

a. The two sounds in each voiced/voiceless pair of sonorants in French seem to be allophones of the same phoneme.

b. None of the pairs consist of separate phonemes.

c. The pair of uvular trills [ʀ ʀ̥] occur in complementary environments. The voiceless trill [ʀ̥] only occurs word-finally when preceded by a voiceless sound, as in [ɛtʀ̥] ‘to be’ and [ʃifʀ̥] ‘number/figure’. In comparison, the voiced trill [ʀ] never occurs in that environment, but can occur elsewhere:

- word-finally after a voiced sound, as in [lɛvʀ] ‘lip’
- word-medially, as in [tɛʀm] ‘term’, even when it’s next to a voiceless sound, as in [pɛʀs] ‘Persian’ and [tʀivjal] ‘trivial’
- word-initially, as in [ʀym] ‘cold/flu’

The pair of laterals [l l̥] have a similar complementary distribution, with the voiceless lateral [l̥] only occurring word-finally after a voiceless sound, as in [pœpl̥] ‘people’ and [ɔ̃kl̥] ‘uncle’, while the voiced lateral [l] occurs everywhere else:

- word-finally after a voiced sound, as in [ɛl] ‘she’
- word-medially, as in [film] ‘film’, even when it’s next to a voiceless sound, as in [ʀɔ̃fle] ‘to snore’ and [klɛmɑ̃] ‘merciful’
- word-initially, as in [limite] ‘limited’

The pair of bilabial nasals [m m̥] have a similar complementary distribution as well, with the voiceless nasal [m̥] only occurring word-finally after a voiceless sound, as in [ʀymatizm̥] ‘rheumatism’ and [ʀitm̥] ‘rhythm’, while the voiced nasal [m] occurs everywhere else:

- word-finally after a voiced sound, as in [film] ‘film’
- word-medially, as in [klɛmɑ̃] ‘merciful’, even when it’s next to a voiceless sound, as in [simetrikm̥ɑ̃] ‘symmetrically’ and [ʀymatizmal] ‘rheumatic’
- word-initially, as in [mɛtʀ] ‘to put’

In each case, the voiceless allophone occurs in a specific environment, while the voiced allophone occurs in multiple environments. This suggests that /ʀ l m/ are phonemes in French, and they each have voiceless allophones that are derived by a phonological rule.

Because all three phonemes involve the same allophonic change (devoicing) in the same environments (word-finally after a voiceless sound), and they all form a natural class (sonorant consonants), this seems to be a prime candidate for a single analysis of a repeated pattern. Instead of three separate devoicing rules, one for each phoneme, we only need one rule that devoices all word-final sonorant consonants when they are preceded by a voiceless sound.

But we must be careful: the natural class of sonorant consonants in French includes more sounds than just /ʀ l m/. Just from the data we have, we know that French has /n/ and /j/, which are also both sonorant consonants. It is impossible to exclude /n/ from the natural class containing /ʀ l m/, so simplifying our analysis to a single rule necessarily predicts that /n/ must also be devoiced word-finally after a voiceless sound. We have no examples to contradict this prediction, so our simplified, single-rule analysis is safe.

Whether we want our rule to affect /j/ is essentially a matter of aesthetics, because there are no requirements forcing us either way. It is possible to exclude /j/ from the natural class, by making use of the [-cons] feature, but we could include it in the natural class by using the C feature instead. Without data to support or contradict either choice, the simplest solution is just to pick the most general analysis, in which case, we predict that /j/ would also be affected. But this is not a necessary prediction. Again however, we have no examples to contradict this prediction, so we can keep it.

Pushing further, we can actually generalize our rule even more. There is no data to contradict simplifying the rule to affect all consonants, whether they are sonorants or obstruents. (In fact, in many dialects of French, the uvular phoneme is actually a fricative /ʁ/, which does indeed devoice exactly where this analysis says it should, which supports the need for a rule that is not specific to sonorants.) Such a generalization also makes sense from a phonetic point of view: obstruents are more difficult to voice than sonorants, so if we find sonorants devoicing in a particular environment, it would be expected for obstruents to also devoice in the same environment.

Note that the same appeal to naturalness cannot be used to generalize our rule to include /j/ however, since /j/ is a vocoid, and vocoids have a strong tendency to be voiced. So while it is both more general and natural to include the obstruents, it would only be mildly more general to include /j/, and we gain nothing in naturalness. (As it turns out, /j/ doesn't even occur in the relevant environment in French anyway, so we can never properly test this part of our analysis!)

We cannot make the rule more general than that, however, because vowels are not affected by this rule, as we can see in words like [limite] 'limited', in which the vowel is in the correct environment, but remains voiced. Here, there is direct evidence that would contradict a more general rule.

Thus, we can analyze the devoicing in French with a rule that devoices all consonants when they are word-final and preceded by a voiceless sound. This rule is formalized as follows:

word-final consonant devoicing

$$C \rightarrow [-\text{voi}] / [-\text{voi}]_ \#$$

Since this rule causes two adjacent sounds to become more similar, it is a type of assimilation, which makes this a natural rule. In addition, part of the triggering environment is the end of the word, and word-final devoicing is a common, natural rule found in many languages. So, this is certainly a plausible rule that we should be unsurprised to find.

d. The following derivations show how the word-final consonant devoicing (WFCD) rule applies correctly to /R l m/ (1-3), and how it fails to apply when the rule's requirements are not met in various ways: targeting a word-final vowel instead of a consonant (4); targeting a medial consonant after a voiceless sound (4,5); and targeting a word-final consonant preceded by a voiced sound (5-7):

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UR	'to put' /mɛtʁ/	'uncle' /ɔ̃kl/	'rhythm' /ritm/	'symmetrically' /simetrikmã/	'to please' /plɛziʁ/	'table' /tabl/	'film' /film/
WFCD	ʁ	l̥	m̥	—	—	—	—
SR	[mɛtʁ̥]	[ɔ̃kl̥]	[ritm̥]	[simetrikmã]	[plɛziʁ]	[tabl]	[film]