CONSONANT GRADATION IN FINNISH

by

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Stops in Finnish are weakened in the environment of closed syllables by a rule of consonant gradation. How a stop will be affected by consonant gradation depends on the type of stop involved. If the stop is a geminate, then the stop is weakened to the corresponding non-geminate:

(1)	pp ~ p	piippu	~ piipun[1]	'pipe'
		helppo	~ helpon	'easy'
	tt ~ t	hattu	~ hatun	'hat'
		lantti	~ lantin	'coin'
	kk ~ k	paikka	~ paikan	'place'
		kirkko	~ kirkon	'church'

The occurrence of a liquid or nasal before the geminate stop will not alter the gradation of the stop.

On the other hand, the occurrence of a liquid or nasal before a single, non-geminate stop will affect gradation. For example, a single stop will be nasalized when preceded by a nasal:

(2)	mp ~ mm	lempe	~ lemmen	'love'
	nt ~ nn	ranta	~ rannan	'beach'
	ŋk ~ ŋŋ	saŋko	~ saŋŋon	'bucket'

Except when preceded by a nasal, the labial stop p is weakened to v:

(3)	p ~ v	halpa	~	halvan	'cheap'
		arpa	~	arvan	'chance'
		tapa	~	tavan	'custom'

The dental stop t will become a liquid when preceded by a liquid:

(4)	lt ~ ll	silta	~	sillan	'bridge'
	rt ~ rr	virta	~	virran	'stream'

Otherwise, t is weakened to d:

(5)	t ~ d	tahto	~	tahdon	'will'
		pato	~	padon	dam'

When preceded by a liquid or h and followed by the vowel e, the velar stop k is weakened to the glide j:

(6)	lke ~ lje	kulke	~	kuljen[2]	'to go'
	rke ~ rje	kurke	~	kurjen	'crane'
	hke ~ hje	puhketa	~	puhjetah[3]	'to burst'

In the environment of high, rounded vowels, k is gradated to v:

(7)	uku ~ uvu	suku	~	suvun	'kin'
	yky ~ yvy	kyky	~	kyvyn	'ability'

In all other environments, k is deleted:

(8)	k ~ Ø	alku	~	alun	'beginning'
		pyrki	~	pyrin[4]	'to strive'
		uhka	~	uhan	'threat'
		sika	~	sian	'pig'

In some cases, a preceding h blocks the deletion of k; for example:

(9) hk ~ hk[5] sähkö sähkön 'electricity'

Gradation will not affect the stop if the stop is preceded by s or by a non-homorganic stop:

(10) sp ~ sp piispa ~ piispan 'bishop'

st ~ st posti ~ postin 'mail'

sk ~ sk hauska ~ hauskan 'fun'

tk ~ tk matka ~ matkan 'trip'

Gradation applies only once to a given stop:

piippu + n → piipun

Gradation does not reapply:

piipun → *piivun

In addition, gradation cannot apply to an initial stop:

piippu → *viippu

Let us first consider the gradation rule for the non-geminate stops. Superficially, we could write rules like p → v, t → d, and k → Ø to handle most of the cases. For example, p → v occurs unless p is preceded by a nasal. We could therefore write the following rule for the gradation of p:

$$p \rightarrow v \; / \; \begin{bmatrix} +son \\ -nasal \end{bmatrix} \_\_ \; VC \; \begin{Bmatrix} C \\ \# \end{Bmatrix}$$

The feature for nasality [-nasal] must be specified because of case (2): p → m / m ___. Of course, we could order the

rule for nasal environment before this rule and thus eliminate the feature for nasality in that rule:

(1) $p \rightarrow v \; / \; [+son] \_\_\_ VC\{^{C}_{\#}$

With the other stops t and k, our gradation rule will not be as simple. For example, to handle case (4) we will need a rule like

$$t \rightarrow d \; / \; \begin{bmatrix} +son \\ -cons \end{bmatrix} \_\_\_ VC\{^{C}_{\#}$$

The feature [-cons] must be specified because of cases (2) and (4):

$t \rightarrow n \; / \; n \_\_\_$

$t \rightarrow l \; / \; l \_\_\_$

$t \rightarrow r \; / \; r \_\_\_$

But again, if we order the rule for liquid environment before this rule, as well as our rule for nasal environment, we will have

(2) $t \rightarrow d \; / \; [+son] \_\_\_ VC\{^{C}_{\#}$

But in order to naturally explain what happens with the velar stop, we cannot simply write

(3) $k \rightarrow \emptyset \; / \; [+son] \_\_\_ VC\{^{C}_{\#}$

because of cases (6) and (7). If k is preceded by either a liquid or h and followed by the vowel e, then $k \rightarrow j$ occurs. Hence, before $k \rightarrow \emptyset$ applies, we need the rule

$$(4)\quad k \rightarrow j \;/\; \begin{bmatrix} +\text{cont} \\ +\text{son} \\ -\text{syll} \end{bmatrix} \_\_\_ \; eC\left\{\begin{matrix} C \\ \# \end{matrix}\right.$$

Similarly, in order to explain case (7), we need the rule

$$k \rightarrow v \;/\; \begin{bmatrix} +\text{syll} \\ +\text{high} \\ +\text{round} \end{bmatrix} \_\_\_ \begin{bmatrix} +\text{syll} \\ +\text{high} \\ +\text{round} \end{bmatrix} C\left\{\begin{matrix} C \\ \# \end{matrix}\right.$$

There is evidence in Finnish that v is underlyingly the glide w.[6] Thus our rule will be

$$(5)\quad k \rightarrow w \;/\; \begin{bmatrix} +\text{syll} \\ +\text{high} \\ +\text{round} \end{bmatrix} \_\_\_ \begin{bmatrix} +\text{syll} \\ +\text{high} \\ +\text{round} \end{bmatrix} C\left\{\begin{matrix} C \\ \# \end{matrix}\right.$$

A later rule w → v will apply in all environments.

The problem is that we need a natural explanation for these rules. In once case, the front vowel e appears to cause a palatalization of k into a front glide. In the other case, a round glide is produced in the environment of high rounded vowels. These glides are, of course, voiced and continuous. Another problem is that each of our rules (1)-(5) is a gradation rule. We have specified the environment for gradation in each rule. Instead, let us consider the possibility that there is a single gradation rule that will apply to a non-geminate stop in the environment

$$[+\text{son}] \_\_\_ VC\left\{\begin{matrix} C \\ \# \end{matrix}\right.$$

and will change that stop to another segment. The problem is to determine what kind of segment the gradation rule will produce.

One possibility would be that the gradated segment is the voiced counterpart to the voiceless stop. This would give us a gradation rule of the form

$$\begin{bmatrix}-\text{cont}\\-\text{son}\end{bmatrix} \rightarrow [+\text{vcd}] \;/\; [+\text{son}] \;\_\_\_\; \text{VC}\begin{Bmatrix}\text{C}\\\#\end{Bmatrix}$$

We could then postulate certain rules operating independently of the environment for gradation that would give us the correct output:

$$g \rightarrow j \;/\; \begin{bmatrix}+\text{cont}\\+\text{son}\\-\text{syll}\end{bmatrix} \;\_\_\_\; e$$

$$g \rightarrow b \;/\; \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix} \;\_\_\_\; \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix}$$

and then $g \rightarrow \emptyset$ would apply in all remaining environments. The voiced labial stop b would be later converted to w by another rule.

There are some problems with this rule for gradation. First, in any loan words that originally contained voiced stops, these stops are generally pronounced as voiceless stops in standard Finnish. Thus $b \rightarrow p$, $d \rightarrow t$, and $g \rightarrow k$ rather than d remaining unchanged and $b \rightarrow w$ and $g \rightarrow \emptyset$. The old Baltic word for 'people', gansa, became kansa in Finnish, not *ansa. The Swedish loan words for 'dozen' and 'ball' are tusina and pallo rather than *dusina and *wallo or *vallo. Secondly, if the gradation rule just makes voiced stops, then why wouldn't the palatalization environment of

rule (4) merely change a voiced velar stop to a voiced palatal stop. In fact, the changes k → j and k → w imply that the stop must somehow become continuous as well as voiced.

An obvious alternative is that the gradation rule does something in addition to voicing the stops. A more natural solution is to claim, in fact, that gradation changes the voiceless stop to its corresponding voiced fricative, which will be a continuous segment:

(1') p → β

(2') t → δ

(3') k → γ

or more formally,

$$\text{(A)}\quad \begin{bmatrix}-\text{cont}\\-\text{son}\end{bmatrix} \rightarrow \begin{bmatrix}+\text{cont}\\+\text{vcd}\end{bmatrix} \;/\; [+\text{son}]\ \_\_\_\ \text{VC}\begin{Bmatrix}\text{C}\\\#\end{Bmatrix}$$

This formulation explains the rules of velar palatalization and labialization more naturally. Our secondary rules will therefore be:

$$\text{(4')}\quad \gamma \rightarrow \text{j} \;/\; \begin{bmatrix}+\text{cont}\\+\text{son}\\-\text{syll}\end{bmatrix}\ \_\_\_\ \text{e}$$

$$\text{(5')}\quad \gamma \rightarrow \text{w} \;/\; \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix}\ \_\_\_\ \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix}$$

Note that the change involved in rules (4') and (5') is very minor. The voiced fricative loses the feature of consonality, thus becoming a glide. The features for height, backness, and roundness for these glides are determined by the vowels in the

environmental specification. The remaining voiced fricatives will be finally realized as:

(6) $\beta \rightarrow w$

(7) $ð \rightarrow d$

(8) $\gamma \rightarrow \emptyset$

and there will be a low-level rule

(9) $w \rightarrow v$

One might claim that rule (7) is unnecessary in our earlier formulation since d would be produced by gradation directly. But in most dialects of Finnish d doesn't appear at all. Instead, the gradated t is either ð, l, or r, or is deleted. The d which appears in the standard language is a result of Swedish influence on Finnish.[7] The voiced dental fricative ð can naturally explain the dialectical appearance of the liquids l and r, also voiced dental continuants, in closed syllables. Similarly, the loss of the dental fricative in some dialects would be similar to the loss of the velar fricative in all dialects, including the standard language. We want to represent the fact that the voiced dental stop d is unnatural in Finnish. A gradation rule directly producing voiced stops would not capture this fact about Finnish.

We have already postulated that our gradation rule for single stops (rule A) is preceded by gradation rules for nasal and liquid environments; namely:

t → l / l ___

t → r / r ___

t → n / n ___

p → m / m ___

k → ŋ / ŋ ___

These rules are strikingly similar. Note first that the original stop is homorganic to the environmental consonant. Further, the environment's consonants are either liquids or nasals, that is, sonorant consonants. We could therefore express a single gradation rule for both liquid and nasal environments:

(B) $\begin{bmatrix}+\text{cons}\\+\text{son}\end{bmatrix}$ $\begin{bmatrix}-\text{cont}\\-\text{son}\end{bmatrix}$ $VC\begin{Bmatrix}C\\\#\end{Bmatrix}$

1 2 3 → 1 1 3

condition: 1 and 2 are homorganic

However, this rule seems to be both an assimilation rule and a gradation rule.

We have tentatively assumed that there is a single gradation rule for non-geminate stops. Let us consider the possibility that our original gradation rule (A) also applies to the consonant sequences mp, nt, ŋk, lt, and rt The environment of rule (A) specifies that the stop must be preceded by a liquid or a nasal. Rule (A) will cause the changes

mp → mβ

nt → nδ

ŋk → ŋγ

lt → lδ

rt → rδ

Now we can postulate a simple assimilation rule:

$$(B)\quad \begin{bmatrix}+\text{cons}\\+\text{son}\end{bmatrix}\begin{bmatrix}+\text{cons}\\+\text{cont}\\+\text{vcd}\end{bmatrix} \rightarrow \quad 1 \quad 1$$

condition: 1 and 2 are homorganic

There is independent evidence for this assimilation rule. In underlying stems in Finnish, as well as in surface forms, the consonant sequences lr, rl, nr, nl, ln, and rn are systematically lacking, although we do find the geminate clusters ll, rr, and nn. We could claim that there is a morpheme structure condition which will specify that a voiced consonantal segment preceded by a homorganic consonantal sonorant will have the same feature specifications as the preceding sonorant:

$$(B'')\quad \begin{bmatrix}+\text{cons}\\+\text{son}\end{bmatrix}\begin{bmatrix}+\text{cons}\\+\text{vcd}\end{bmatrix} \rightarrow \quad 1 \quad 1$$

condition: 1 and 2 are homorganic

This morpheme structure condition additionally acts as a phonological rule. For example, the past participle of tule

'to come' and pure 'to bite' will be derived from the underlying representations tule+nut and pure+nut. The stem-final e vowel will be deleted between dental sonorants, giving us the forms tulnut and purnut.[8] Using rule (B") as a phonological rule, we can explain why the past participles are realized as tullut and purrut. Note that rule (B") includes rule (B') since the voiced fricatives are voiced consonants. Thus rule (B") will produce the correct gradated segments:

mβ → mm

nδ → nn

rδ → rr

lδ → ll

ŋγ → ŋŋ

We can therefore eliminate this additional gradation rule (B) by allowing an independently-needed assimilation rule (B") to apply to the output of our original gradation rule (A). Of course, this assimilation rule will necessarily precede rules (4')-(9).

One further note on the environment for our gradation rule. We need the specification of sonorance for two reasons. First, it will block gradation from applying to such sequences as sp, st, and sk since the s is non-sonorant. Second, the extra segmental specification will automatically prevent the gradation rule from applying to a word-initial stop since the stop would

not be preceded by any segment, much less a sonorant segment.

We have now handled all the cases of gradation in Finnish except for the first case, the geminate stops. In accordance with the orthographic convention, we have represented these stops as a sequence of two homorganic stops. On the phonetic level, the geminate consonants are distinguished from single consonants by length.[9] It is not altogether obvious that phonetically long consonantal segments are underlyingly geminates. We must look for evidence that geminate stops exist at some level of representation. Consider first the environment for gradation; gradation takes place in a closed syllable. We have hitherto claimed that any sequence of two or more consonants or a single non-final consonant will close the preceding syllabic segment. Actually, if a sequence of two or more consonants occurs, a vowel must follow.[10] A syllable boundary will be inserted before the last consonant in a sequence of one or more consonants.[11] And of course, a syllable boundary automatically occurs whenever a word boundary occurs. The actual environment for consonant gradation should be

$$[+son] \_\_\_ VC.$$

where '.' stands for some underlying syllable boundary. The original environment

$$[+son] \_\_\_ VC\{^{C}_{\#}$$

claimed that there were two environments for gradation. It

missed the generalization that both CC and C# close the preceding syllabic segment.

Now if we assume that there are no underlying geminate consonants, but only long consonants, we will unnecessarily complicate our environment for gradation. We would have to include the fact that long consonants also close syllables; gradation would take place in the environment

$$[+son] \_\_\_ V\{^{C.}_{C:}$$

where 'C:' represents an underlying long consonant.

Independently of our gradation problem, we would have to explain why no long consonants ever occur in word-final position. Only single consonants can occur at the end of a word. There is, in fact, a rule that will delete consonants occurring before the word-final consonant:

$$C_0 \rightarrow \emptyset \; / \; \_\_\_ \; C\#$$

For example, consider the derivation of the nominative singular form of tarkoitukse 'purpose':

tarkoitukse → tarkoituksi[12] → tarkoituks[13] → tarkoitus

After the final i is deleted, the k preceding the final s must be deleted. Now consider the same derivation for a stem like sydämme 'heart':

sydämme → sydämmi → sydämm → sydäm → sydän[14]

If the sequence mm is actually a long m in underlying representation, we will have to change our rule of consonant deletion to

two rules:

$$C_0 \rightarrow \emptyset \; / \; \_\_\_ \; C\#$$

$$C: \rightarrow [-long] \; / \; \_\_\_ \; \#$$

The only common factor between these two rules is that consonants are altered in word-final position. The problem is that every time a rule involves sequences of consonants, we will have to build an extra subpart into the rule to account for the underlying long segments. In order to simplify our rules, we need only claim that phonetically long clusters are underlyingly geminates.

There is, in fact, independent evidence for a phonetic rule that converts an underlying sequence of homorganic stops to a long consonant.[15] Consider the derivation for the partitive of <u>käte</u> 'hand':

käte + tä → kättä → kät:ä

The stem-final <u>e</u> is deleted between the two dental stops. Phonetically, we end up with a long dental stop. In any event we will need a rule converting derived geminates into long segments.

The environment for gradation, however, also gives evidence that at the point the gradation rule applies to an underlying geminate stop, the stop has already been converted to a phonetically-long segment. To show this consider the possi-

bility that the gradation rule for geminates deletes one of the two homorganic stops. The problem is in determining which stop the rule will delete. The choice is completely arbitrary. We could delete the first or second of the stops:

$$(C)\quad [+son]\ \begin{bmatrix}-cont\\-son\\\alpha F\end{bmatrix}\ \begin{bmatrix}-cont\\-son\\\alpha F\end{bmatrix}\ VC. \qquad 16,17$$

$$1 \quad 2 \quad 3 \quad 4 \quad \rightarrow \quad 1 \quad \emptyset \quad 3 \quad 4 \quad \text{or}$$

$$1 \quad 2 \quad \emptyset \quad 4$$

In trying to chose between these two alternatives, we might try to argue that the structural change in rule (C) should be

$$1 \quad \emptyset \quad 3 \quad 4$$

since this would avoid some complications in the rules for syllable division. Consider the word kirkko 'church', which will be divided into syllables as kirk.ko. If the second stop is deleted, we would have kirk.on. Then we would need an additional rule to alter the syllable structure to kir.kon. If the first stop is deleted, there will be no need for this re-adjustment rule. The problem with this argument is that there is independent evidence for such a rule. Consider the derivation of the nominative singular for velje 'brother':

$$velje \rightarrow velji \rightarrow veli$$

The j is deleted before the final i. Before that rule takes place the syllable boundary is between the l and the j: vel.ji. After the rule operates, the syllable boundary must be shifted

to give us ve.li. The rules for syllable structure automatically apply in Finnish. If the second stop is deleted in kirk.ko, the syllable structure rule would apply.

In order to avoid specifying which of the stops is deleted, our rule could be:

$$(C') \quad \begin{bmatrix} -\text{cont} \\ -\text{son} \\ \alpha F \end{bmatrix} \begin{bmatrix} -\text{cont} \\ -\text{son} \\ \alpha F \end{bmatrix} \rightarrow \begin{bmatrix} -\text{cont} \\ -\text{son} \\ \alpha F \end{bmatrix} / [+\text{son}] \_\_\_ \text{VC}.$$

In using rule (C') we must somewhere specify that both stops are homorganic. Otherwise, the rule would apply to the sequence of stops in matka+n. If gradation gave us *makan or *matan, then we would have crucial evidence for a rule like

$$(C'') \quad [+\text{son}] \begin{bmatrix} -\text{cont} \\ -\text{son} \end{bmatrix} \begin{bmatrix} -\text{cont} \\ -\text{son} \end{bmatrix} \text{VC}.$$

$$1 \quad 2 \quad 3 \quad 4 \rightarrow 1 \quad \emptyset \quad 3 \quad 4 \quad \text{or}$$

$$1 \quad 2 \quad \emptyset \quad 4$$

If this were the case, we wouldn't need the specification for homorganity. This restriction claims that gradation doesn't really apply to sequences of stops. If we proposed that consonant gradation applied only to phonetically long consonants, we wouldn't need to restrict the rule of gradation to homorganic stops. Our rule for the gradation of homorganic stops could therefore be:

$$(D) \quad \begin{bmatrix} -\text{cont} \\ -\text{son} \\ +\text{long} \end{bmatrix} \rightarrow [-\text{long}] / [+\text{son}] \_\_\_ \text{VC}.$$

There is a problem with this rule, however. Consider a verb stem like viittata 'to point out'. In deriving the infinitive form, the final a will be deleted between the two t's:

viittata + tah → viittattah

We must convert the first sequence of tt into a phonetically long stop, but leave the second sequence as a homorganic sequence in order to meet the environment for gradation. Then when gradation applies to the second tt, it must be converted to a long stop. There is evidence in Finnish that several rules apply from left to right, including the rule of gradation itself.[18] If we let our rule of phonetic lengthening apply from left to right and before any given application of gradation, we can account for the derivation of viitatah:

underlying representation	viittata + tah
phonetic lengthening	viit:ata + tah
a-deletion	viit:attah
gradation	viitattah
phonetic lengthening	viitat:ah
gradation	viitatah

By this formulation, the rules of phonetic lengthening and gradation are applying in a cycle. Such a solution is in agreement with other arguments for a cycle in Finnish.

We have assumed that the gradation rule for long stops is separate from the gradation rule for single stops, rule (A).

Let us consider the proposition that rule (A) actually does apply to geminate stops. Of course, we still have the problem of determining which stop would be gradated to the voiced fricative. Suppose that rule (A) applied to the first stop, so that gradation would produce the sequences βp, δt, and γk. We would then need a rule to change βp to p, δt to t, and γk to k. Now the question is: Is there any evidence for a rule of the nature

$$\begin{bmatrix} +\text{cont} \\ +\text{vcd} \\ +\text{cons} \end{bmatrix} \rightarrow \emptyset \; / \; \_\_\_ \; \begin{bmatrix} -\text{cont} \\ -\text{son} \end{bmatrix}$$

Unfortunately, this proposed rule would eliminate such consonant clusters as rk, rt, rp, lk, lt, and lp in Finnish, which do occur: arka 'sensitive', virta 'stream', arpa 'chance', alku 'beginning', aalto 'wave', and halpa 'cheap'. Thus we would have to reformulate our rule to act only on non-sonorant segments; that is, on only those voiced continuants produced by gradation:

$$\begin{bmatrix} -\text{son} \\ +\text{cont} \\ +\text{vcd} \end{bmatrix} \rightarrow \emptyset \; / \; \_\_\_ \; \begin{bmatrix} -\text{cont} \\ -\text{son} \end{bmatrix}$$

This rule is ad-hoc since there is no other evidence for its existence in Finnish.

On the other hand, suppose that rule (A) applied to the second stop, thus producing the sequences pβ, tδ, and kγ. Again, we would need a rule of the form

$$\begin{bmatrix}+\text{cont}\\+\text{vcd}\\+\text{cons}\end{bmatrix} \rightarrow \emptyset \; / \; \begin{bmatrix}-\text{cont}\\-\text{son}\end{bmatrix} \_\_$$

to change pβ to p, tδ to t, and kγ to k. This rule, like the other one, would eliminate the consonant clusters kr, tr, pr, kl, tl, and pl in Finnish. Although these clusters do not occur with any great frequency in Finnish, there are a few examples of words containing clusters of stops followed by liquids: vuokra 'rent', vikla 'sandpiper', atrain 'fish spear', hiprakka 'state of drunkedness', kupla 'bubble'. Again our proposed rule would eliminate such clusters. Historically, such clusters have actually been eliminated, but whenever they have been, it has been the stop and not the liquid which has been affected. Thus atrain → ahrain 'fish spear', nakris → nauris 'turnip', eklen → eilen 'yesterday'.[19] So if we restrict our rule to apply to only non-sonorants, we will again have an ad-hoc rule. It appears then that there is no natural way to make the gradation rule for single stops apply to geminate stops.

In summary, there are two rules of gradation in Finnish, one to shorten the phonetically long stops and another to gradate the single stops. The environment for both rules is the same. In some sense, we want to claim that both gradation rules are the same. Both rules weaken stops in closed syllables. No rules are ever crucially ordered between these gradation rules. For a given stop in a closed syllable, only one of the rules will

apply. We could order the rules disjunctively in order to prevent gradation from re-applying to a stop which has already been gradated.[20]

In many borrowed words, geminate stops obey gradation while single stops do not. For example, the genitive of auto 'car' is auton, not *audon, but the genitive of Amerikka 'America' is Amerikan, not *Amerikkan. If we only have one gradation rule we must state that borrowed words containing single stops are not subject to gradation. If we have two separate rules -- or two subparts to a single rule -- we need only say that the gradation rule for long stops applies to borrowed words.[21] Similarly, this phenomenon holds for proper names in the native vocabulary of Finnish. The genitive of Sirpa is Sirpan, not *Sirvan, but the genitive of Sirkku is Sirkun rather than *Sirkkun.

We have proposed the following two rules to handle gradation of stops in Finnish:

$$\text{(D)} \quad \begin{bmatrix} -\text{cont} \\ -\text{son} \\ +\text{long} \end{bmatrix} \rightarrow [-\text{long}]$$

$$\text{(A)} \quad \begin{bmatrix} -\text{cont} \\ -\text{son} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cont} \\ +\text{vcd} \end{bmatrix}$$

Both rules occur in the environment of the closed syllable:

$$[+\text{son}] \_\_\_ \text{VC}.$$

If rule (D) applies to a given consonant cluster, rule (A)

cannot. Our independently motivated assimilation rule will now apply:

(B") $\begin{bmatrix}+\text{cons}\\+\text{son}\end{bmatrix}\ \begin{bmatrix}+\text{cons}\\+\text{vcd}\end{bmatrix}$

$1 \qquad 2 \quad \rightarrow \quad 1 \quad 1$

condition: 1 and 2 are homorganic

The velar fricative produced by rule (A) will now be altered in certain special environments to a glide:

(4') $\gamma \rightarrow j \ / \ \begin{bmatrix}+\text{cont}\\+\text{son}\\-\text{syll}\end{bmatrix} \_\_\_ \ e$

(5') $\gamma \rightarrow w \ / \ \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix} \_\_\_ \ \begin{bmatrix}+\text{syll}\\+\text{high}\\+\text{round}\end{bmatrix}$

In standard Finnish all the remaining voiced fricatives will be eliminated by the following rules:

(6) $\beta \rightarrow w$

(7) $\delta \rightarrow d$

(8) $\gamma \rightarrow \emptyset$

In all environments the glide w will be realized as v:

(9) $w \rightarrow v$

FOOTNOTES

[1] Unless the example is a verb, the first form is the stem of a noun or adjective, the second is the genitive singular.

[2] kuljen is the present first person singular of the verbal stem kulke.

[3] puhjetah is the infinitive form of the verbal stem puhketa derived as follows:

puhketa + tah → puhkettah → puhjetah

Incidentally, this example shows that gradation applies either from left to right or simultaneously. Both hk and tt must be in closed syllables when gradation applies.

[4] pyrin is the present first person singular of the verbal stem pyrki.

[5] In all cases ht gradates to hd. Further, hke always gradates to hje. This implies that the alternation hk ~ h should be viewed as the normal, expected case. Those words in which alternation does not occur should be viewed as exceptions. Historically, these items may not have been exceptions since many h's have been derived from obstruents (cf. Hakulinen and Rapola). As will be seen, gradation does not apply to stops preceded by other obstruents, such as s.

[6] For example, the verb stem käy [käü] 'to visit' has the imperfect form kävi. The problem is to naturally explain the v in the imperfect form and the loss of the high round vowel ü which is found in the underlying stem. Independently, we can show that Finnish has a rule of the form

$$\begin{bmatrix} +\text{syll} \\ +\text{high} \end{bmatrix} \rightarrow [-\text{syll}] \; / \; [+\text{syll}] \_\_\_ [+\text{syll}]$$

For example, the genitive of poika 'boy' is pojan, not *poian. We can use this rule to explain the v in the imperfect of käy. The underlying form would be käü+i. ü → ʊ would occur intervocalically, giving käʊi. A low-level rule changing the rounded glides w and ʊ to the voiced fricative v would be very natural since both segments are already voiced and continuous.

[7] Collinder (1965), p. 68.

[8] There is a general rule of e and ä deletion in Finnish. In verb stems e is deleted in the environment

[+syll] [dental sonorant] ___ + [non-labial stop] V

In nouns and adjectives, e is deleted after t also:

[+syll] [dental consonant] ___ + [non-labial stop] V

ä-deletion is basically the same except that it is blocked from applying in the second syllable (cf. Skousen (1971), pp. 4-17).

[9] Skousen (1970a).

[10] Except in obvious loan words, consonant clusters can only occur internal to the word.

[11] In the native vocabulary, syllable boundaries (here represented as '.') occur in the following positions: V.CV, VC.CV, and VCC.CV.

[12] e → i / ___ #

[13] In the native vocabulary, i → Ø / ___ # unless i ends a two-syllable stem.

[14] m → n / ___ #

[15] I owe much of the following argument to Charles Pyle. He noticed that the gradation of geminates is arbitrary in that either one of the stops in the geminate could be deleted. He suggested that the rule of gradation actually applies to long segments rather than to a sequence of homorganic segments.

[16] Actually the environmental specification of sonorance is predictable for the gradation of geminates since no geminate occurs in word-initial position and s never precedes a geminate consonant cluster. In other words, a sonorant segment must precede every geminate cluster.

[17] The notational device αF specifies that all other segmental features are the same. This guarantees that both stops are identical.

[18] Cf. L. Anderson (1967) and Skousen (1970b), pp. 35-51.

[19] Rapola (1966), pp. 197-218.

[20] We could equivalently switch the order of these rules and allow the rules to apply conjunctively. But of course the rule for single stops would never feed the rule for phonetically long stops. Thus the conjunctive ordering would be trivial.

[21] S. Anderson (1969), pp. 103-109.

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