next to [r] and [l] which are liquids according to the Sonority Scale.

Table 2.

	/pre/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7

☞	(pre)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rpe)	✳!								
	/tri/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(tri)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rti)	✳!								
	/kray/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(kray)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rkay)	✳!								

Table 3.

	/ple/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(ple)	✓	✓	✓	✓	✓	✓	✓	✳
	(lpe)	✳!							
	/kle /	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(kle)	✓	✓	✓	✓	✓	✓	✓	✳
	(lke)	✳!							

The average distance for /prV/, /trV/, /krV/ clusters is 6.5 and the average distance for /plV/, and /klV/ clusters is 5.5. We see that the average distance for voiceless stop and liquid consonant clusters is 6. However, we notice that /tlV/ clusters are missing from the English language. The SSP does not seem to have any explanation for this. It is important to note that the SSP should not be used as a rule of how to create consonant cluster onsets, but how why English has a preference for the ones we do have. Continuing with the analysis of CCV onsets, Table 4 shows voiceless stop and glide consonant clusters.

Table 4.

	/pwe/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(pwe)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wpe)	✳!									
	/pyu/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(pyu)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(ypu)	✳!									
	/twɪl/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(twɪl)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳

	(wtɪl)	✳!									

The average distance for [pw], [py], and [tw] is 7.5. Again, one sees that there is no /tyV/ cluster represented. In some dialects of English such as British-English, /tyV/ clusters occur. However, these have been excluded from the analysis despite the fact that they would satisfy the SSP.

The next set of CCV onsets have voiced stops in first positions. Table 5 and Table 6 show voiced stops next to [l] and [r].

Table 5.

	/ble/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(ble)	✓	✓	✓	✓	✓	✓	✓	✳
	(lbe)	✳!							
	/glo/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
	(glo)	✓	✓	✓	✓	✓	✓	✓	✳
	(lgo)	✳!							

Table 6.

	/bri/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(bri)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rbi)	✳!								
	/dray/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(dray)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rday)	✳!								
	/gro/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(gro)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(rgo)	✳!								

The average distance for /blV/ and /glV/ clusters is 5 and the average distance for /brV/, /drV/, and /grV/ clusters is 6. We see that the average distance for voiced stop and liquid consonant clusters is 5.5. Again we notice that certain clusters satisfy the SSP but do not show up in English. This is the case with /dlV/ clusters. Table 7 show voiced stop and glide consonant clusters.

Table 7.

	/bwe/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(bwe)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wbe)	✳!									
	/byu/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(byu)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(ybu)	✳!									
	/dwɛl/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(dwɛl)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wdɛl)	✳!									
	/gwɛn/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7	SSP ≥ 8
☞	(gwɛn)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wgɛn)	✳!									

The average distance for /bwV/, /byV/, /dwV/, and /gwV/ is 7. There does not appear to be any /dyV/ or /gyV/ clusters. However, in certain dialects there does seem to be /dyV/ clusters, as in the word [dyun].

The next part of the analysis will cover fricatives in initial position of the onset cluster. It is important to note that fricatives are difficult for the SSP to handle. The main problem is that the SSP cannot account for /sCV/ onsets in any way. This will violate the SSP if the second consonant is lower in sonority than /s/. For /sk/, /sf/, /sp/ and /st/, this seems to be the case. However, /sn/, /sm/, /sl/, and /sw/ still follow the SSP because they rise in sonority from the margin to the peak. Despite these following the SSP, we will see that they do not have a great enough difference in sonority values. Ultimately, SSP does not handle /sCV/ onsets very well at all. Either known consonant clusters of English clearly violate the SSP, or they do not have a great enough distance in sonority ranking. The same problems arise with /ʃCV/ and will be treated later with /sCV/. We have not yet established what a satisfactory distance is. However, it will be clear later that these clusters to not satisfy that distance. To demonstrate how /sCV/ onsets immediately violate the SSP, consider Table 8.

Table 8.

	/ste/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4
	(ste)	✳!				
☞	(tse)	✓	✓	✓	✓	✳

Putting aside /sCV/ and /ʃCV/ onsets, for now, the analysis continues with other fricatives that satisfy the SSP. Table 9 shows voiceless fricatives and [r] while Table 10 shows voiceless fricatives with [l].

Table 9.

	/fri/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(fri)	✓	✓	✓	✓	✓	✓	✓	✳
	(rfi)	✳!							
	/θri/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(θri)	✓	✓	✓	✓	✓	✓	✓	✳
	(rθi)	✳!							

Table 10.

	/fli/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5
☞	(fli)	✓	✓	✓	✓	✓	✳
	(lfi)	✳!					

The average distance for /frV/ and /ɵrV/ clusters is 5 and the average distance for /flV/ clusters is 4. There does not seem to be any /ɵlV/ onsets in English. This could have something to do with too small of a distance on the sonority scale. Consequently, we will see how /flV/ causes a problem later on in the analysis. Table 11 shows voiceless fricatives and glides in onset position.

Table 11.

	/fyu/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(fyu)	✓	✓	✓	✓	✓	✓	✓	✓	✳

	(yfu)	✳!								
	/fwɛ/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(fwɛ)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wfɛ)	✳!								
	/θwɔ/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6	SSP ≥ 7
☞	(θwɔ)	✓	✓	✓	✓	✓	✓	✓	✓	✳
	(wθɔ)	✳!								

The average distance for /fyV/, /fwV/ and /ɵwV/ clusters is 6. There does not seem to be any /ɵyV/ onsets in English. However if there was, they would satisfy the SSP.

The next set of CCVs have voiced fricatives in the onset position. There are not very many of these and, although we have them in English, it is important to keep in mind that most of their occurrences in English are associated with foreign words. Table 12 shows voiced fricatives and [r] and Table 13 shows voiced fricatives and [l] in onset position.

Table 12.

	/vrum/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5
☞	(vrum)	✓	✓	✓	✓	✓	✳
	(rvum)	✳!					

Table 13.

	/vlæsɪk/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4
☞	(vlæsɪk)	✓	✓	✓	✓	✳
	(lvæsɪk)	✳!				

The average distance for /vrV/ clusters is 4 and the average distance for /vlV/ clusters is 3. It is interesting that these are the only two examples of a voiced fricative and a liquid in CCV position. This is most likely because their distance on the sonority scale is very small. They do not actually seem like they belong in English when you compare them to every other cluster. However, one can infer that the reason we only have these two is because they are borrowed words, and that somehow affects the SSP. Table 14 shows voiced fricatives and glides in onset position.

Table 14.

	/vyu/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(vyu)	✓	✓	✓	✓	✓	✓	✓	✳
	(yvu)	✳!							
	/zwɛk/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4	SSP ≥ 5	Dep	SSP ≥ 6
☞	(zwɛk)	✓	✓	✓	✓	✓	✓	✓	✳
	(wzɛk	✳!							

The average distance for /vyV/ and /zwV/ clusters is 5. One thing to notice hear is that we are missing the /vwV/ and the /zyV/ clusters despite these being perfectly acceptable.

In English there is also one nasal and glide consonant cluster onset. This is [my] and it is another example of a cluster being able to satisfy the SSP without satisfying any minimum sonority distance constraint. The sonority distance is only 3, yet this is not a cluster belonging to a foreign word. For example, the word music is not a foreign word by any means. This [my] problem will be discussed in detail later. Table 15 shows the tableau for /myV/.

Table 15.

	/myu/	SSP ≥ 0	SSP ≥ 1	SSP ≥ 2	SSP ≥ 3	SSP ≥ 4
☞	(myu)	✓	✓	✓	✓	✳
	(ymu)	✳!				

After analyzing all of the clusters in OT we can find the averages of allowed onset clusters and try to find a sonority distance minimum that we could use to help explain the allowed consonant clusters in English. In Fig 3, average distances are assigned to specific manner categories. We can see that consonant cluster onsets are allowable in English from around a distance of 4.5. These would fall into a broader category of Obstruent- Approximant clusters. As one can see from the chart, if the distance is around 4.25 or less, then it will not be an allowable cluster onset. Consequently, we do not have these cluster onsets in English.

Therefore, there seems to be some evidence to support the sonority distance theory.

Fig 3.

CC(αβ) Structure	*Average Distance*
Stop – Glide	7.25
Stop – Liquid	5.85
Fricative – Glide	5.60
Fricative – Liquid	4.50
*Stop – Nasal	4.25
*Fricative – Nasal	3.00
*Nasal – Liquid	2.00
*Liquid – Glide	2.00

However, to come back to our hypothesis that the SSP should be applied to all consonant cluster onsets we do have, and if it is violated than the cluster is not a valid consonant cluster onset, we find that it is not supported. This is mainly due to the /sC/ and /ʃC/ clusters which will discussed later. The second part of the hypothesis, stating that there must be some type of minimum sonority distance that eliminates consonant cluster which are not allowable in English, is not necessarily supported with a great degree of confidence. There are problems with the minimum distance on the chart. The cluster /pm/ has a sonority distance of 4.5. According to what was stated before, this should be allowable in English. We know it is not.

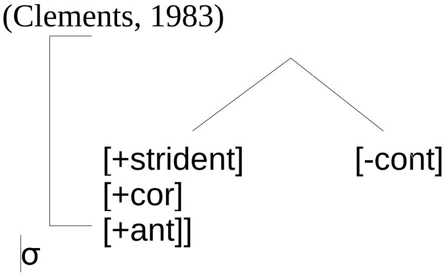
The problem is that these averages are including the consonant cluster onsets such as /vl/,/vr/,/fl/, and /my/, all of which have very low sonority distances. If these four consonant cluster onsets are excluded from the sonority distance aspect of the SSP, we can then raise the minimum requirement of the sonority distances to say that anything greater than 4.5 (/pm/) would be allowable in English whereas anything underneath that would not be (except for /vl/,/vr/,/fl/, and /my/) These clusters function strangely with the SSP. The clusters /vr/ and /vl/ seem to be explained by the fact that they are foreign words, not naturally English. The /fl/

cluster does not seem to have any type of explanation at all, it seems out of place and we have many /fl/ words in English. Finally, the /my/ cluster has an interesting explanation behind it, although it does not lead to any conclusions.

One theory behind the /my/ cluster is that /y/ is not present underlyingly. Instead, [y] is inserted after [m] and before an underlying /ɨ/, which is realized as [uw] on the surface. (Clements, 1983) This does not really say much about the SSP, but it brings to mind the idea of what the SSP looks at. Does it look only at surface representations, or does it look only at underlying representations? Which of these, if any does the SSP care about? These are questions that further research could help answer.

As discussed earlier, /sC/ onsets do not seem to care about the Sonority Sequencing Principle, and they do not function well with it. Because the Sonority Sequencing Principle cannot be applied to these clusters, it would make sense to consider these types of clusters as separate from the SSP and that they function on their own rule. Clements and Keyser, 1983, propose this structure to account for /sC/ clusters :

(Clements, 1983)



This model should account for the /sC/ clusters that exist in English. This model is also designed to be used with /ʃC/ onsets as well. If the [+ant] feature is removed from the model, it can then be used to represent /ʃC/ onsets. It may be necessary to note that treating /sC/ clusters with a separate rule may not be an ideal solution. However, for lack a better solution, it is better than just ignoring the problem.

Earlier in this paper it was mentioned that CCCV onsets would be treated separately from CV and CCV onsets. This next section will provide a brief analysis of CCCV onsets. Unlike CCV onsets, CCCV onsets do not follow *either* the Sonority Sequencing Principle or the /sC/ model. Rather, CCCV onsets must follow both the SSP and the /sC/. If we look at Fig 1 again, we notice two interesting things about CCCV onsets.

Fig 1

…

CCCV onsets		
[spC]	[stC]	[skC]
[spl]	[str]	[skw]
[spr]		[skl]
		[skr]

The first thing that stands out is that the /sC/ in each of these CCCV onsets, is also an CCV onset by itself. We find [sp], [st], and [sk] onsets in English. The second thing that one may notice is that the second two consonants in these clusters also stand alone as part of CCV onsets in English. We find [pl], [pr], [tr], [kw], [kl], and [kr] clusters in English. From this, a basic outline of CCCV onsets is created : /sαβV/. We also can say that these CCCV onsets are subject to certain requirements in order to be acceptable onset clusters in English. It seems that CCCV onsets must follow two rules.

1) /Sα/ must follow the sC model
2) /αβ/ must follow the SSP.

These rules explain why we don't have examples such as *[srt], *[snr], etc.

Overall, it seems that the Sonority Sequencing Principle works fairly well to explain the consonant cluster onsets in English. It was found that the SSP seems to explain the Obstruent-Approximant cluster onsets fairly well. However, it was found that it is not enough to apply the SSP to consonant cluster onsets without first stipulating that there must be a minimum distance on the sonority scale. This minimum distance has to be above 4.5 to make sure it does not include illegal clusters such as *[pm]. It would be nice to be able to say that all English CCV clusters must not only follow the SSP but also must have a distance on the sonority scale of above 4.5. However, this does not explain consonant clusters like [vr], [vl], [fl], and [my]. These are English consonant clusters, yet do not the minimum distance on the sonority scale. Furthermore, /sC/ clusters do not work because they either do not satisfy the SSP, or they do not meet the minimum distance on the sonority scale. These /sC/ clusters must follow the /sC/ model and not the SSP. Lastly, the SSP cannot alone deal with CCCV onsets. These CCCV onsets are represented as /sαβV/ where /sα/ must follow the /sC/ model and /αβ/ must follow the SSP.

In conclusion, we can say that the Sonority Sequencing Principle can most frequently apply to obstruent-approximant consonant clusters so long as they have a minimum distance above 4.5 on the sonority scale. The hypothesis that the Sonority Sequencing Principle will be able to be applied to all of the CV and CCV onsets in English is not completely supported. However, it is safe to say that there is definite evidence that the Sonority Sequencing Principle does have some relevance in explaining the onset clusters in the English language.

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