Copying Contiguous Gestures: An Articulatory Account of Bella Coola Reduplication

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1 Introduction

Partial reduplication has long been of interest to phonologists, because it identifies a string of segments that forms a unit but is not identical to a pre-existing morpheme. It is therefore tempting to assume that reduplication makes reference to a phonological unit of some kind. Using articulatory gestures as the fundamental unit of representation, I intend to show that reduplication in the Salish language Bella Coola (also called Nuxalk) is best described as the copying of a contiguous sequence of coordinated gestures. While previous analyses have described Bella Coola reduplication as highly irregular, several generalizations emerge on the gestural level, which cannot be expressed on the segmental level.

2 Previous Analyses of Bella Coola Reduplication

Reduplication in Bella Coola always copies a sequence of 2 or 3 segments, one of which must be a vowel or sonorant. It is generally accompanied by one or several sound changes in the base or in the reduplicant, such as syncope, vowel lengthening, consonant alternation or deletion. In this analysis, I will restrict myself to those alternations which occur in the reduplicant.

Reduplication in Bella Coola has been described as highly variable by Newman (1971) and Nater (1984), who distinguish 29 and 51 different patterns of reduplication respectively. Bagemihl (1991) narrows it down to essentially three basic patterns, shown in (1). In (1) and throughout, the reduplicative morpheme is underlined.

(1)	CV-[1]	sum	<u>su</u>sumii[2]	'trousers (+DIM.)' (Nater 1984:109)
	CVC-	silin	<u>sil</u>slini	'kidney (+DIM.)' (Newman 1971:37)
	?V-[3]	k'c	<u>?n</u>k'ci[4]	'sperm whale (+DIM.)' (Nater 1984:109)

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[1] The labels CV, CVC etc. refer to the segmental content of the reduplicant, where V may stand for either a vowel or a syllabic sonorant.

[2] The diminutive also requires the suffix -i/-ii/-y/-yi (Nater 1984: 56).

The main reason for the divergent numbers of patterns in previous analyses is that reduplication may "skip" word-initial consonants, as shown by the examples in (2).[5] Newman (1971) and Nater (1984) analyzed these cases as suffixation or infixation. As pointed out by Bagemihl (1991), the uncopied segments in these forms never include vowels or sonorants.

(2) stn stntni 'tree (+DIM.)' (Nater 1990:116)
tq'ɬa tq'ɬaaɬay 'knife (+DIM.)' (Nater 1984:109)
pɬtkn pɬtknknɬp 'bark of bitter cherry tree' / 'bitter cherry tree' (-ɬp 'tree') (Nater 1984:90)

As shown in (2), reduplication always copies the leftmost vowel or sonorant. Assuming that the copied vowel or sonorant is the nucleus of a syllable, Bagemihl (1991:612f) claims that reduplication "affixes a template to the first syllable of the word." In his analysis, the uncopied segments that precede the reduplicant in (2) are not part of any syllable, and reduplication therefore copies only those elements which belong to a syllable in the base. However, the claim that reduplication targets a syllable is weakened by the fact that it may copy less or more than a syllable, as shown in (3) and (4) respectively.

(3) sma smsma 'story, myth' / 'tell a story' (Bagemihl 1991:619)
x^wnaɬ x^wnx^wnaaɬi 'well, spring (+DIM.)' (Bagemihl 1991:615)
(4) milix^w milmilix^{w}ɬp 'bear berry' / 'bear berry plant' (Nater 1984:108)
silin silslini 'kidney (+DIM.)' (Newman 1971:37)

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[3] Bagemihl (1991: 603f) interprets the glottal stop as epenthetic and refers to this pattern as V-reduplication (see 4.4. below).

[4] Bella Coola has the following inventory (' denotes glottalization):

p	t	c		k	k^w	q	q^w	
p'	t'	c'	ƛ'	k'	$k^{w'}$	q'	$q^{w'}$	ʔ
		s	ɬ	x	x^w	χ	$χ^w$	(h)
m	n		l					
			i (y) u (w)				a	

Adapted from Bagemihl (1991: 591) and Nater (1984: 3). I follow Carlson (1997) in rejecting a separate phoneme status for "syllabic" sonorants.

[5] Reduplication also serves to express a variety of meanings (most typically the diminutive or the continuative), but these grammatical functions are not associated with specific patterns, unlike in other Salish languages.

Carlson (1997) demonstrates that many of the phonological alternations between base and reduplicant in Bella Coola can be explained as a case of "the emergence of the unmarked," following McCarthy and Prince (1994). For example, she proposes a number of markedness constraints against secondary articulation that prevent ejectives and labialized consonants from surfacing in the reduplicant coda (as shown in 5).

(5) six^{w} sixsix^{w} - 'burn (+CONT.)' (Newman 1971:36)
nik'- nixnik'- 'cut (+CONT.)' (Bagemihl 1991:601)

However, an important problem for her analysis is posed by the pattern of ʔV-reduplication, where a prevocalic ejective in the base corresponds to a glottal stop in the reduplicant. Carlson (1997:38) interprets these cases to be caused by the same markedness constraint against secondary glottalization that prevents ejectives from surfacing in the reduplicant coda, but she does not explain why this markedness constraint causes ejectives to be copied differently, depending on whether they are prevocalic or postvocalic. As shown in (6), ejectives lose their secondary glottalization in the reduplicant coda, but their oral place of articulation in the onset.

(6) nik'- nixnik'- 'cut (+CONT.)' (Bagemihl 1991:601)
k'nc ʔnk'nci 'sperm whale (+DIM.)' (Nater 1984:109)

All previous analyses have in common that they rely on lexical specification of reduplicative patterns. Using the articulatory gesture as the main unit of analysis, I intend to show that reduplication in Bella Coola is in fact more predictable than previously assumed.

3 Theoretical Background

My analysis draws upon the gestural model developed by Browman and Goldstein (1988, 1991, 1992), which proposes the articulatory gesture as the fundamental unit of phonological analysis. Gestures are "characterizations of discrete, physically real events that unfold during the speech production process" (Browman and Goldstein 1992:156). They are dynamically defined units with a spatial and a temporal dimension, involving different sets of articulators and contrasting on the basis of constriction degree and location. As the notion of movement implies a beginning and an end, articulatory gestures are delineated by the *onset* of movement (i.e. the point at which an articulator begins moving towards its target), the *achievement* of target (where

the constriction is held for a certain amount of time, resulting in a so-called *gestural plateau*, with the *c-center* as its midpoint), and finally the *release*, when the articulator begins to move away from the target. These discernible points in time that characterize the gestural movement can be referred to as *landmarks* (Gafos, to appear).

As characterizations of spatio-temporal articulatory events, gestures may overlap in various ways with other gestures. Gestures belonging to different segments may overlap substantially, for example English prevocalic consonant clusters (Browman and Goldstein 1991:318). On the other hand, gestures belonging to the same segment, such as the velic and lip gestures of English [m], do not necessarily occur simultaneously, and their relative timing may even vary according to the syllable position of the segment, as demonstrated by Krakow (1989) (see also Browman and Goldstein 1995).

My analysis also relies heavily on the distinction between *vocalic* and *consonantal* gestures, proposed by Sproat and Fujimura (1993), and others. They are distinguished on the basis of constriction degree, where "consonantal gestures are those that produce an extreme obstruction in the mid-sagittal plane" and vocalic gestures do not, but may instead produce an opening. Consequently, the component gestures of vowels are vocalic and the component gestures of obstruents are consonantal. However, sonorant consonants consist of both vocalic and consonantal gestures. For example, the velic opening gesture of nasals can be defined as vocalic because it produces an opening, while their oral gestures (e.g. lips or tongue tip) are consonantal because they produce a closure.

The partial overlap of tautosegmental gestures demonstrated in the above mentioned studies suggest that segments which consist of several gestures (such as nasals, glides and liquids, but also segments with secondary articulation) can be interpreted as sequences of gestures. Unless the gestures are simultaneous, their respective landmarks are sequentially ordered. Articulatory phonology thus allows a dual representation of lexical items. Words are thought of primarily as sequences of segments, yet as these segments can be broken down into their component gestures, entire words can be interpreted as sequences of overlapping gestures as well.

4 Gestural Analysis of Bella Coola Reduplication

The following analysis of Bella Coola reduplication intends to show the phonological relevance of both intersegmental and tautosegmental timing patterns. In the absence of articulatory data on Bella Coola, I will attempt to characterize gestural timing patterns based on the available descriptions (in particular Newman 1947 and Nater 1984), and draw upon evidence from

other Salish languages where possible (e.g. Steriade 1997). The available descriptions indicate the presence of audible releases between obstruents, with the exception of homorganic stop-fricative or fricative-fricative sequences. I will thus assume a pattern of intersegmental CC-coordination that allows for a transition period between the release of the first consonant and the achievement of target of the second consonant. On the basis of these assumptions, a number of generalizations can be made about reduplication in Bella Coola.

4.1 Identifying the Reduplicant

As shown in (1) above, the reduplicant always contains a vowel or sonorant. Given that a sonorant segment consists of a vocalic and a consonantal gesture, we can generalize that the reduplicant always contains at least one vocalic gesture. It appears thus, that reduplication always targets the leftmost vocalic gesture in the base, irrespective of whether it is part of a vowel or a sonorant on the segmental level. Given this generalization, we can explain why *sma* 'story' in (3) above reduplicates as *sm**sma*** and not as ***sma**ma*. The velic opening gesture of the sonorant is copied as the first vocalic gesture of the base, whereas the pharyngeal gesture of the vowel is the second vocalic gesture and therefore not targeted by reduplication.

The segment containing the targeted vocalic gesture however must be preceded by an onset, as evidenced by all patterns shown in (1). In stems with an initial sonorant-vowel sequence, e.g. *nik'* 'to cut' in (6), both sonorant and vowel are copied, resulting in ***nix**nik'* and not ****n**nik'*.

4.2 Sonorants in the Reduplicant

Sonorant consonants frequently occur in the nucleus of the reduplicant. However, Bagemihl (1991:605) observes that stems with a pre-vocalic obstruent-sonorant cluster as in (3) never occur with a coda in the reduplicant. This is also true of stems with a syllabic sonorant, with two exceptions known to me, both of which are attested only in one source (Newman 1971).[6] These exceptions aside, the generalization holds that syllabic sono-

[6]The forms are *mnɬkʷa* → ***mn**ɬmnɬkʷni* 'hair (+DIM.)' and *kɬ-* → ***kn**ɬkn**ɬ*-* 'fall (+CONT.)' (Newman 1971: 37, 36). Nater (1984, 1990) does not give reduplicative forms for either stem. Note that ***kn**ɬkn**ɬ*-* involves the insertion of a sonorant in the base of an obstruent-only stem. Other exceptional reduplicant shapes occurring with obstruent-only stems (e.g. the maintenance of the uvular in *sχ* → ***si**χs**χ*** 'to peel (+CONT.)', Newman 1971: 36) suggest that different faithfulness constraints may apply for these

rants do not participate in CVC-reduplication, as shown in (7). This generalization appears to have been overlooked in previous analyses.

(7)	k'nc	?nk'nci	'sperm whale (+DIM.)' (Nater 1984:109)
	tqnk-	tqnqnk	'underneath' / 'underwear' (Newman 1971:38)
	smɬk	smsmɬk	'fish (+DIM.)' (Nater 1990:112)
	tlk^{w}-	tltllk^{w}	'to swallow' / 'pill' (Nater 1990:128)
	q'lsx^{w}	?lq'lsx^{w}i	'rope (+DIM.)' (Nater 1990:102)

All stems in (7) include a consonant that follows the sonorant, but which is not copied. As mentioned above, sonorant segments consist of both a vocalic gesture and a consonantal gesture. Independent of their exact temporal coordination, the gestural content of an obstruent-sonorant sequence can be compared to that of a sequence of consonant-vowel-consonant, as in (8).

(8)	tlk^{w}	tltllk^{w}	'to swallow' / 'pill' (Nater 1990:128)
	tiiχ^{w}	tixtiiχ^{w}m	'hit' / 'drive poles for eulachon net' (Nater 1984:109)

Both reduplicants in (8) consist of four gestures. Following the initial consonantal segment (/t/ with its tongue tip and glottal gestures), both reduplicants contain a vocalic gesture, namely the tongue body gesture of /i/ in *tix* and the tongue dorsum gesture of /l/ in *tl*. Furthermore, both contain a subsequent consonantal gesture which is coordinated with the vocalic gesture (the tongue body gesture of the fricative in *tix*, the tongue tip gesture of the /l/ in *tl*). In both cases, we find that the vocalic gesture is coordinated with two preceding consonantal gestures and with one subsequent or simultaneous one. This generalization, which can only be stated at the level of gestures, is summarized in (9), as well as in figures 1 and 2.

(9)		Segmental content	Gestural content
tl	(*tltllk^{w}*)	CL	CCVC
tix	(*tixtiiχ^{w}m*)	CVC	CCVC

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stems. Bagemihl (1991: 607) notes that of the 12 obstruent-only roots that participate in reduplication (to his knowledge) all but one reduplicate as CVC. Interestingly, this one exception also involves nasal insertion: *ɬq'-* → *ɬnɬnq'* 'slap (+CONT.).'

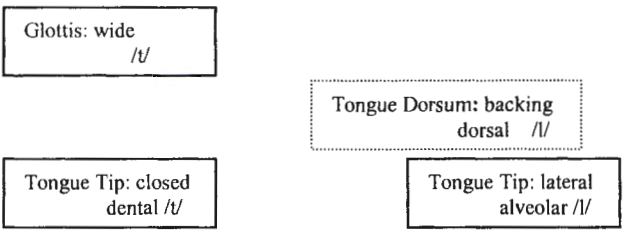

Figure 1. Gestural score for *tl-* (the dotted line indicates a vocalic gesture)[7]

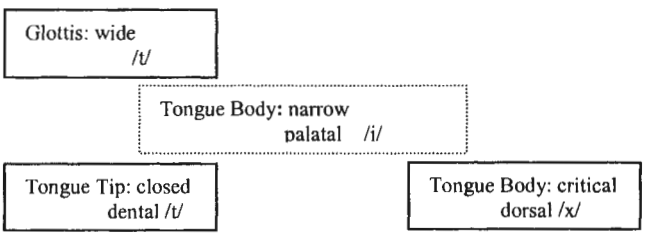

Figure 2. Gestural score for *tix-* (the dotted line indicates a vocalic gesture)

4.3 The Reduplicant Coda

If we claim that sonorants cannot be followed by a consonant in the reduplicant, this leads us to the general question of which segments may be found in post-vocalic position in the reduplicant at all. As Carlson (1997:32) points out, the set of segments that are found in this position is limited, consisting exclusively of fricatives and sonorants (*l*, *ɬ*, *x*, *s*, and *n*, "with a few exceptions"). In the data available to me, the exceptions set aside by Carlson consist of a number of cases in which the reduplicant coda is occupied by *m*, *w*, or *χ*, as well as one reduplicant ending in x^w in a number of lexicalized forms.[8] Even including these exceptions, the generalization can be maintained that only fricatives, sonorants and glides are allowed in the reduplicant coda.

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[7] In order to illustrate the coordination of gestures, I adopt the notational device of a *gestural score* (Browman and Goldstein 1991:317). The gestures are represented by boxes, whose spacing from left to right represents the gestures' temporal sequencing.

[8] They are *mux ʷmuk ʷɬ* 'bluegrouse', *mux ʷmuk ʷɬxɬp* 'goatsbeard (plant)' and *mux ʷmukuuɬ* 'gold', of which the last two seem to be derived from the stem *muk ʷ* 'red' (Nater 1990:75-76). Note that all three have the vowel [u], which contains a lip rounding gesture that could arguably be extended to effect labialization of the fricative.

On the gestural level, the fricatives which occur in post-vocalic position in the reduplicant can be described as consisting of no more than one (oral) consonantal gesture. We can thus generalize that the vocalic gesture at the nucleus of the reduplicant can be followed by no more than one consonantal gesture. If the vocalic gesture is part of a vowel, the following consonantal gesture can belong to a different segment, but if it is part of a sonorant, it cannot, because the sonorant already contains a consonantal gesture.

The failure of syllabic sonorants to participate in CVC-reduplication can thus be explained easily on the gestural level, if we posit a constraint *COMPLEX-G which prohibits sequences of consonantal gestures (10).

(10)*COMPLEX-G sequences of consonantal gestures are prohibited

Given the abundance of consonant clusters in Bella Coola, this constraint must be low ranked, but it outranks Faith-BR. It can be seen as related to VC-coordination. Browman and Goldstein (1988:152) note (for English) that post-vocalic consonant sequences cannot act as a unit, because only the first of them "will be linked to, and partially overlap the vowel" but not the following consonant. Assuming that this pattern holds for Bella Coola, we can assume that only one following consonantal gesture may overlap the targeted vocalic gesture of the reduplicant.

Several alternations between postvocalic consonants in the base and in the reduplicant are motivated by the constraint *COMPLEX-G. When segments with secondary articulation occur in postvocalic position in the base, they are either not copied at all, or they correspond to a permissible segment in the reduplicant. For example, as pointed out by Carlson (1997), postvocalic glottalized velars and uvulars in the base correspond to a velar fricative in the reduplicant. Examples are shown in (11).

(11)	nik'-	nixnik'	'cut (+CONT.)' (Bagemihl 1991:601)
	sik^{w}'-	sixsik^{w}'-	'pull (+CONT.)' (Newman 1971:36)
	niq'χ	nixniq'χm	'otter' / 'to have cramps' (Nater 1984:108)
	ƛ'aq^{w}'t	ƛ'axƛ'aq^{w}' ɬp	'Douglas fir bark/tree' (Nater 1984:108)

As stops with secondary articulation, each of these segments consists of (at least) two different gestures, an oral gesture and a glottal gesture. Articulatory data for Bella Coola was not available to me, but the existing descriptions allow one to conclude that the oral closure must precede the glottal gesture. For example, according to Nater (1984:19) an ejective is "phonetically identical" to a sequence of plain occlusive and glottal stop. This is consistent with cross-linguistic descriptions, such as Ladefoged and Maddieson

(1996:78), Kingston (1985:252), or Steriade (1997:77). For example, according to Silverman (1997:58) "ejectives involve a glottal constriction ... during an oral closure. ... After oral release, glottal closure is released as well." Based on these descriptions, it is plausible to assume that the landmarks of the oral gesture precede the corresponding landmarks of the glottal gesture, as illustrated by the gestural score in figure 3.

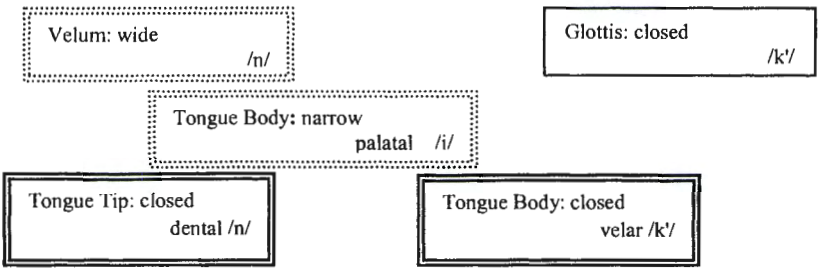

Figure 3. Gestural score for *nik'-* (reduplicating gestures indicated by a double frame, vocalic gestures indicated by a dotted frame)

As indicated in figure 3, reduplication copies only the tongue body gesture, but not the glottal gesture. The tongue body gesture of [k'] is presumed to reduplicate, as it shares both the articulator set and the constriction location with the corresponding gesture of [x] in the reduplicant. The two corresponding gestures thus differ merely in their constriction degree, as stops are disallowed in the reduplicant coda.

The same process is found with labialized velars and uvulars, which reduplicate as the velar fricative as well, as shown in (12). The available descriptions of labialized segments in Bella Coola (e.g. Nater 1984:4), as well as cross-linguistically (Ladefoged and Maddieson 1996:356-8), suggest again that the tongue body gesture precedes the lip-rounding gesture.

(12)	cak^{w}	cax-cak^{w}a$\dot{\text{t}}$	'long' / 'tall person' (Nater 1984:108)
	six^{w}	six-six^{w} -	'burn (+CONT.)' (Newman 1971:36)
	tiiχ^{w}	tix-tiiχ^{w}m	'hit' / 'drive poles for eulachon net' (Nater 1984:109)

In both postvocalic glottalized and labialized segments, reduplication copies that gesture which is closer to the targeted vocalic gesture. This generalization can be captured by positing a constraint I-CONTIG-G that requires the copying of a contiguous string of gestures in the base, shown in (13).

(13) I-CONTIG-G reduplication must copy a contiguous string of gestures in the base.[9]

The tableau in (14) shows how the contiguity constraint interacts with the constraint posited in (10) in assuring that reduplication copies only the first consonantal gesture following the targeted vocalic gesture.

(14) Partial copying of post-vocalic ejectives

/RED+nik'/	I-CONTIG-G	*COMPLEX^{G}	*CODA-STOP	MAX-BR
nik'nik'		!*	**	
☞ nixnik'			*	*
niknik'			**!	*
ni?nik'	*!		**	*

4.4 The Reduplicant Onset

A final generalization can be found in prevocalic position. While stops and multiply articulated segments occur in the reduplicant onset, prevocalic ejectives in the base mostly correspond to glottal stops in the reduplicant, as shown in (15). Yet when the reduplicant is preceded by a consonant-final prefix, no glottal stop is found (16). As a consequence, Newman (1971), Nater (1984), and Bagemihl (1991) interpret the glottal stop in (15) as epenthetic and posit a separate pattern of reduplication, labeled V-reduplication by Bagemihl. A small number of stems (five, according to Nater 1984:109), follow this pattern without having an ejective in the base (17).

(15) k'nc ʔnk'nc 'sperm whale (+DIM.)' (Nater 1984:109)
c'usm ʔusc'usmi 'evening' / 'dusk' (DIM.) (Nater 1984:109)
(16) t'li sɬt'liisɬ / *sʔɬt'liisɬ 'dog salmon' / 'horsefly'[10] (Nater 1984:59)
(17) knic snknic 'to eat' / 'food' (Nater 1984:109)

[9] I follow McCarthy and Prince (1995) in distinguishing between input- and output-contiguity. This constraint prevents skipping, but not insertion. Carlson (1997) proposes a segmental contiguity constraint that is highly ranked in her analysis.

[10] Literally 'characteristic of dog salmon season' (*s-* nominalizer, *-sɬ* 'characterizer').

Nevertheless, most stems with initial ejectives reduplicate with this pattern, especially those with a syllabic sonorant.[11] According to Bagemihl (1991:604), Bessell (1988) interprets these forms as the result of debuccalization, i.e. the deletion of all non-laryngeal features in the onset segment. Bagemihl argues against this analysis by pointing out that the glottal stop fails to surface after consonant-final prefixes in reduplicated forms, but not in un-reduplicated forms, where it is underlying as in (18).

(18)	ʔmt	sʔmtsta / *smtsta	'to sit down' / 'chair' (Nater 1984:20)
(19)	ʔlq'	slq' / *sʔlq'	'to think' / 'brain, mind' (Nater 1984:20)

However, (19) shows that this is not always the case. Moreover, glottal stops are frequently found to be deleted in "allegro speech" (Nater 1984:20). The short text included in Nater (1984:139ff), contains many instances of ʔ-deletion, especially in affixes (e.g. *ʔaɬ-* 'stative-progressive', *ʔac-* 'demonstrative', *-ʔituk* 'but'). It appears that ʔ-deletion occurs commonly in the onset of bound grammatical morphemes, i.e. exactly the environment found in reduplication. In the TETU framework (McCarthy and Prince 1994), the contrast between **sʔɬt'liisɬ* (16) and *sʔmtsta* (18) is not surprising, as long as we posit that the markedness constraint[12] causing ʔ-deletion is ranked below FAITH-IO, but above FAITH-BR. Instead of assuming ʔ-epenthesis in some contexts and ʔ-deletion in others, it is preferable to propose underlying ʔ in the reduplicant and ʔ-deletion after consonant-final prefixes. ʔV- and ʔVC-shaped reduplicants can then be subsumed under the patterns CV and CVC.

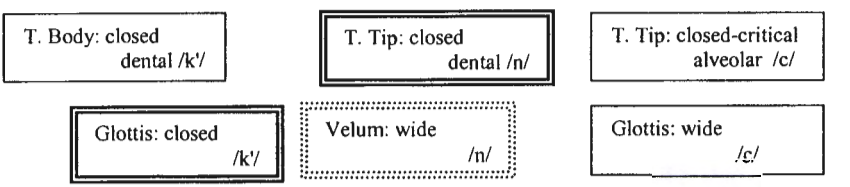

Figure 4. Gestural score for *k'nc* (reduplicating gestures = double frame)

[11] I identified 24 stems with an ejective-sonorant sequence. 22 reduplicate as in (15).
[12] Cross-linguistically, glottal stops are most salient in pre-vocalic position, thus they have to be considered marked in this environment (s_m), following Kingston (1985), Silverman (1997) and Steriade (1997). Note also that Bagemihl (1991: fn. 19) concedes that the glottal stop does surface in the reduplicant after a vowel-final prefix.

The gestural timing of ejectives was discussed above in 4.3. It is illustrated again here in figure 4, with a prevocalic ejective. As in the above examples, we find that reduplication copies a contiguous string of gestures. What appears as ?V-reduplication on the segmental level, can again be demonstrated—for sonorants—to satisfy a CVC-template on the gestural level, as the reduplicant consists of a consonantal gesture (glottal constriction) followed by a vocalic gesture (velum) and another consonantal gesture (tongue tip constriction). In contrast to the postvocalic ejectives, it is the glottal gesture and not the tongue body gesture, which is copied here. However, as in the previous cases, reduplication copies that consonantal gesture which is closer to the vocalic gesture.

Recall that Carlson (1997) proposes a markedness constraint against secondary articulation and notes that the same constraint prevents ejectives from surfacing in prevocalic or postvocalic position. However, her analysis does not explain which component gesture of the ejective is copied. In contrast, an analysis that relies on gestural contiguity can explain this difference, as reduplication must copy that gesture which is closer to the copied vocalic gesture. The correct forms for both pre-vocalic and post-vocalic ejectives can be derived with the constraints stated above, as shown (20) and (21).

(20) Partial copying of post-vocalic ejectives

/RED+nik'/	I-CONTIG-G	*COMPLEX-G	MAX-BR
a. nik'nik'		!*	
☞b. nixnik'			*
c. ni?nik'	*!		*

(21) Partial copying of pre-vocalic ejectives

/RED+k'nc/	I-CONTIG-G	*COMPLEX-G	MAX-BR
a. k'nk'nc		!*	
b. knk'nc	*!		*
☞c. ?nk'nc			*

The candidates under (a) copy the ejective, violating *COMPLEX-G. It is then I-CONTIG-G that selects which component gesture is to be copied. Browman and Goldstein (1988) show that languages with close transition between consonantal gestures (e.g. English) allow several prevocalic gestures to be coordinated with the vowel. Bella Coola however has open transition between consonantal gestures, i.e. adjacent consonants are non-overlapped (see Steriade 1997). As a result, only one pre-vocalic consonant may overlap with a following vowel. Applying this pattern to multiply ar-

ticulated segments, we can conclude that there does not seem to be sufficient overlap between the component gestures of ejectives for both to be coordinated with the vowel. As a consequence, we can identify the consonantal gestures copied in reduplication as those consonantal gestures that are coordinated with the vocalic gesture.

5 Conclusion

This study has provided further evidence for the claim that articulatory gestures are a fundamental unit of phonology. In particular, it demonstrates that gestures, which belong to the same segment on the phonemic level, may be coordinated separately with adjacent gestures. Furthermore, it was shown that grammars may explicitly refer to the distinction between vocalic and consonantal gestures.

This study has shown that a gestural model of phonology can provide important insights into such complex phenomena as reduplication in Bella Coola, which traditional, a-temporal models of phonology have not been able to explain. While the reduplicant's shape and content could not be predicted in all cases, generalizations on the gestural level, concerning the number and the relative timing of the gestures involved, allowed to reach a more comprehensive analysis than previously possible. In particular, it was shown that the reduplicant is more adequately characterized as a sequence of coordinated gestures than as a syllable. It follows that Bella Coola reduplication requires reference to a level of representation below the segment, namely, gestures and their timing relations. In sum, along with other recent work (e.g. by Sproat and Fujimura 1993, Silverman 1997, Steriade 1997, and Gafos, in print) the core argument of this paper provides converging evidence for the relevance of gestural timing in phonology.

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