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Similarity in Phonology:

Evidence from Reduplication and Loan Adaptation

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by

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ABSTRACT OF THE DISSERTATION

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by

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This dissertation concerns the role of similarity in phonology, specifically with respect to two processes: onset simplification in reduplication, and onset simplification in loanword adaptation. These two processes have previously been considered two distinct realms, with different explanations proposed for each. However, I highlight a commonality across the two phenomena. In reduplication and in loanword adaptation, *obstruent* + *sonorant* onset clusters exceptionally permit skipping (i.e., deletion or failure to copy the second cluster member) and intrusion (i.e., insertion of a vowel between the two cluster members).

I propose that this exceptional behavior of *obstruent* + *sonorant* onsets stems from a general principle: that phonological processes occur more freely when the result of the process sounds quite similar to the original form. *Obstruent* + *sonorant* onset clusters are more vulnerable than other clusters to skipping and intrusion—triggered by phonotactic constraints against consonant clusters—because correspondence is evaluated according to the standard of perceptual similarity, and an intact *obstruent* + *sonorant* onset is minimally distinct from the result of skipping or intrusion.

The claim, then, is that obstruent + sonorant clusters sound more like their counterparts affected by skipping or intrusion, than other clusters sound like their comparably affected counterparts. That is, *pra* sounds more like *pa* or *pira* than *sta* sounds like *sa* or *sita*. I examine a variety of evidence in support of this claim: linguistic evidence, from alliteration and a large corpus of English-language puns; and direct experimental evidence, from a discrimination task.

With this evidence in hand, I formalize an analysis in which similarity plays a direct role in the grammar, in the form of context-sensitive correspondence constraints which penalize correspondence between more similar forms less severely than correspondence between less similar forms.

CHAPTER 1

Introduction

1. *Overview of the dissertation*

This dissertation takes as a starting point the hypothesis that phonological processes are shaped by pressure to maintain perceptual similarity between corresponding forms. The aim of this project is to establish what the facts of perceptual similarity are, in a particular domain, and to show that those facts, when incorporated into the grammar, can provide a unified explanation for certain phonological phenomena previously considered separate and distinct. Further, it aims to show that incorporation of facts of perceptual similarity provides an explanation for aspects of the phenomena which are puzzling without recourse to the similarity hypothesis.

The dissertation examines modifications to onset consonant clusters—specifically, vowel insertion and consonant deletion—in reduplication and loanword adaptation. The starting observation is that when clusters must be simplified for phonotactic reasons, there are cross-linguistic regularities in how those simplifications are realized, and those regularities are tied to cluster type: when a vowel must be inserted, or a consonant deleted, the location of insertion or deletion is at least partially predictable as a function of the consonants that make up the cluster.

The project originates with the observation that violations of the correspondence constraint CONTIGUITY (Kenstowicz 1994, McCarthy & Prince 1995), which prohibits skipping and intrusion in correspondence relationships, are often permitted for *obstruent*

+ *sonorant* (OR) onsets, but not for other complex onsets, e.g. *sibilant* + *stop*, *stop* + *fricative*, *stop* + *stop*. That is, there are a number of cases in which (1) or (2) holds:

(1) Restricted skipping: * $C_1C_2V_3 \rightarrow C_1V_3$, except $O_1R_2V_3 \rightarrow O_1V_3$

(2) Restricted intrusion: * $C_1C_2V_3 \rightarrow C_1VC_2V_3$, except $O_1R_2V_3 \rightarrow O_1VR_2V_3$

My study of **restricted skipping** focuses on reduplication patterns in which some or all base complex onsets are simplified in the reduplicant. On the basis of a typological survey drawing on Steriade (1988), I have identified three basic patterns of partial onset transfer in reduplication. In one pattern, all complex onsets simplify according to a single criterion: in Old Irish (Thurneysen 1961), the leftmost consonant is copied; in Nuxalk (Bagemihl 1991), the rightmost consonant is copied; in Sanskrit (Steriade 1982), the less sonorous consonant is copied. But in the two other patterns, OR clusters behave exceptionally, showing patterns I will call **sufficient copy** or **selective copy**:

(3) Sufficient copy: $O_1R_2V \rightarrow O_1V$, other $C_1C_2V \rightarrow C_1C_2V$

a. Gothic (Braune 1883): ge-grot, se-slep, but ste-stald, ske-sked

b. Klamath (Barker 1964): pi-pnaʔaːk, t’i-t’laqdiːla, but sti-stiːq’a, kti-ktoːtʃn’a

(4) Selective copy: $O_1R_2V \rightarrow O_1V$, other $C_1C_2V \rightarrow V$

a. Attic Greek (Steriade 1982): ge-grapʰa, pe-pneuka, but e-sparmai, e-ktona

In these patterns, *obstruent* + *sonorant* onsets seem to allow skipping for no good reason: in sufficient copy patterns, other clusters are not compelled to simplify, but OR clusters do—via the skipping map; in selective copy patterns, other clusters are not compelled to reduplicate, but OR clusters do—again, via the skipping map.

The problem is to explain OR's apparent propensity for skipping. I argue that OR is uniquely vulnerable to skipping because the perceptual difference between O_1R_2V and O_1V is particularly small.

My study of **restricted intrusion** looks at patterns of cluster-resolving vowel epenthesis in loanword adaptation. In **anaptyxis-prothesis asymmetries** (Broselow 1992a; Fleischhacker 2001), epenthetic vowels are inserted before *sibilant* + *stop* clusters, but inside OR clusters. In **anaptyxis-zero asymmetries**, OR clusters are resolved by cluster-internal vowel epenthesis, while sibilant-stop clusters are not simplified at all:

(5) Anaptyxis-prothesis asymmetry: $O_1R_2V \rightarrow O_1VR_2V_3$, other $C_1C_2V_3 \rightarrow VC_1C_2V_3$

a. Egyptian Arabic (Broselow 1992a): ***bilastik*** 'plastic', but ***ʔiskii*** 'ski'

(6) Anaptyxis-zero asymmetry: $O_1R_2V \rightarrow O_1VR_2V_3$, other $C_1C_2V_3 \rightarrow C_1C_2V_3$

a. Hawai'ian Creole (Nagara 1972): [puránti:] 'plenty', but [ste:] 'stay'

These examples suggest that *obstruent* + *sonorant* clusters are unusually receptive to intrusive vowels: in Hawaiian Creole, OR clusters simplify—here, via the intrusion map—even though other clusters do not. In Egyptian Arabic, OR clusters allow intrusion even though non-cluster-splitting epenthesis is demonstrably an option. As with the cases of restricted skipping, the question is why OR should show this behavior; I argue that the answer lies in the fact that $O_1R_2V_3$ is quite similar to $O_1VR_2V_3$.

My interpretations of the restricted skipping and intrusion data are based on the assumptions about relative similarity stated in (7) and (8):

(7) $\Delta(C_1C_2V\text{-}C_1VC_2V) > \Delta(O_1R_2V\text{-}O_1VR_2V)$, where $(C_1C_2V\text{-}C_1VC_2V)$ is not $(O_1R_2V\text{-}O_1VR_2V)$

That is, the perceived difference between O_1R_2V and O_1VR_2V is smaller than that between C_1C_2V and C_1VC_2V in the general case.

(8) $\Delta(C_1C_2V\text{-}C_1V)$, $\Delta(C_1C_2V\text{-}C_2V) > \Delta(O_1R_2V\text{-}O_1V)$, where $(C_1C_2V\text{-}C_1V)$ is not $(O_1R_2V\text{-}O_1V)$

That is, the perceived difference between O_1R_2V and O_1V is smaller than that between C_1C_2V and C_1V in the general case, and smaller than that between C_1C_2V and C_2V.

I've taken several approaches towards establishing support for the claims in (7) and (8). Assuming with Zwicky & Zwicky (1986) that imperfect puns (like *Napoleon Blown-apart*) bear on relative similarity, I constructed and analyzed a corpus of imperfect puns. In this corpus, O_1R_2V–O_1V puns (e.g. *Blown-apart–Bonaparte*) are overrepresented compared to the set of English O_1R_2V–O_1V words. By contrast, S_1T_2V–S_1V puns (e.g. *sturgeon–surgeon*) are underrepresented, while C_1C_2V-C_2V puns (e.g. *Stabitha–Tabitha*; *raise–praise*) appear at expected frequency. If frequency in the corpus correlates with relative similarity, these facts provide partial support for (8). Additional support for (8) comes from the alliterative verse systems of Germanic (Kuryłowicz 1971) and early Irish (Murphy 1961), assuming that pairs that do alliterate are more similar than pairs that do not. In these systems, O_1R_2V alliterates with O_1V, but *sp*-, *st*-, *sk*- (and *sm*-, in Irish) only alliterate with themselves—not with *s*V.

In an experiment reported in Fleischhacker (2001), I collected from English speakers judgments relevant to the relative similarity of $T_1R_2V_3$–$T_1əR_2V_3$ and $S_1T_2V_3$–$S_1əT_2V_3$ (T = stop, S = sibilant fricative, R = sonorant consonant). Subjects listened to pairs like *crave*–*c*[ə]*rave*, *scold*–*s*[ə]*cold* and rated the similarity of each pair on a 7-point scale. $T_1R_2V_3$–$T_1əR_2V_3$ pairs were rated significantly more similar than $S_1T_2V_3$–$S_1əT_2V_3$; this provides partial support for (7). Other experimental work (done in collaboration with Keith Johnson of Ohio State University) attempted to establish experimentally the relative similarity of $C_1C_2V_3$-$C_1VC_2V_3$, $C_1C_2V_3$-C_1V_3, and $C_1C_2V_3$-C_2V_3 for a variety of cluster types (thus, the results bear on both (7) and (8)). In this experiment, English speakers were asked to decide whether the members of pairs like *pra*–*pa*, *psa*–*sa*, *sta*–*sita* etc. are the same or different. Time to decision in this task is taken as an indicator of relative similarity: faster decisions indicate that the stimuli are easy to discriminate, and therefore relatively different; slower decisions indicate that the stimuli are relatively similar.

My claim, in broad strokes, is that phonological processes occur more freely when the result of the process sounds quite similar to the original form. *Obstruent* + *sonorant* onset clusters are more vulnerable than other clusters to skipping and intrusion—triggered by phonotactic constraints against consonant clusters—because correspondence is evaluated according to the standard of perceptual similarity, and an intact OR onset is minimally distinct from the result of skipping or intrusion.

This view makes necessary a novel and non-standard approach to the formal grammatical mechanisms that govern these phenomena. Standard correspondence constraints reference strings, not their contents: CONTIGUITY examines the input and the output (or the base and the reduplicant, or other correspondent strings), determines whether segments have been added or removed, and assesses violations accordingly; all insertions and deletions are equal. But because sounds affect and are affected by their neighbors, string-identical additions and deletions are not of perceptually equal significance. However, if correspondence constraints are to serve the purpose of minimizing the difference between input and output (or base and reduplicant, etc.), so that ultimately the output is recognizable as belonging to its input, the constraints must assess violations in proportion with the perceived difference between input and output. Therefore, monolithic CONTIGUITY, which regulates skipping and intrusion on a string-identical basis, is here augmented with a family of ranked constraints that penalize skipping and intrusion in proportion to the resulting magnitude of perceptual difference between correspondent strings. Greater vulnerability of OR as against other complex onsets to skipping and intrusion is observed when relevant phonotactics are prioritized above the correspondence constraints relevant to $O_1R_2V_3 \rightarrow O_1V_3$ and $O_1R_2V_3 \rightarrow O_1VR_2V_3$, but below the correspondence constraints relevant to general-case $C_1C_2V_3 \rightarrow C_1V_3$, $C_1C_2V_3 \rightarrow C_2V_3$, and general-case $C_1C_2V_3 \rightarrow C_1VC_2V_3$. I show that this mechanism correctly accounts for the observed patterns of restricted skipping and intrusion.

2. *Structure of the dissertation*

Chapters 2 and 3 describe the phenomena to be explained: Chapter 2 looks at restricted skipping in reduplicative onset transfer, and Chapter 3 discusses restricted skipping and restricted intrusion in the domain of loanword adaptation. Chapter 4 presents the linguistic and experimental evidence in support of the proposed similarity scales. Chapter 5 discusses the way in which facts about perceptual similarity are encoded in the grammar, and uses the mechanism proposed to develop analyses of reduplicative onset transfer and vowel insertion in loanword adaption. It also addresses the role of CONTIGUITY as a member of the universal constraint set, co-existing with constraints which assess faithfulness based on the perceived similarity between correspondent strings. Chapter 6 briefly sums up.

CHAPTER 2

Reduplicative Onset Transfer

1. *Introduction*

A frequently noted property of reduplication is that the reduplicant tends to be a contiguous substring of the base (e.g., Marantz 1982; McCarthy and Prince 1986, 1995; Lamontagne 1996). For example, Lamontagne (1996) identifies $[[\text{ABC}]_R[\text{ABCDE}\ldots]_B]$ as a typical reduplication pattern, and $[[\text{ACD}]_R[\text{ABCDE}\ldots]_B]$—in which segment B of the base is skipped—as atypical. An example of skipping is the Klamath distributive form $[[\text{t'}_1\text{a}_3]_R[\text{t'}_1\text{w}_2\text{aː}_3\text{j̊}_4\text{a}_5]_B]$ 'work for-DIST' (Barker 1964).

However, I suggest that reduplicative mappings in which a member of the base cluster is skipped—specifically, those in which a $[C_1C_2V_3\ldots]$ base corresponds to a $[C_1V_3]$ reduplicant, as in the Klamath example above—are actually characteristic in one case: when C_1 is an obstruent and C_2, the skipped consonant, is a sonorant. I will call the phenomenon **restricted skipping**, and document it in this chapter through examination of the typology of partial onset transfer in reduplication; that is, reduplication patterns in which, for at least one type of base-initial biconsonantal cluster, only one cluster member is copied.

Restricted skipping in reduplicative onset transfer takes two forms. Simplification of base *obstruent* + *sonorant* clusters via the skipping map (i.e., $O_1R_2V_3 \rightarrow O_1V_3$) cooccurs both with no simplification of other clusters (e.g., bases *pra*, *sta* → reduplicated *pe-pra* but *ste-sta*, as in Klamath and Gothic, §2.1), and with no copy of other clusters (e.g., bases *pra*, *sta* → reduplicated *pe-pra* but *e-sta*, as in Ancient Greek perfect reduplication, §2.2).

I argue that restricted skipping in reduplicative onset transfer reflects facts of perceptual similarity. As argued in Chapter 4, the perceptual difference between $O_1R_2V_3$ and O_1V_3 is smaller than the perceptual difference between $C_1C_2V_3$ and C_1V_3 in the general case (i.e., when C_1 is not an obstruent, or C_2 is not a sonorant), and smaller than the difference between $C_1C_2V_3$ and C_2V_3, at least for C_1C_2 clusters */s/* + *stop* and *obstruent* + *sonorant*.[1] This means that a simplified O_1V_3 reduplicant still sounds very much like its $O_1R_2V_3$-initial base; but when the base begins with a cluster other than *obstruent* + *sonorant*, copying only C_1 or only C_2 results in a reduplicant that is relatively dissimilar to its cluster-base.

The claim, then, is that *obstruent* + *sonorant* clusters have greater freedom than other clusters to simplify under reduplication because base-reduplicant correspondence is assessed in part on the basis of the perceptual similarity between base and reduplicant. Even if the reduplicant allows complex onsets, *obstruent* + *sonorant* clusters are simplified via the skipping map. This is a phonotactic improvement with a relatively minor cost in terms of base-reduplicant similarity. However, clusters other than *obstruent* + *sonorant* are not simplified under reduplication; here, achieving a phonotactically better reduplicant is not worth the similarity cost. In contrast, when the reduplicant allows only singleton onsets, neither member of a *non-obstruent* + *sonorant*

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[1] I have no clear evidence regarding the relative similarity of $C_1C_2V_3$–C_1V_3 and $C_1C_2V_3$–C_2V_3 for non-obstruent + sonorant clusters other than /s/ + stop (i.e., clusters like /mn/, /kt/), but not for lack of trying; see Chapter 4.

cluster is copied. There is no simplification map which achieves sufficient perceptual similarity between base and reduplicant, and requirements of base-reduplicant similarity outweigh the imperative to reduplicate at all.

In the sections below, I present a survey of partial onset transfer in reduplication. The data discussed extend somewhat the typology of onset transfer presented by Steriade (1988); but note that the languages included—thirteen in all—were happened upon rather than identified by a systematic survey of reduplication in languages which allow word-initial clusters. The transfer patterns are grouped into two main classes: restricted skipping (§2), in which *obstruent* + *sonorant* clusters reduplicate via the skipping map, while other clusters show different behavior under reduplication—either full copy or no copy; and cluster-blind simplification (§3), in which all onset clusters are simplified under reduplication, and all clusters are simplified in the same way.

A note on typography and data organization: in the data presented below, onsets of base and reduplicant are underlined, and a dash separates the reduplicant (prefixed, unless otherwise noted) from the base. I make a distinction between *obstruent* + *sonorant* onsets (OR) and all other onset clusters (¬OR); and recognize two subgroups of OR: *stop* + *sonorant* and *non-sibiliant fricative* + *sonorant* onsets (TR), and *sibilant fricative* + *sonorant* onsets (SR). Finally, note that in every pattern presented, CV-initial bases take CV- reduplicants; this is illustrated by the (a)-form in each numbered example below.

2. *Restricted skipping*

The two transfer patterns discussed below exemplify **restricted skipping** in reduplicative onset transfer: *obstruent* + *sonorant* clusters simplify via the skipping map, while other clusters behave differently. In **sufficient copy** patterns (§2.1), both members of non-OR clusters are copied; in **selective copy** patterns (§2.2), neither member of a non-OR cluster is copied.

2.1. *Sufficient copy*

Under sufficient copy reduplication, all complex onsets other than OR are copied in full; only OR is simplified, and always by failure to copy the sonorant. This is *sufficient copy*, according to the interpretation of restricted skipping pursued here, in the sense that only as much of a base cluster is copied as is necessary to achieve an acceptable degree of perceptual similarity between base and reduplicant. Full copy is required in the case of non-OR clusters, because partial copy (i.e., $C_1C_2V_3 \rightarrow$ either C_1V_3 or C_2V_3) would result in a reduplicant that does not sound enough like its base. In contrast, OR clusters are free to reduce via the skipping map, thereby satisfying markedness constraints against complex onsets, because a simplified O_1V_3 reduplicant is, for the purposes of base-reduplicant correspondence, similar enough to its $O_1R_2V_3$-initial base.

In Gothic (Braune 1883; Wright 1910; Steriade 1988), a reduplicating C(C)V– prefix (with fixed vowel *e*) marks the perfect for a subset of the strong verbs:

(1) Gothic (data from Braune 1883)

a. CV: [he-het] 'called'

b. TR: [ge-grot] 'wept', [fe-fres] 'tried, tempted'

c. SR: [se-slep] 'slept'

d. ¬OR: [ste-stald] 'possessed', [ske-sked] 'separated'

All OR clusters are simplified under reduplication, with copy of the obstruent only (b,c). In contrast, /sp, st, sk/—the only non-OR onset clusters of Gothic—are copied in full (d).

In Klamath (Barker 1964; Steriade 1988), a reduplicating C(C)V– prefix marks distributive action (DIST) in verbs:

(2) Klamath (data from Barker 1964)

a. CV: [so-soːtʃa] 'light a fire-DIST'

b. TR: [t'a-t'waːj̊a] 'work for-DIST', [go-gmtʃa][2] 'get old-DIST'

c. TR: [q'ja-q'japga] 'lie on their sides-DIST', [p'na-p'nandiːla] 'bury underneath-DIST'

d. TR: [qni-qnj'a] ~ [qi-qnj'a] 'have an erection-DIST'

e. SR: [sl'o-sl'q'a] 'shed hair-DIST', [sn'o-snɢis] 'policeman (lit. habitual catcher)'

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[2] The base of [go-gmtʃa] is /gmotʃa/; for some $C_1(C_2)V_1C_3V_2$ stems, the first stem vowel deletes in reduplicated forms (Barker 1964:84). This process also applies to the forms in ((2)d,e); their bases, in order: /qnij'a'/, /sl'oq'a/, /sn'oɢjs/.

f. ¬OR: [sti-sti:q’a] 'have a cramp-DIST', [pse-pse:jisap] 'uncles, father's brothers-DIST', [lwo-lwasga][3] 'take off clothes-DIST', [wqe-wqe:w’a] 'break plural objects in two with long instruments-DIST'

TR clusters are simplified in some reduplicated forms, with copy of the stop only (b); in other forms, TR is copied fully (c), and there is at least one case of free variation between full copy and simplification of TR (d). All clusters other than TR, including SR (e) and Klamath's rich set of *obstruent* + *obstruent*, *sonorant* + *obstruent*, and *sonorant* + *sonorant* clusters (f), always show full onset transfer.[4]

Klamath thus differs from Gothic in that only a subset of the OR onsets—namely, only TR—allow skipping: compare Klamath [sl’o-sl’q’a] 'shed hair-DIST', showing full copy of an SR cluster, with Gothic [se-slep] 'slept', in which the SR cluster is simplified. This cross-linguistic difference in restricted skipping behavior is mirrored in the perceptual similarity facts reported in Chapter 4, which shows that $S_1R_2V_3$–S_1V_3 pairs are less similar than $T_1R_2V_3$–T_1V_3 pairs: e.g., *sla–sa* are less similar than *kla–ka*. The analysis I will propose (see Chapter 5) holds that requirements of base-reduplicant similarity are stricter in Klamath than in Gothic: Klamath permits only the most similar $O_1R_2V_3 \rightarrow O_1V_3$ maps, namely $T_1R_2V_3 \rightarrow T_1V_3$, while in Gothic, both TR and SR may be simplified through skipping.

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[3] The base of [lwo-lwasga] is /lwosga/; the change in stem vowel quality is accounted for by Barker (1964:89) as the result of a rule mapping /…V_{RED} + CGV_1CC…/ to […V_1 + CGaCC…], where G = /w, j/ — i.e., the base vowel is overwritten by [a], but its quality survives in the reduplicant.

[4] With one exception: [qa-qta] 'sleep-DIST' (Barker 1964:85).

I claim that another difference between Klamath and Gothic—namely, the fact that Klamath has a vast array of non-OR cluster types, while Gothic has only /sp, st, sk/—is not relevant to the analysis pursued here. Explanations of Gothic reduplication (e.g., Kuryłowicz 1971; Davidsen-Nielsen 1974; Kiparsky 1979; Ewen 1982; Broselow 1992; van de Weijer 1996) which focus on the unitary behavior—and therefore, special properties—of */s/* + *stop* clusters are, I suggest, misled by the impoverished cluster inventory of Gothic. The clusters showing unusual behavior—namely, exceptional skipping—in both Klamath and Gothic reduplication are the *obstruent* + *sonorant* clusters, and it is this behavior that requires explanation.

A final potential case of sufficient copy reduplication is Ilokano (Hayes and Abad 1989). The biconsonantal onset clusters of Ilokano are *obstruent* + *liquid* (OL) and *consonant* + *glide* (CG), including non-OR clusters like /mj, nw, ŋj, lw, ɾw/. Under reduplication, OL clusters are typically copied in full, but in casual speech may be simplified by loss of the liquid: e.g., [klas-kláse] ~ [ka-kláse] 'classes', [pleg-plégis] ~ [pe-plégis] 'creases'.[5] There are two reduplication patterns for CG-initial bases: one with full copy of the base-initial cluster, and one in which the vowel of the reduplicant corresponds to the base glide. Many CG-initial bases allow both patterns: e.g., [pjeː-pjék] ~ [piː-pjék] 'chicks', [ŋjaː-ŋjáw] ~ [ŋiː-ŋjáw] 'is meowing'; when only one reduplicated form is possible, it is usually the full-copy variant. (As Hayes and Abad (1989) explain,

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[5] The weight differences in the two reduplicant variants (e.g., heavy *klas* versus light *ka*) are also attributable to speech rate differences (Hayes and Abad 1989).

the glide vocalization pattern—although semi-productive now—arose historically through the application of glide formation to bases with an initial consonant followed by a non-low vowel: e.g., present day [buː-bwája] 'crocodiles' < earlier [buː-buája].)

The fact that both OL- and CG-initial bases allow full copy (in formal speech for OL, as one of two variants for CG) suggests that casual-speech simplification of *obstruent* + *liquid* clusters is in the spirit of sufficient copy —assuming, as seems reasonable, that the standard of sufficient perceptual similarity between reduplicant and base may be somewhat looser in casual speech than in formal speech. Under this interpretation, though, it is puzzling that *obstruent* + *glide* clusters do not also allow skipping in casual speech,[6] since in Klamath and Gothic *obstruent* + *glide* clusters pattern with *obstruent* + *liquid* clusters. However, it seems at least possible that the prior existence of two reduplicative patterns for CG-initial bases might have an inhibitory effect on innovative glide-skipping for *obstruent* + *glide* clusters, especially since one preexisting pattern—namely, glide vocalization—already achieves cluster simplification.

2.2. *Selective copy*

In the sufficient copy patterns discussed above, the reduplicant allows complex onsets; OR clusters give in to phonotactic pressures against complex onsets because an O_1V_3 reduplicant is sufficiently similar to its $O_1R_2V_3$-initial base, but clusters other than OR are not compelled to simplify under reduplication. In contrast, in selective copy

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[6] I'm assuming that this is an actual gap, rather than an observational one; note that casual speech pronunciations are relatively rare in elicitation contexts.

reduplication, cluster simplification is mandatory—no reduplicant contains a complex onset. Under selective copy, OR clusters simplify via the skipping map, but for clusters other than OR, neither cluster member is copied. This is selective copy, in the sense that clusters participate in reduplication only if the requisite degree of perceptual similarity between base and reduplicant can be achieved, given that cluster simplification is mandatory. $O_1R_2V_3$-initial bases map to O_1V_3 reduplicants, satisfying the reduplication-enforced requirement of cluster simplification while maintaining a high degree of base-reduplicant similarity. For clusters other than OR, however, there is no cluster-simplification map that would result in sufficient base-reduplicant similarity (i.e., neither $C_1C_2V_3 \rightarrow C_1V_3$ nor $C_1C_2V_3 \rightarrow C_2V_3$ is acceptable); and because full copy is impossible, reduplication fails.

In Ancient Greek (Goodwin 1879; Hadley 1884; Steriade 1982, 1988), a reduplicating (C)V– prefix (with fixed vowel *e*) marks the perfect:

(3) Ancient Greek (data from Steriade 1982)

a. CV: [l̲e-l̲uːka] 'untied'

b. TR: [p̲e-p̲n̲euka] 'breathed', [k̲e-k̲l̲opʰa] 'stole', [g̲e-g̲r̲apʰa] 'wrote'

c. SR: [e-s̲m̲ɛːgmenos] 'wiped off with soap', [e-s̲m̲ugmai] 'smoldered away'

d. ¬OR: [e-s̲p̲armai] 'sowed', [e-k̲t̲ona] 'killed', [e-p̲s̲auka] 'touched'

Only TR clusters participate in reduplication, and just the stop of these clusters is copied (b). Clusters other than TR, including SR (specifically, */s/* + *nasal*—Greek has no */s/* + *liquid* or */s/* + *glide* onsets (Steriade 1982)) (c), and all clusters other than OR (d)—

namely, *fricative* + *stop*, *stop* + *fricative*, *stop* + *stop*, and *nasal* + *nasal*—do not reduplicate, either in whole or in part.

It should be noted that there are exceptions to the generalizations above, in both directions. A few forms are attested in which the leftmost member of a non-OR cluster is unexpectedly reduplicated: e.g., [me-mnɛːmai] 'remembered', [ke-ktɛːmai] 'possessed', although expected [e-ktɛːmai] is also attested (Goodwin 1879; Hadley 1884; Devine and Stephens 1994). Steriade (1982:207) notes that of the five *bl*-initial forms with attested perfects, three have both reduplicated (i.e., *be-bl-*) and unexpectedly non-reduplicated (i.e., *e-bl-*) attestations, while two have only reduplicated attestations; of the two *gl*-initial forms with attested perfects, one has both reduplicated and non-reduplicated attestations, and one has only a non-reduplicated attestation.

Finally, there is the question of initial orthographic γν, which never reduplicates, as illustrated by the two forms in (4):

(4) No reduplication of initial γν

	'knew'						'recognized'							
orthography	ε-	**γ**	**ν**	ω	κ	α	ε-	**γ**	**ν**	ω	ρ	ι	κ	α
sound	e-	**{g, ŋ}**	**n**	ɔː	k	a	e-	**{g, ŋ}**	**n**	ɔː	r	i	k	a

Devine and Stephens (1994:34), citing Allen (1987:35), claim that "γ in γν and γμ [μ = [m]] was probably not a stop but a velar nasal"; but Allen himself does not make the claim as strongly: while arguing that γμ represents [ŋm], he notes (1987:37) that "there is no cogent evidence for γν = [ŋn]." If γν = [gn], its failure to reduplicate must be treated (along with *bl-* and *gl-*, to a lesser extent) as an exception to the general TR pattern; but if γν = [ŋn], then its behavior is unsurprising—apart from the exceptions noted above, no other non-OR clusters reduplicate.

Note that Ancient Greek is like Klamath (§2.1) in that it allows only TR clusters to simplify via the skipping map. I have not found an example of a selective copy pattern analogous to Gothic, in which both SR and TR clusters allow skipping (i.e., hypothetical bases *pra*, *sla*, *sta* → reduplicated *pe-pra*, *se-sla*, but *e-sta*), but predict that such a language is possible.

3. *Cluster-blind simplification*

In contrast to the cases of restricted skipping presented above, in the patterns discussed below, all base clusters are simplified under reduplication. Further, the simplification strategy employed is "cluster-blind," in the sense that it applies regardless of the cluster type that it affects—all clusters are simplified according to a single criterion. The attested cluster-blind simplification strategies are reduplication of only the less sonorous member of the cluster (§3.1), only the leftmost cluster member (§3.2), and only the rightmost cluster member (§3.3).

3.1. *Sonority-based simplification*

In Sanskrit (Whitney 1885, 1889; Kiparsky 1979; Steriade 1982, 1988; Gnanadesikan 1995; Morelli 1999), a reduplicating CV– prefix marks the perfect (and intensive, not shown here):

(5) Sanskrit (data from Whitney 1885)

a. CV: [ta-taːma] 'fainted', [ru-rud^{h}e] 'obstructed'

b. TR: [pa-prac^{h}a] 'asked', [du-druve] 'ran'

c. SR: [si-ṣmije] 'smiled', [ʃa-ʃrat^{h}e] 'slackened'

d. ¬OR: [tu-ṣṭuve] 'praised', [pa-psaːu] 'devoured', [ma-mlaːu] 'relaxed'

e. ¬OR: [ma-mnaːu] 'noted'

Base clusters are simplified by copy of the less sonorous cluster member only (b,c,d). If there is no sonority difference between the two members of the cluster, as with *nasal* + *nasal* clusters (e), the leftmost segment is copied (note, however, that this form is prescribed by Sanskrit grammarians but not actually attested (Whitney 1885). Thus, skipping occurs in Sanskrit reduplication when C_2 is more sonorous than or equally sonorous to C_1—that is, for every base cluster (including *obstruent* + *sonorant*, *stop* + *fricative*, *nasal* + *nasal*, and *nasal* + *liquid*) except */s/* + *stop*.

Sonority-based cluster simplification makes sense phonotactically, assuming that the less sonorous a consonant is, the better onset it makes (Gnanadesikan 1995; Morelli 1999). Given that cluster simplification is mandatory in Sanskrit reduplication, the sonority-based strategy chooses—by appropriate ranking of markedness constraints assessing onset fitness—the best possible singleton onset from the two consonants available in the base cluster.

3.2. *Leftmost copy*

Old Irish, Ancient Greek present reduplication, Coast Tshimshian, and Khmer exemplify leftmost copy, in which all base clusters are simplified by copy of only the leftmost cluster member. Note that leftmost copy illustrates across-the-board skipping: all clusters simplify via the $C_1C_2V_3 \rightarrow C_1V_3$ map.

In Old Irish (Thurneysen 1961; Kuryłowicz 1971), a reduplicating CV– prefix (with fixed vowel *e*) marks the perfect (and future, not shown here) for a subset of the strong verbs; in the data below, reduplicated perfect forms are followed by unreduplicated present forms, in order to clarify the pattern with respect to SR clusters:

(6) Old Irish (data from Thurneysen 1961)

a. CV: [me-mad-] 'broke'

b. TR: [be-brag-] 'farted', cf. [braigid] 'farts, bleats'; [ge-glann-] 'learned', cf. [fo-gleinn] 'learns'

c. SR: [se-laig] 'felled', cf. [sligid] 'fells'; [se-naig] 'dripped', cf. [snigid] 'drips'

d. ¬OR: [se-skann-] 'flew off', cf. Modern Irish [skeinnim] 'I spring off, fly off'

Base clusters are simplified by copy of the leftmost cluster member (b,c,d), although this becomes clear in the case of SR (c) only on inspection of morphologically related forms. Thurneysen (1961:132) notes that "after reduplication syllables *–sn–*, *–sl–* gave single *n*, *l*"; generally, underlying intervocalic *sm*, *sn*, *sl* are realized as geminated *mm*, *nn*, *ll* respectively.

Ancient Greek present reduplication (Goodwin 1879; Hadley 1884; Steriade 1982) is also characterized by copy of the leftmost base consonant: e.g., [ti-trɔːskɔː] 'wound', [mi-mnɛːskɔː] 'remind'. The Khmer lexicon has remnants of a no-longer-productive process of reduplication that conveyed repetition or intensification in verbs, characterized by copy of the leftmost base consonant: e.g., [sɑ-srɑk] 'to keep on dripping' (Gorgoniyev 1966; Jacob 1968, 1979).[7] Similarly, in Coast Tsimshian plural reduplication (Dunn 1979), only the initial consonant of the base form (or less commonly, of the stressed syllable) is copied: e.g., [sɨk-stuːl] 'accompany–PL', [sik-sweda] 'sweater-PL'.

Leftmost copy is a cluster simplification strategy that might plausibly be attributed to facilitation of lexical access, because when prefixed, a C_1-initial reduplicant in effect provides advance notice of the first segment of the stem (on the role of word onsets in lexical access, see e.g. Marslen-Wilson and Zwitserlood 1989).

3.3. *Rightmost copy*

Rightmost copy, a cluster-blind simplification strategy in which only the rightmost member of any base cluster is reduplicated, is exemplified by Nuxalk (Bella Coola) (§3.3.1); and possibly by Ancient Greek nominal reduplication, Latin, and Pima (§3.3.2). Rightmost copy reduplication is, in effect, anti-skipping: because all base

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[7] Khmer has initial clusters including obstruent + liquid, sibilant + stop, and stop + stop; Gorgoniyev (1966) and Jacob (1968; 1979) state that only the first consonant of a cluster is reduplicated, but give only the example shown above.

clusters are simplified by copying only the last segment in the cluster, the reduplicant always corresponds to a contiguous substring of the base.

3.3.1. *Nuxalk (Bella Coola)*

Nuxalk reduplication (Newman 1971; Nater 1984; Bagemihl 1991; Carlson 1997) generally marks diminutive (DIM) in nouns and continuative (CONT) in verbs, but is also used to derive forms with idiosyncratic semantic relationships to their bases. The pattern is illustrated by the forms in (7) below (O = obstruent, S = vowel or sonorant consonant; reduplicants are underlined):

(7) Nuxalk (data from Bagemihl 1991; Carlson 1997)[8]

a. OS: [qa-qajt-i] 'toadstool-DIM', [xʷn̩-xʷnaːɬ-i] 'spring of water-DIM'

b. OOS: [p’-ɬa-ɬa] 'wink-CONT', [s-tn̩-tn-iː] 'tree-DIM'

c. OOOS: [tq’-ɬaː-ɬa-j] 'knife-DIM', [st’-qʷl̩-qʷlus-i] 'black bear snare-DIM'

d. OOOOS: [qps-ta-ta-] 'to taste-iterative', [pɬt-kn̩-kn̩-ɬp] 'bitter cherry tree'

Descriptively, the reduplicant is a copy of the leftmost vowel or sonorant consonant of the base,[9] the immediately preceding segment (but see below), and sometimes an

[8] Syllabicity alternations in these data, as in [s-tn̩-tn-iː] 'tree-DIM' < [stn̩] 'tree' ((7)b), are predictable: sonorants are syllabic in the environment {C,#}__{C,#} and non-syllabic elsewhere (Newman 1947; Bagemihl 1991). Vowel length alternations, as in [tq’-ɬaː-ɬa-j] 'knife-DIM' < [tq’ɬa] 'knife' ((7)c) are "one of a number of auxiliary phonological modifications [including fortition and lenition] that may be used by themselves or in combination with reduplication and/or each other to indicate the same derived meanings that reduplication is used for" (Bagemihl 1991:598).

[9] More precisely, the leftmost vowel or non-word-initial sonorant consonant: e.g., base [mn̩a] reduplicates as [mn̩-mn̩-t͡s] 'children', not *[m̩-mn̩-t͡s].

immediately following consonant. Thus, under reduplication, any cluster of obstruents preceding the base segment (vowel or sonorant consonant) corresponding to the reduplicant nucleus is simplified by copying only the last member of the cluster (b,c,d). Note that the reduplicant appears immediately before the portion of the base it corresponds to; thus, when more than one obstruent precedes the first vowel or sonorant consonant of the base (as in b,c,d above), the reduplicant is infixed.

Several complexities of Nuxalk reduplication should be noted here. First, as is well known, Nuxalk has a number of obstruent-only words; Bagemihl (1991) calculates that of the morpheme shapes tabulated by Nater (1984), accounting for 1800 native morphemes, about 10% contain no vowel or sonorant consonant. However, only 12 obstruent-only words participate in reduplication—and in each case, the base of reduplication is an allomorph (evidently appearing only in reduplicative contexts) containing [i] or [n̩]: e.g., obstruent-only [ɬq'] 'slap', but reduplicated [ɬn̩-ɬn̩q'-] 'slap-CONT'; [t'χt] 'stone', but [t'ix-t'iχt][10] 'large stones' (Carlson 1997; Bagemihl 1991 treats [i, n̩] in these cases as epenthetic). Second, several aspects of reduplicant shape are not predictable based on phonological properties of the base (Nater 1984; Bagemihl 1991; Carlson 1997). For some lexical items, the consonant preceding the first vowel or sonorant consonant of the base is unexpectedly not copied: e.g., the reduplicated form of

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[10] Base [χ] corresponds to reduplicant [x] in [t'ix-t'iχt]; in general, if any velar or uvular obstruent has a correspondent in the reduplicant coda, that correspondent is [x] (Carlson 1997).

[t’ixɬala] 'robin' is [ʔi-t’ixɬala-j][11] 'robin-DIM', with copy of only the first base vowel; cf. expected *[t’i-t’ixɬala-j]. Unexpectedly unreduplicated segments are usually glottalized, but non-glottalized consonants also sometimes fail to reduplicate, and glottalized consonants do reduplicate in some cases. Additionally, possible reduplicant codas are /l, n, ɬ, s, x/; but in some forms, an available coda is not reduplicated: e.g., [sm̩-sm̩ɬk-i] 'fish-DIM', *[sm̩ɬ-sm̩ɬk-i]; cf. [yaɬ-yaːɬk-] 'do too much-CONT'.

3.3.2. *Potential rightmost copy cases*

In addition to Nuxalk, I have found three potential cases of rightmost copy—but because each of these cases is characterized by extremely sparse data, confident classification is impossible.

The surviving examples of Ancient Greek nominal reduplication in bases with initial clusters are [ka-skandiks] 'wild chervil' and [ko-skulmat-ia] 'leather cuttings' (Steriade 1988). Without evidence on the behavior under reduplication of clusters other than ST, these data can be interpreted as rightmost copy (predicted TR pattern: *ra-pra* < base *pra*); or as copy of the less sonorous cluster member, as in Sanskrit (predicted TR pattern: *pa-pra* < base *pra*).

Latin perfect reduplication (Helfenstein 1870; Kuryłowicz 1971; Steriade 1988) is attested only by the following three forms, all with initial */s/* + *stop* clusters: [ste-t-iː],

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[11] The initial glottal stop in [ʔi-t’ixɬala-j] is epenthetic, appearing predictably before a vowel that would otherwise be word-initial (Newman 1947; Nater 1984).

base [ste-]; [spo-pond-iː], base [spond-]; and [ski-kid-iː], base [skid-]. As with Ancient Greek nominal reduplication, this pattern is interpretable either as rightmost copy, but with the reduplicant syllable infixed rather than prefixed (predicted TR pattern: *pra-rati* < base *prati*); or as the infixing counterpart of Sanskrit (predicted TR pattern: *pra-pati* < base *prati*).

In Pima plural and distributive reduplication (Riggle 2001, Marcus Smith, p.c.), the reduplicant is an infixed –CV– or bare –C–: e.g., [ho-ho-d̪ai] 'rocks' < [hod̪ai] 'rock', [si-s-puk] 'cardinals' < [sipuk] 'cardinal'. Monomorphemic complex onsets appear in only three Pima words known to Smith and Riggle: [trogi] 'truck', [trampi] 'tramp', and [spulvam] 'alfalfa'. The two forms with initial [tr-] reduplicate by copying the [r] and the following vowel: [trogi] → [tro-ro-gi][12] and [trampi] → [tra-ra-mpi]—although [trampi] can also appear unreduplicated in plural and distributive contexts. This looks like rightmost copy with an infixed reduplicant, but the expected ST pattern (*sta-ta-ti* < base *stati*) is not observed: [spulvam] does not reduplicate (i.e., *[spu-pu-lvam]).[13] The failure of [spulvam] to participate in reduplication could have a phonological explanation: for example, the reduplicant syllable must have only a singleton onset, and as in Ancient Greek perfect reduplication, copying only part of an ST cluster is deemed worse than failing to copy at all. But there could also be a semantic explanation, if—as Riggle and

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[12] [trogi] can also reduplicate as [tro-r-gi], with copy of the bare [r] only.

[13] But note the behavior of [s-kais] 'the rich', with a bimorphemic ST cluster (cf. [kais] 'rich'; *s-* is a stative prefix (Marcus Smith, p.c.)). Reduplicated [s-kai-kai-s] has been, on separate occasions, produced and explicitly rejected by Riggle and Smith's Pima consultant.

Smith's Pima consultant has confirmed—[spulvam] 'alfalfa' refers to something that has an inherently plural, distributed interpretation.[14]

It is interesting to note that in Nuxalk, Latin, and Pima, the reduplicant is infixed, appearing immediately adjacent to the copied portion of the base. In contrast, in all of the other reduplication patterns presented above—sufficient copy (§2.1), selective copy (§2.2), sonority-based copy (§3.1), and leftmost copy (§3.2)—the reduplicant is prefixed; and in all of these patterns, if a base cluster is only partially copied, it is C_1, rather than C_2, that is reduplicated (with the exception of Sanskrit */s/* + *stop* clusters, of which the stop is copied). I suspect that the correlation between rightmost copy and infixation may have a perceptual explanation: as shown in Chapter 4, $C_1C_2V_3$–C_2V_3 are less similar than $C_1C_2V_3$–C_1V_3, at least for C_1C_2 clusters ST and OR. Thus, rightmost-copy reduplicants do not sound much like their cluster-initial bases—but when infixed (e.g., $[C_1[C_2V_3]_RC_2V_3\ldots]_B$, as in Nuxalk [p-ɬa-ɬa] 'wink-CONT'), and thus immediately adjacent to their corresponding portion in the base, their correct—that is, reduplicative—interpretation may be aided by the observation of repetition in adjacent strings. If a rightmost-copy reduplicant is prefixed (e.g., $[C_2V_3]_R[C_1C_2V_3\ldots]_B$, as in *[ɬa-pɬa]), and thus separated from the portion of the base it corresponds to by uncopied consonants, it may run the risk of being mistaken for a non-reduplicative prefix.

[14] A final potential case of rightmost copy that has been suggested to me is Old High German (Helfenstein 1870; Jasanoff 2001), which contains several relics of proto-Germanic perfect reduplication: [steraz] 'pushed', from *[ste-staut] through *[stezaut], and [pleruz] 'sacrificed', from *[be-βlōt] through *[blelōt]. But if I understand Jasanoff and Helfenstein correctly, these result from sound changes applied to forms that are historically reduplicated but contemporarily morphologically opaque; thus, they do not bear on the question of reduplicative typology.

4. *Summary*

The table below in (8) summarizes the typology of partial onset transfer in reduplication:

(8) Reduplicative onset transfer patterns

	OR-initial base	¬OR-initial base	*example*
Sufficient copy	simplify: $O_1R_2V_3 \rightarrow O_1V_3$	full copy: $C_1C_2V_3 \rightarrow C_1C_2V_3$	Klamath
Selective copy	simplify: $O_1R_2V_3 \rightarrow O_1V_3$	no copy: $C_1C_2V_3 \rightarrow V_3$	Ancient Greek
Cluster-blind simplification	copy less sonorous consonant: $C_1C_2V_3 \rightarrow C_{1/2}V_3$		Sanskrit
	copy leftmost consonant: $C_1C_2V_3 \rightarrow C_1V_3$		Old Irish
	copy rightmost consonant: $C_1C_2V_3 \rightarrow C_2V_3$		Nuxalk

The sufficient copy and selective copy patterns are rather difficult to explain without recourse to the perceptual similarity explanation sketched in §§1-2, and discussed further below. In sufficient copy, cluster simplification under reduplication is clearly not mandatory, since clusters other than OR reduplicate fully—but some (as in Klamath) or all (as in Gothic) OR clusters simplify anyway. Looking ahead to Chapter 5, this is exactly counter to what we expect on markedness grounds: *obstruent* + *sonorant* clusters are generally assumed to be the least marked among complex onsets (e.g., Morelli 1999), so it is not obvious why these relatively unmarked clusters should be singled out for simplification, while more deviant clusters (like the *obstruent* + *obstruent*, *sonorant* + *sonorant*, and *sonorant* + *obstruent* clusters of Klamath) are faithfully copied, thereby doubling in the reduplicated form the number of phonotactic violations incurred by the base. Further, in simplifying via the skipping map (i.e., $O_1R_2V_3 \rightarrow O_1V_3$), OR clusters undergo modifications that are patently avoidable, given the fact that the reduplicant allows complex onsets. The question raised by sufficient copy reduplication, then, is why OR onsets simplify, when all evidence suggests that they need not, and in fact should not.

Under selective copy, as in Ancient Greek, OR clusters reduplicate via the skipping map, but clusters other than OR are simply not copied, either in whole or in part. This means that reduplicative outputs formed on bases with initial non-OR clusters end up onsetless, incompletely copied, and unanchored—all problems that could, for example, be avoided or minimized through copy of the leftmost cluster member, as in the exceptional Greek forms [<u>k</u>e-<u>k</u>tɛːmai] 'possessed', [<u>m</u>e-<u>m</u>nɛːmai] 'remembered'. Thus, the question raised by selective copy is why clusters other than *obstruent* + *sonorant* fail to reduplicate at all, since at least $C_1C_2V_3 \rightarrow C_1V_3$ simplification is possible—a fact demonstrated by the behavior of OR clusters; and since failure to reduplicate results in seemingly gratuitous phonotactic problems and unfaithfulness.

But if restricted skipping reflects facts of perceptual similarity—namely, that $O_1R_2V_3$–O_1V_3 are more similar than any other $C_1C_2V_3$–C_1V_3 pair, and more similar than any $C_1C_2V_3$–C_2V_3 pair—these questions find answers. As to why, in sufficient copy, OR clusters should simplify when other clusters do not, I suggest that they do so essentially because they can—the difference in similarity between a simplified O_1V_3 reduplicant and its $O_1R_2V_3$-initial base is small enough that the phonotactic benefits of cluster simplification outweigh its costs. That is, in sufficient copy, the phonotactic demand for cluster simplification is subordinated to the requirement that base and reduplicant be sufficiently similar—and thus, OR clusters can simplify, but other clusters cannot. As to why, in selective copy, non-OR clusters do not simplify even though OR clusters do, I suggest that there is no simplification strategy (neither failure to copy C_1, nor failure to copy C_2) available by which to achieve an acceptable degree of similarity between the cluster-initial base and its simplified reduplicant—and because cluster simplification is mandatory, reduplication fails: the demand for reduplication is sacrificed in order to satisfy the demand of sufficient similarity between base and reduplicant.

I propose in Chapter 5 that these facts about relative similarity are incorporated in the grammar in the form of a family of constraints which penalize $C_1C_2V_3 \rightarrow C_1V_3$ and $C_1C_2V_3 \rightarrow C_2V_3$ maps in proportion to the resulting magnitude of perceptual difference between correspondent strings. The constraints regulating $O_1R_2V_3 \rightarrow O_1V_3$ are ranked at the bottom of this constraint family, in virtue of the fact that these mappings are—perceptually speaking—relatively faithful ones. In contrast, the constraints regulating $C_1C_2V_3 \rightarrow C_2V_3$ and general-case $C_1C_2V_3 \rightarrow C_1V_3$ are ranked higher, as these mappings involve greater perceptual differences between the correspondent strings. The claim, then, is that *obstruent* + *sonorant* onsets can simplify via the skipping map, even when other clusters do not simplify by either available deletion map (i.e., either $C_1C_2V_3 \rightarrow C_1V_3$ or $C_1C_2V_3 \rightarrow C_2V_3$), because phonotactic constraints banning consonant clusters, and morphological constraints demanding reduplication, may be prioritized above the correspondence constraints relevant to $O_1R_2V_3 \rightarrow O_1V_3$, but below the correspondence constraints relevant to general-case $C_1C_2V_3 \rightarrow C_1V_3$ and $C_1C_2V_3 \rightarrow C_2V_3$.

CHAPTER 3

Cluster resolution in loanword adaptation

1. *Introduction*

Chapter 2 documented the phenomenon of **restricted skipping** through examination of the typology of reduplicative onset transfer, showing that *obstruent + sonorant* (OR) onsets in the base of reduplication may be simplified in the reduplicant via C_2-deletion, or skipping, even when base onset clusters other than *obstruent + sonorant* are not simplified under reduplication, and even when non-OR onsets in the base are not reduplicated at all.

This chapter provides additional evidence for restricted skipping from the typology of cluster resolution in loanword adaptation. In loanword adaptation, as in reduplication, OR onsets in source forms may be simplified through skipping even when deletion of segments belonging to source onset clusters is, in the general case, impossible—but in loanword adaption, skipping cooccurs with resolution of non-OR source clusters through vowel epenthesis (§2.1), as in the Thai loanwords [páttìk] 'plastic', but [sata:j] 'style' (Nacaskul 1979).

In examining the typology of cluster resolution in loanword adaptation, this chapter also documents the phenomenon of **restricted intrusion**, in which OR clusters are repaired by the insertion of a cluster-internal vowel even though, in the general case, source clusters may not be split by epenthetic vowels. In the restricted intrusion data discussed here, resolution of OR clusters through intrusive vowel epenthesis cooccurs with resolution of non-OR clusters through word-initial vowel epenthesis (§2.2), as in the

Egyptian Arabic loanwords [bilastik] 'plastic', but [ʔiskiː] 'ski' (Broselow 1992a); and with no resolution of non-OR clusters (§4.1), as in the Hawai'ian Creole forms [purántiː] 'plenty', but [steː] 'stay' (Nagara 1972).

Thus, as is perhaps telegraphed by the terms *restricted skipping* and *restricted intrusion*, the focus of this chapter is on loanword adaptation patterns in which simplification of source OR clusters exceptionally allow skipping (i.e., $xyz \rightarrow xz$) and intrusion (i.e., $xy \rightarrow xay$).

The explanation I propose for restricted skipping in loanword adaptation is the same as that proposed in Chapter 2 for reduplicative onset transfer: OR onsets allow skipping even when other clusters do not, because only in the case of OR is the result of skipping similar enough to the sound of the intact cluster. The proposed explanation for restricted intrusion is along the same lines: OR onsets permit intrusion more freely than other clusters, because, as shown in Chapter 4, $O_1R_2V_3$–$O_1V_4R_2V_3$ are more similar than any $C_1C_2V_3$–$C_1V_4C_2V_3$ or $C_1C_2V_3$–$V_4C_1C_2V_3$ pair, at least for C_1C_2 clusters OR and ST. At the analytical level, restricted skipping and restricted intrusion are derived when correspondence constraints assessing the relationship between source form and adapted loanword are sensitive to the perceptual similarity between correspondent strings; because $O_1R_2V_3 \rightarrow O_1V_3$ and $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$ maps are relatively faithful, perceptually speaking, these are penalized less harshly than $C_1C_2V_3 \rightarrow C_1V_3$ and $C_1C_2V_3 \rightarrow C_1V_4C_2V_3$ maps in the general case.

The typology of cluster resolution in loanword adaptation presented below is based on observations from 39 languages, including creoles—I know of no reason to suppose that the phonological adaptations made by speakers of creoles are guided by principles fundamentally different from those guiding loanword adaptation. Further, I make no formal distinction between loanword adaptation (i.e., how non-native words are brought into compliance with native language phonotactics for use in the native language context) and interlanguage phonology (i.e., phonotactically-driven production errors made by non-native speakers in the non-native context). The languages included in the typology are simply those for whose loanword adaptation strategies I could find documentation; they were not selected on some principled basis (for example, I did not survey a balanced set of randomly determined languages from the major language families); thus, it should be noted that the typology may be flawed by observational gaps.

Note that the discussion below focuses specifically on differences in simplification behavior between *obstruent + sonorant* and */s/ + stop* (ST) clusters; with the exception of the data presented in §2.2.3, I have no evidence on the behavior in loanword adaptation of source non-OR clusters other than ST. This is in part an accident of history (languages like English, French, Spanish, and Portuguese, which have no non-OR clusters other than ST, if that, seem to have done more than their fair share of imperializing) and it is in part the result of a personal limitation: as Gouskova (2002) points out, Russian loanwords are abundant in the minority languages of the former Soviet Union—but as the relevant source materials are typically written in Russian, they are inaccessible to me. Nevertheless, I maintain that differences in loanword adaptation behavior between ST and OR are properly interpreted as stemming from a special vulnerability of OR clusters to skipping and intrusion—and not, for example, a special invulnerability of ST clusters. The cases of restricted skipping documented in Chapter 2 show that OR onsets more freely allow skipping and intrusion than non-OR onsets in general, of which ST is just one example.

Finally, some organizational and typographical notes: In the patterns presented in §2 and §3, all source-initial clusters are repaired in loanwords; but the languages discussed in §2 employ different methods to resolve OR as against ST clusters, while the languages discussed in §3 employ a single strategy for resolving both OR and ST. In the patterns presented in §4, only one cluster type—either OR or ST—is simplified. In every case, unless otherwise noted, clusters that are repaired in loanwords do not occur in native forms either. I use underlining to highlight those consonants in a loanword corresponding to consonants in the source-initial cluster.

2. *Asymmetrical cluster resolution*

In the patterns discussed in this section, all source-initial clusters are repaired, but different cluster resolution strategies are employed to repair OR and ST clusters. The patterns in §2.1 illustrate restricted skipping: post-obstruent sonorants are deleted, even though consonant deletion is otherwise impossible—ST clusters are repaired by vowel epenthesis. The patterns in §2.2 illustrate restricted intrusion: OR clusters are repaired by the insertion of a cluster-internal vowel, even though, in the general case, cluster-internal epenthesis is impossible—ST clusters are repaired by an epenthetic vowel inserted before the cluster.

2.1. *Restricted skipping*

Chapter 2 documented restricted skipping in reduplicative onset transfer, showing that simplification of *obstruent* + *sonorant* clusters via the skipping map (i.e., $O_1R_2V_3 \rightarrow O_1V_3$) cooccurs both with no simplification of other onset clusters, i.e., sufficient copy: bases *pra*, *sta* → reduplicated *pe-pra* but *ste-sta*; and with no reduplication of other clusters, i.e., selective copy: bases *pra*, *sta* → reduplicated *pe-pra* but *e-sta*. At the analytical level, I propose that in sufficient copy, the reduplicant allows complex onsets, but phonotactic constraints against onset clusters favor simplification so long as the reduplicant is sufficiently similar to its base; this results in simplification of OR onsets only. In contrast, in selective copy, the reduplicant allows maximally a single-consonant onset—and because clusters other than OR cannot be simplified and still sound enough like their bases to satisfy high-ranking base-reduplicant correspondence constraints, only OR clusters participate in reduplication.

In the loanword adaptation patterns presented below, just as in selective copy reduplication, all source-initial clusters must be simplified in the adapted loanword, and OR clusters exceptionally allow skipping of the sonorant. However, unlike in selective copy, though, the consonants of source non-OR clusters do achieve a surface realization, via insertion of a cluster-internal vowel (i.e., anaptyxis). This makes a great deal of sense as a loanword adaptation strategy: in reduplication, base consonants lacking correspondents in the reduplicant will still be present in the reduplicated form itself; but failure to represent either member of a source cluster in loanwords would result in a massive loss of contrast.[15] (The loanword adaptation analog of sufficient copy, in which only OR clusters are simplified, is discussed in §4.1.)

Cantonese (Silverman 1992; Yip 1993) does not allow word-initial consonant clusters, and repairs clusters in English borrowings through vowel epenthesis or consonant deletion:

(1) Cantonese (data from Yip 1993)

a. TR: [fi^{55}sa^{35}] 'freezer', [puk^{55}k^{h}a^{35}] 'broker'

b. SR: [si^{22}wit^{55}tsi^{35}] 'switch', [si^{22}maːk^{55}] 'smart'

c. ST: [si^{22}pe^{55}] 'spare'

d. STR: [si^{22}t^{h}aw^{55}pe^{55}lej^{35}] 'strawberry'

Anaptyxis is employed to repair SR and ST clusters (b,c,d), while liquids[16] are deleted from source TR clusters (a,d). Note that deletion of source consonants, as opposed to vowel epenthesis, occurs in only one other context in Cantonese—namely, when a stop is word-final and post-consonantal: e.g., [pen^{55}] 'band' (Yip 1993).

The Cantonese facts are slightly complicated by the fact that anaptyxis, rather than liquid deletion, is employed to repair TR clusters in those cases where the adapted

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[15] Other motivations may play a role; for example, avoiding embarrassment or being understood by L1 speakers.

[16] Neither Yip (1993) nor Silverman (1992) provide examples of the behavior of source stop + glide clusters, but I would expect glides to behave like liquids (e.g., [tenti] < *twenty*) or to be realized as their same-place vowels.

loanword would otherwise be monosyllabic.[17] Thus, skipping is observed only for bisyllabic and longer source forms (e.g., [p̲^{h}ɛn^{H}t^{h}a^{MH}] 'printer' (Silverman 1992)); and for monosyllabic source forms requiring the insertion of an epenthetic vowel to repair an illegal coda. Possible Cantonese codas are /p, t, k, m, n, ŋ, w, j/ (Silverman 1992; Yip 1993); thus, a source form like *place*, with an impossible coda [s], surfaces as [p̲^{h}ej^{55}si^{35}] 'place' (Yip 1993)—the necessity of post-[s] epenthesis guarantees bisyllabicity for the resulting loanword, making skipping of [l] in the onset cluster possible. In contrast, a monosyllabic source form like *plum*, with a legal coda, surfaces as [p̲ow^{33}l̲am^{55}] 'plum' (Yip 1993), with an anaptyctic vowel inside the source TR cluster; liquid deletion is also blocked when deletion of a word-final post-consonantal stop leaves behind a monosyllable with an acceptable coda: e.g., *print* [p̲i^{L}l̲in^{H}] 'print' (Silverman 1992).[18]

As in Cantonese, Thai loanword adapation (Noss 1964; Harris 1972; Gandour 1979; Nacaskul 1979) is characterized by skipping of sonorants in source TR clusters, but epenthesis inside SR and ST clusters:

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[17] Silverman (1992) and Yip (1993) argue that the action of a bisyllabicity requirement in Cantonese is revealed by hypocoristic formation and other processes in the native phonology; in any case, the only examples of monosyllabic loanwords presented by Yip (1993) are those for which the corresponding source form is monosyllabic with a singleton onset, and with either a legal coda (e.g., [kem^{55}] 'game') or a coda cluster repairable by stop deletion (e.g., [siŋ^{55}] 'sink').

[18] There are a few exceptions to these generalizations, in both directions: e.g., monosyllabic [pin] 'print', with unexpected skipping of an onset liquid, is attested for at least one speaker; [sipitliŋ] 'spring' shows unexpected retention of an onset liquid in a form whose bisyllabicity is not at stake (Yip 1993). (The unexpected coda [t] in [sipitliŋ] is part of a wider phenomenon; see Yip 1993, footnote 6.)

(9) Thai (data from Gandour 1979; Nacaskul 1979)

a. TR: [páttìk] 'plastic', [k^hi:m] 'cream'

b. SR: [sawít] 'switch', [samá:t] 'smart (fashionable)'

c. ST: [sata:j] 'style', [saték] 'steak', [sakʌ́:t] 'skirt'

Note that word-initial *stop + liquid* and *stop + glide* clusters are permitted in Thai native phonology, although a sound change in progress documented by Beebe (1975) mirrors the loanword adaptation pattern: sonorants are frequently deleted from native TR clusters as well.

Word-initial OR, ST, and STR clusters in the creole Saramaccan were documented in a word list compiled in 1778 by Moravian missionary C. L. Schumann (Aceto 1996); and as Aceto (1996) argues, it is fairly certain that Schumann's transcriptions of clusters reflected actual pronunciation: Schumann recorded sporadic examples of vowel epenthesis inside clusters, as well as final epenthetic vowels, cross-speaker variation in voicing and liquid quality, etc. But contemporary Saramaccan has no initial clusters; as shown by the forms in (10) below, cluster-initial words from Schumann's list have all been repaired through consonant deletion and vowel epenthesis:

(10) Contemporary Saramaccan (data from Aceto 1996)[19]

a. TR: [dɛ́:] 'dry' < *dre*, [fú:ta] 'fruit' < *fruta*, [pú:ma] 'feather < *pluma*

b. SL: [sá:pu] 'sharp' < *srabbo*, [sé:pi] ~ [sé:i] 'self' < *srepi*

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[19] Only high tones are marked in the contemporary forms. Etyma are Portuguese, Dutch, and "English," by way of the neighboring English-based creole Sranan (Aceto 1996); thus, the 1778 forms *srabbo* 'sharp' and *srepi* 'self' ((10)b): metathesis of coda liquids is a feature of Sranan (see §4.2.2).

c. SN: [sumúku] 'smoke' < *smoko*, [sumáː] 'small' < *smâla*

d. ST: [sitónu] 'stone' < *stoon*, [sikópu] 'shovel' < *skôp*

e. STR: [sikífi] 'to write' < *skrifi*, [sukúfu] 'screw, rust' < *skrúfu*

Anaptyxis applied to historical SN and ST clusters (c,d,e), while the sonorants of historical TR and SL clusters have been lost (a,b,e). Thus, Saramaccan differs from Cantonese and Thai in that SL clusters behave like TR clusters in allowing skipping.

In Cantonese, Thai, and Saramaccan, post-stop sonorants are exceptionally skippable: ST clusters do not allow comparable skipping (i.e., of the stop); and as shown by the treatment of ST, anaptyxis is a patently available strategy in these languages for simplifying source-initial clusters while still retaining all consonants belonging to the cluster. Further, resolving TR clusters through anaptyxis would result in an adapted loanword that sounds very much like the cluster-initial source form: as shown in Chapter 4, $T_1R_2V_3$–$T_1V_4R_2V_3$ are quite similar. So why do TR onsets simplify through skipping rather than anaptyxis? The explanation pursued by Yip (1993:268) for Cantonese is that post-stop liquids are less salient than the stops that precede them, and it is "this lack of salience [that] renders them relatively vulnerable to deletion"—a claim that is supported by the finding reported in Chapter 4, that $T_1R_2V_3$–T_1V_3 are quite similar. Extending Yip's explanation slightly, I suggest that skipping is possible as an alternative to anaptyxis for TR onsets because in either case, the adapted loanword will sound very much like its source form. What favors skipping over anaptyxis is the fact that the loanword in which the sonorant is skipped will contain fewer segments—assuming that in speech, all else being equal, less is better (a preference formalized as the constraint

*STRUC (McCarthy and Prince 1993)); and perhaps more to the point, the loanword adapted through skipping will have the same number of syllables as the source form.[20]

The fact that in Saramaccan, but not in Cantonese and Thai, SL clusters also allow skipping, suggests that Saramaccan is slightly more permissive than Cantonese and Thai in determining which $O_1R_2V_3$–O_1V_3 pairs are similar enough that the benefits of skipping (namely, reduction of the loanword's syllable/segment count) are worth its dissimilarity cost. As shown in Chapter 4, $S_1R_2V_3$–S_1V_3 are less similar than $T_1R_2V_3$–T_1V_3; if, further, $S_1N_2V_3$–S_1V_3 are analogously less similar than $S_1L_2V_3$–S_1V_3 (although note that I provide no evidence to support this claim), then Saramaccan allows only the most similar $S_1R_2V_3 \rightarrow S_1V_3$ mappings, while Cantonese and Thai prohibit $S_1R_2V_3 \rightarrow S_1V_3$ mappings entirely.

2.2. *Restricted intrusion*

The loanword adaptation patterns presented in this section are examples of anaptyxis-prothesis asymmetries (Broselow 1992a; Fleischhacker 2001; Gouskova 2002): source OR clusters are resolved by vowel epenthesis into the cluster (i.e., anaptyxis), while source ST clusters are resolved by epenthesis before the cluster (i.e., prothesis). Anaptyxis-prothesis asymmetries illustrate restricted intrusion: OR clusters allow intrusive vowel epenthesis, even though in the general case—i.e., in the case of ST clusters—intrusive vowel epenthesis is impossible. Canonical anaptyxis-prothesis

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[20] Or at least, if vowel epenthesis applies elsewhere in the word (as in Cantonese $[\underline{p}^{h}ej^{55}si^{35}]$ 'place'), the loanword will be closer in syllable count to the source word.

asymmetries, in which all OR clusters permit anaptyxis, are discussed in §2.2.1; §2.2.2 discusses patterns in which some or all SR clusters pattern with ST instead of TR—triggering prothesis rather than anaptyxis; and finally, §2.2.3 presents what evidence I have on the behavior of non-OR clusters other than ST in languages displaying anaptyxis-prothesis asymmetry in loanword adaptation.

2.2.1. *Canonical anaptyxis-prothesis asymmetry*

Canonical anaptyxis-prothesis asymmetries are characterized by vowel epenthesis into source OR clusters, but before source ST clusters; two illustrative examples are the loanword adaptation patterns of Egyptian Arabic and Sinhalese:

(11) Egyptian Arabic (data from Broselow 1992a)

a. OR: [b̲il̲astik] 'plastic', [t̲ir̲ansilet] 'translate', [s̲il̲aid] 'slide'

b. ST: [ʔis̲k̲iː] 'ski', [ʔis̲t̲adi] 'study'

c. STR: [ʔis̲p̲ir̲iŋ] 'spring', [ʔis̲t̲ir̲iːt] 'street'

(12) Sinhalese (data from Samarajiwa and Abeysekera 1964)

a. OR: [t̲ir̲ividə] < Sanskrit [trividə] 'triple', [s̲ir̲ijavə] < Skt. [srijavə] 'grace'

b. ST: [is̲k̲ul] 'school', [is̲t̲ik] 'stick'

c. STR: [is̲t̲ir̲i] < Skt. [stri] 'woman'

As shown in ((11)a) and ((12)a), in Egyptian Arabic and Sinhalese, both TR and SR clusters are repaired by anaptyctic vowels. In contrast, source ST clusters are resolved through the insertion of a prothetic vowel ((11)b,(12)b); note that in Egyptian Arabic, which prohibits vowel-initial words (Broselow 1992b), glottal stops are epenthesized to provide onsets for prothetic vowels. Source STR clusters are resolved in Egyptian Arabic and Sinhalese by insertion of two vowels—one before the sibilant, and another between the stop and sonorant ((11)c,(12)c); this appears to be the typical anaptyxis-prothesis asymmetry strategy—Hindi (Singh 1985; Broselow 1992a) is the only case I know of in which source STR is repaired by a single prothetic vowel (e.g., [ɪskru] 'screw').

Other languages displaying canonical anaptyxis-prothesis asymmetries—anaptyxis into OR, prothesis before ST—in loanword adaptation or interlanguage phonology include Amharic (Broselow 1992a; Leslau 1995), Bengali (Mahato 1974; Broselow 1992a), Central Pahari (Sharma 1980; Broselow 1992a), Fula (Paradis and Lacharité 1997), a variety of Hindi (Singh 1985; Broselow 1992a),[21] Kirgiz (Gouskova 2002), a variety of Turkish (Swift 1963; Broselow 1992a),[22] and Uyghur (Gouskova 2002).

Anaptyxis-prothesis asymmetries reflect a loanword adaptation strategy in which the site of vowel epenthesis is chosen to maximize the perceptual similarity between source form and adapted loanword. As shown in Chapter 4, $O_1R_2V_3$–$O_1V_4R_2V_3$ are more similar than $O_1R_2V_3$–$V_4O_1R_2V_3$, meaning that for source OR clusters, the result of anaptyxis will sound more like the intact cluster than will the result of prothesis. But the reverse is true for ST onsets: $S_1T_2V_3$–$V_4S_1T_2V_3$ are more similar than $S_1T_2V_3$–

[21] As noted in the following section, the variety of Hindi described by Bharati (1994) allows prothesis for source SN and SL clusters.

[22] Yavas (1980) reports that anaptyxis applies to all recent cluster-initial loans in Turkish (e.g. [sɨpor] < Fr. *sport*), although earlier loans with initial ST clusters were adapted via prothesis (e.g. [ispirto] < Ital. *spirito*).

$S_1V_4T_2V_3$—meaning that an loanword adapted through prothesis will sound more like the ST-initial source form than will a loanword adapted through anaptyxis.

2.2.2. *Variable behavior of SR clusters*

As noted above, canonical anaptyxis-prothesis asymmetries are characterized by epenthesis into all SR clusters: e.g., Egyptian Arabic [silaid] < English [slaɪd] ((11)a), Sinhalese [sirijavə] < Sanskrit [srijavə] 'grace' (12)a. However, in other languages displaying anaptyxis into TR, but prothesis before ST, some or all SR clusters pattern with ST clusters: they are repaired by prothesis, rather than by anaptyxis as in the canonical pattern.

Adaptation of Russian loanwords in Kazakh shows the hallmarks of anaptyxis-prothesis asymmetry, namely anaptyxis into TR and prothesis before ST: [pɨrava] < [prava] 'right', [iʃtat] < [ʃtat] 'state', [ɨspɨrafka] < [sprafka] 'information' (Sulejmenova 1965). But in Kazakh, *sibilant fricative* + *nasal* clusters may trigger either anaptyxis or prothesis:

(13) Kazakh (Sulejmenova 1965)

a. SN — prothesis: [ismen] < [smena] 'change'

b. SN — anaptyxis: [sɨmorodina] < [smorodina] 'currant'

c. SN — free variation: [ɨsmat] ~ [sɨmat] < [smat] (proper name)

d. SL — anaptyxis: [silesir] < [slesar] 'metalworker', [ʃilija] < [ʃleja] 'breech'

Some Russian loans with initial SN clusters are produced with prothetic vowels (a), while others are produced with anaptyctic vowels (b); in some cases, anaptyxis and prothesis are in free variation (c). In contrast, SL clusters always trigger anaptyxis (d).

A similar pattern is seen in the pronunciation of English words by the native Hindi speakers described by Bharati (1994). For these speakers, initial /sm/ clusters, like ST clusters, are always resolved through prothesis: e.g. [ismaːil] 'smile'; however, for initial /sn/ and /sl/ clusters, prothesis and anaptyxis are in free variation: e.g. [sinek] ~ [isnek] 'snake', [silo] ~ [islo] 'slow'.

Farsi represents a further variation on this theme. Farsi displays the basic properties of anaptyxis-prothesis asymmetry: [pelutus] 'Plutus', [esparta] 'Sparta', [esterife] 'Strife' (Shabnam Shademan, p.c.). However, at least in the idiolect of the one Farsi speaker I have consulted, *sibilant + nasal* and *sibilant + /l/* clusters are resolved through prothesis, while *sibilant + /r/* and *sibilant + glide* clusters are repaired with an anaptyctic vowel:

(14) Farsi (Shabnam Shademan, p.c.)

a. SN — prothesis: [esmintian] 'Sminthian', [eʃnaɪdɛr] 'Schneider'

b. S + /l/ — prothesis: [eslepnir] 'Sleipnir', [eʃlas] 'Schloss'

c. S + /r/ — anaptyxis: [seri laŋka] 'Sri Lanka', [ʃerodɛr] 'Schroeder'

d. SW — anaptyxis: [s<u>o</u><u>w</u>anhild] ~ [s<u>e</u><u>v</u>anhild] 'Swanhild', [ʃ<u>o</u><u>w</u>artz] ~ [ʃ<u>e</u><u>v</u>artz] 'Schwartz'[23]

(The adapted forms in (14) were obtained in an artificial loanword adaptation task based on proper names; of these, only [s<u>e</u>r<u>i</u> laŋka] (c) was considered by Ms. Shademan to be an established lexical item in Farsi.) Note that Karimi (1987) reports that prothesis applies before all source *sibilant* + *liquid* (and *sibilant* + *nasal*) clusters in Farsi, although it is not obvious from the data reported that the epenthesis behavior of /sr/ and /ʃr/ clusters was examined.[24]

Finally, Wolof displays anaptyxis-prothesis asymmetry in loanword adaptation, as evidenced by the behavior of initial ST and TR clusters: [e<u>st</u>ati] 'statue', [<u>k</u>a<u>l</u>aːs] 'classe' (Ka 1985; Broselow 1992a). Further data from Omar Ka reported by Broselow (1992a) indicate that /sn/ and /sl/ clusters pattern with TR, triggering anaptyxis: [<u>s</u>o<u>n</u>ob] < French [snob] 'snob', [<u>s</u>i<u>l</u>ip] < Fr. [slip] 'undergarment'; but in the idiolect of the one Wolof speaker I've consulted, all SR clusters may be resolved either through anaptyxis or prothesis:

(15) Wolof (Mariame Sy, p.c.)

a. SN — prothesis: [<u>e</u>smok] 'to smoke', [<u>e</u>smɛtwɪk] 'Smetwick'

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[23] Farsi has no phoneme /w/, and initial [w] in loanwords is typically mapped to [v]: e.g., [vink] 'wink'. However, Farsi does have the diphthong /ow/, which can occur prevocalically in colloquial speech; presumably these facts are behind the two patterns of /sw/ simplification seen here.

[24] Unlike Ms. Shademan, Karimi's (1987) consultants simplified sibilant + glide clusters by vocalizing the glide and inserting [ʔ] or [j] to resolve the resulting hiatus: e.g. *sweet* is realized as [suʔit] or [sujit].

b. SN — anaptyxis: [s<u>o</u>mokıŋ] 'smoking jacket', [s<u>e</u>nek] 'snake'

c. SL — prothesis: [<u>e</u>slɛpnir] 'Sleipnir'

d. SL — anaptyxis: [s<u>o</u>lovaki] 'Slovakia', [s<u>i</u>ri laŋka] 'Sri Lanka'

e. SW — prothesis: [<u>e</u>swanhild] ~ [s<u>e</u>wanhild] 'Swanhild'

f. SW — anaptyxis: [s<u>o</u>wasilænd] 'Swaziland'

(The data in (15) include both novel forms (e.g. [e<u>sl</u>ɛpnir], [<u>s</u>e<u>n</u>ek]) obtained in an artificial loanword adaptation task, and forms that were considered by Ms. Sy to be established loanwords in Wolof (e.g. [e<u>sm</u>ok], [<u>s</u>o<u>m</u>okıŋ].) As illustrated by the forms above, choice of anaptyxis versus prothesis is apparently unpredictable for individual source clusters, whether SN, SL, or SW.

As noted above, I suggest that anaptyxis-prothesis asymmetries reflect facts of perceptual similarity: source clusters may be repaired by cluster-internal vowel insertion only if the resulting loanword will sound very similar to the cluster-initial source form. The data in this section suggest that some languages are stricter than others in setting the cut-off point for cluster-internal vowel epenthesis. As shown in Chapter 4, $S_1R_2V_3$–$S_1V_4R_2V_3$ are less similar than $T_1R_2V_3$–$T_1V_4R_2V_3$, meaning that a loanword in which source SR is repaired through anaptyxis will sound less like its cluster-initial source form than will a loanword in which source TR is repaired through anaptyxis. In canonical anaptyxis-prothesis asymmetries, as in Egyptian Arabic, all OR clusters allow intrusive vowel epenthesis—but in Hindi, Farsi, Kazakh, and Wolof, less-similar $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$ maps, namely $S_1R_2V_3 \rightarrow S_1V_4R_2V_3$, for some or all SR clusters, are ruled out.

In Hindi, anaptyxis into [sm] is impossible, and only optional for [sn] and [sl]; in Kazakh, anaptyxis into all SN clusters is optional; in Farsi, anaptyxis into SN and [sl, ʃl] is impossible; in Wolof, each of SN, SL, and SW may be repaired by either anaptyxis or prothesis. Note that Chapter 4 does not provide unequivocal evidence that $S_1N_2V_3$–$S_1V_4N_2V_3$ are less similar than $S_1L_2V_3$–$S_1V_4L_2V_3$, or that $S_1L_2V_3$–$S_1V_4L_2V_3$ are less similar than $S_1W_2V_3$–$S_1V_4W_2V_3$, but that is an implication of my interpretation of the loanword adaptation data.

2.2.3. *Evidence for the behavior of non-OR clusters other than /s/ + stop*

In Kirgiz (Gouskova 2002), OR and ST clusters in Russian loanwords are repaired as in the canonical anaptyxis-prothesis asymmetries discussed above:

(16) Kirgiz (data from Gouskova 2002)

a. TR: [turupke] < [trupka] 'pipe', [kineʃke] < [kniʃka] 'book'

b. SR: [ʃilija] < [ʃleja] 'breach-band'

c. ST: [ɯstakan] < [stakan] 'glass cup', [ɯʃtap] < [ʃtap] 'headquarters'

d. STR: [ɯʃtarap] < [ʃtraf] 'penalty'

TR and SR clusters are repaired with anaptyctic vowels (a,b,d), while ST clusters are repaired with prothetic vowels (c,d). For Gouskova (2002), the crucial generalization is that anaptyxis is employed to repair clusters characterized by rising sonority, and prothesis is used otherwise—a generalization that is supported by the behavior in Kirgiz of non-OR clusters other than ST:

(17) Kirgiz (data from Gouskova 2002)

a. [uzvana] < [zveno] 'chain link', [ymnemonitʃeskij] < [mnemonitʃeskij] 'mnemonic', [ylbovskij] < [lbovskij] (nonce surname)

b. [kɯbas] < [kvas] 'kvas', [mɯrɯlov] < [mrɯl'ov] (surname)

The forms in (a) show that prothesis, not anaptyxis, is employed to repair source *fricative + fricative*, *nasal + nasal*, and *sonorant + obstruent* clusters—all cases in which sonority falls or does not change across C_1 and C_2. In contrast, anaptyxis applies to source clusters in which sonority rises, as in the case of *nasal + liquid* and *stop + fricative* (b)—although note that in [kɯbas], the loanword correspondents [k] and [b] of the source cluster [kv] are of equal sonority.

Gouskova (2002) concludes that epenthesis site in Kirgiz loanword adaptation—and in fact, in all cases of anaptyxis-prothesis asymmetry—is determined by the constraint ranking SYLLABLECONTACT » CONTIGUITY. To avoid violating SYLLABLECONTACT (Murray and Vennemann 1983), which disprefers sonority rises across syllable boundaries, rising-sonority clusters are repaired through anaptyxis; when SYLLABLECONTACT is indifferent, as in the case of clusters characterized by falling or level sonority, CONTIGUITY favors prothesis.

This proposal leaves unexplained the variable behavior of SR onsets, which are characterized by rising sonority and should, if Gouskova (2002) is correct, always be resolved by anaptyxis; but as shown above in §2.2.2, some or all SR clusters allow prothesis in Kazakh (Sulejmenova 1965), Farsi (Karimi 1987; Shabnam Shademan, p.c.), Wolof (Mariame Sy, p.c.), and the dialect of Hindi described by Bharati (1994). Second, the Kirgiz facts—such that the behavior of non-OR clusters other than ST is predictable based on sonority profile—are not universally true. Informal loanword adaptation tasks with a Farsi speaker suggest a preference for repairing non-OR clusters other than ST through insertion of anaptyctic vowels:

(18) Farsi (data from Shabnam Shademan, p.c., reported in Fleischhacker (2001))

a. [petolomi] 'Ptolemy', [menemosine] 'Mnemosyne'

b. [fekos] *fkos*, [vedal] *vdal*

c. [ʒedat] *zhdat*

(The adapted forms in (a) above were obtained in a production task based on proper names from history and mythology; the nonce source forms in (b,c) were presented (on a different occasion) as potential Russian borrowings, with glosses such as 'brand name for vodka'. See also Shademan (2002).) Anaptyctic vowels are used to resolve *stop* + *stop* and *nasal* + *nasal* clusters (a), *non-sibilant fricative* + *stop* clusters (b), and, somewhat surprisingly, *voiced sibilant fricative* + *voiced stop* clusters (c)—cf. [esparta] *Sparta*, produced by the same speaker (see §2.2.2). In each of these cases, the cluster to be adapted is characterized by falling or level sonority, and thus should, if the SYLLABLECONTACT analysis is correct, be repaired by prothesis rather than anaptyxis.

The differing strategies employed in Kirgiz and Farsi for repairing non-OR clusters other than ST raise a serious question for the analysis proposed here. I suggested above that anaptyxis-prothesis asymmetries are essentially similarity-driven: the site of vowel epenthesis is chosen to maximize the perceptual similarity between source form and adapted loanword. The question, then, is why, if Kirgiz and Farsi speakers agree about the best epenthesis site for resolving OR and ST clusters,[25] do they disagree about the best site for e.g., *nasal* + *nasal* clusters? I can only suggest that perhaps judgments of what the best epenthesis site is—i.e., what epenthesis site will result in the greatest similarity between the source form and adapted loan—are somehow less clear, less decisive for clusters like *nasal* + *nasal* than they are for OR and ST, leaving the door open for constraints preferring prevocalic consonants (as in Farsi) and non-rising sonority across syllable boundaries (as in Kirgiz) to express their preferences.

This is not to say that I do not stand by the claims made in Chapter 2: that full copy of all non-OR clusters (including *fricative* + *stop*, *stop* + *fricative*, *stop* + *stop*, *nasal* + *nasal*, etc.) in Klamath reduplication, and no copy of all non-OR clusters (again, including *fricative* + *stop*, *stop* + *fricative*, *stop* + *stop*, *nasal* + *nasal*) in Ancient Greek reflects a judgment that these clusters cannot be simplified and still enough sound like their bases to satisfy base-reduplicant correspondence constraints. Rather, I suggest that knowing whether or not a cluster can be simplified is not the same thing as knowing how to simplify it. Klamath and Greek speakers need only consider their simplification options for any individual cluster (i.e., $C_1C_2V_3 \rightarrow C_1V_3$ or C_2V_3), and if neither would result in a reduplicant sufficiently similar to its base, abandon simplification or abandon reduplication. But the speaker of Kirgiz, for example, committed to resolving initial

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[25] Although note, there is a little disagreement about that as well: in Kirgiz, all SR clusters are repaired by anaptyxis, while in Farsi, sibilant + nasal and sibilant + /l/ are repaired by prothesis (see §2.2.2)—a difference that, as suggested in §2.2.2, indicates that Farsi is a little stricter than Kirgiz in determining the cut-off point for acceptably similar $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$ maps.

clusters in loanwords through vowel epenthesis, must decide between $C_1C_2V_3 \rightarrow V_4C_1C_2V_3$ and $C_1C_2V_3 \rightarrow C_1V_4C_2V_3$, and it may be that in some cases, neither choice stands out as the similarity-maximizing map—and thus, other factors play a role in the decision.[26]

3. *Symmetrical cluster resolution*

As in the sections above, the sections below survey patterns of loanword adaptation in which all source clusters must be simplified in the adapted loanword. However, in the patterns described below, there is no asymmetry in the treatment of OR and ST clusters: both cluster types are repaired in an identical fashion. If consonants are deleted (§3.1), the consonant targeted by deletion is determined by a single criterion that is insensitive to cluster type; if clusters are repaired through vowel epenthesis (§3.2), the site of epenthesis does not vary across cluster types.

3.1. *Cluster-blind consonant deletion*

The discussion in Chapter 2 of the typology of reduplicative onset transfer identified three cluster-blind simplification strategies employed in reduplication: either

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[26] It may also be relevant that, in Greek or Klamath (or reduplicative cluster simplification in general), the speaker considers simplification options only for clusters that she knows well—they are, after all, present in the native language; judgments of the relative similarity of $C_1C_2V_3$–C_1V_3 and $C_1C_2V_3$–C_2V_3 for any particular cluster may be clarified by, for example, the speaker's past experiences with confusion of these pairs. In contrast, in loanword adaptation, the speaker is faced with the task of finding the simplification strategy that best preserves the sound of a completely novel cluster—and if she happens to lack a clear mental representation of what the novel cluster sounds like, she is in a poor position to judge the similarity of the cluster to potential adaptations of it; it may be easier to perform these calculations on common clusters than on uncommon ones.

the less sonorous consonant in the cluster is copied, or the leftmost cluster member is copied, or the rightmost cluster member is copied.

Two of these strategies find analogues in the typology of consonant-deleting cluster simplification in loanword adaptation: sonority-based cluster reduction (§3.1.1), and deletion of all but the last consonant in the source cluster (§3.1.2). I have not found an example of loanword adaptation in which only the initial consonant of a source cluster is retained (as in the hypothetical system *pra*, *sta* → *pa*, *sa*), which would be analogous to leftmost copy in reduplicative onset transfer. This may very well be an accidental gap, especially given that vowel epenthesis seems to be preferred over consonant deletion as a strategy for repairing initial clusters (e.g., Hancin-Bhatt and Bhatt 1997 and references therein)—the relative rarity of consonant deletion as a cluster-repair strategy makes the existence of accidental gaps, as well as failure to discover actual attestations, more likely.

3.1.1. *Sonority-based cluster simplification*

In Telugu loanword adaptation (Broselow 1992a), initial clusters in English source forms may be resolved by either consonant deletion or vowel epenthesis:

(19) Telugu (data from Broselow 1992a, citing an unpublished ms. by U. G. Rao)

a. OR: [gasu] ~ [galasu] 'glass', [dəmmu] 'drum', [situ] 'sweet'

b. ST: [teʃənu] ~ [isteʃənu] 'station'

When vowel epenthesis occurs, it follows the anaptyxis-prothesis pattern discussed in §2.2: the epenthetic vowel is inserted inside OR, as in [galasu] 'glass' (a), but before ST, as in [isteʃənu] 'station' (b). But when consonant deletion is employed to repair initial clusters, it targets the sonorant of source *obstruent* + *sonorant* clusters, but the /s/ of source */s/* + *stop* clusters: compare [situ] < [swit] 'sweet' (a), in which [w] of an [sw] cluster is deleted, and [teʃənu] < [steʃən] 'station' (b), in which [s] of an [st] cluster is deleted. As Broselow (1992a) notes, this is directly parallel to cluster simplification in Sanskrit reduplication (see Chapter 2): the less sonorous member of the source cluster is selected to serve as the singleton onset of the adapted loanword. As in the case of Sanskrit, sonority-based cluster simplification in Telugu seems to be phonotactically motivated, assuming that the less sonorous a consonant is, the better onset it makes (Gnanadesikan 1995; Morelli 1999).

3.1.2. *Rightmost-oriented deletion*

In Finnish, cluster-initial loans from English and Swedish are repaired by deletion of all but the final consonant in the cluster (Young-Scholten and Archibald 2000):

(20) Finnish (data from Young-Scholten and Archibald 2000)

a. OR: *liisteri* 'paste' < Swedish *klister*

b. ST: *tuoli* 'chair' < Sw. *stol*

c. STR: *ranta* 'waterfront' < Sw. *strand*

This pattern may be unstable: Young-Scholten and Archibald (2000) report from several personal communication sources that more recent borrowings tend to retain all consonants in initial clusters (e.g., *stressi* < English *stress*, *strategia* < Eng. *strategy*), and a claim that "even earlier borrowings from Swedish retained their consonant clusters in slang." That may be because rightmost-oriented deletion leads to fairly extensive levelling of contrasts: for example, Young-Scholten and Archibald (2000) note that the Swedish words *spruta* 'syringe', *pruta* '(to) bargain', and *ruta* 'square' are all produced as [r̠ʉːta] by Finnish speakers following this cluster-resolution strategy; the fact that rightmost-oriented deletion guarantees that the thus-adapted loanwords sound very little like their source forms (see Chapter 4, which shows that for OR and ST, $C_1C_2V_3$–C_2V_3 are less similar than $C_1C_2V_3$–C_1V_3), is also perhaps sufficient motivation for innovative cluster preservation.

As with Nuxalk and the other potential examples of rightmost copy in reduplicative onset transfer (see Chapter 2), the Finnish cluster repair strategy may be viewed as resulting from a desire to allow the segments of the adapted loanword to correspond to a contiguous substring of the base.

3.2. *Cluster-blind vowel epenthesis*

The sections below discuss cluster-blind vowel epenthesis patterns—i.e., those patterns in which all source clusters trigger epenthesis, and epenthesis site does not vary across cluster types. Both logical possibilities are attested: either all clusters are repaired by anaptyxis (§3.2.1), or all clusters are repaired by prothesis (§3.2.2).

3.2.1. *Symmetrical anaptyxis*

In Korean (Nam and Southard 1994), all initial clusters in English loanwords are broken by an anaptyctic vowel:

(21) Korean (data from Nam and Southard 1994)

a. OR: [sɨlim] 'slim', [pɨrɛndɨ] 'brand', [k^{h}ɨləp] 'club'

b. ST: [sɨt^{h}im] 'steam', [sɨp^{h}idɨ] 'speed'

c. STR: [sɨt^{h}ɨraik^{h}ɨ] 'strike'

Note that intervocalic ST sequences are impossible in Korean, owing to heavy restrictions on what consonants may appear in non-prevocalic position (Nam and Southard 1994); thus, the result of prothesis before an initial ST cluster (e.g., *[ɨst^{h}im] 'steam') would be phonotactically ill-formed, requiring dramatic further deformation (e.g. making featural changes to [s] to make it a possible coda).

Other languages that employ anaptyxis to repair all cluster-initial loanwords include Japanese (Lovins 1975), Punjabi (Singh 1985), the variety of Turkish described by Yavas (1980), and Tok Pisin, historically if not synchronically (Laycock 1985). In Japanese and Tok Pisin, as in Korean, anaptyxis into ST clusters can be viewed as a forced choice: in Japanese, sibilants cannot appear in non-prevocalic position (Lovins 1975), and in Tok Pisin, all consonants must be prevocalic (Laycock 1985). In Punjabi, any combination of consonants may form a medial cluster, although medial clusters are often broken by an epenthesized vowel at very slow rates of speech (Gill and Gleason 1969), suggesting at least a weak dispreference for non-prevocalic consonants.

Symmetrical anaptyxis in Turkish is not mandated by constraints on consonant-vowel sequencing, since Turkish freely allows word-medial clusters (Swift 1963), but still emerges as optimal in loanword phonology.

3.2.2. *Symmetrical prothesis*

In Iraqi Arabic (Broselow 1983, 1992b), a prothetic vowel appears before all initial biconsonantal clusters in English loanwords:

(22) Iraqi Arabic (data from Broselow 1983, 1992b)

a. OR: [isnoː] 'snow, [ibleːn] 'plane'

b. ST: [istadi] 'study'

c. STR: [sitrit] 'street', [siblaʃ] 'splash'

(Initial biconsonantal clusters are not banned outright in Iraqi Arabic, but prothetic vowels do appear optionally before clusters in native forms: e.g. [qmaːʃ] ~ [iqmaːʃ] 'cloth' (Broselow 1992b).) Note that source triconsonantal (i.e., STR) clusters are repaired by a vowel inserted after the /s/, rather than before the cluster (c); but because word-medial triconsonantal clusters are impossible in Iraqi Arabic (Broselow 1992b), the result of prothesis before STR would not be phonotactically viable.

Central Siberian Yupik also apparently employs prothesis in fixing initial biconsonantal clusters in loanwords: the one cluster-initial English loan provided by Jacobson (1977) is [avlawa] 'flour', with an epenthetic vowel before an *obstruent* + *liquid* cluster. Central Siberian Yupik also has lexical regularities suggestive of prothesis before initial clusters in the native phonology, at least historically: initial clusters are not allowed, and many lexical items begin əCC-, with the schwa subject to deletion in connected speech (Krauss 1975; Lamontagne 1996).[27]

Symmetrical prothesis plausibly reflects a preference for ensuring that segments adjacent in the source form remain adjacent in the adapted loanword—i.e., that the loanword correspond to a contiguous substring of the source form; as noted above, this same preference is reflected in Finnish loanword adaptation (§3.1.2). The claim that Iraqi Arabic loanword adaption is shaped by this preference is seemingly belied by the fact that anaptyxis applies to initial STR clusters, as shown in ((21)c) above; but as I argue in detail in Chapter 5, violation of CONTIGUITY in this case is forced by the restriction in Iraqi Arabic against word-medial triconsonantal clusters.

4. *Repair of only one cluster type*

The discussion above has been restricted to those loanword adaptation patterns in which word-initial consonant clusters are banned outright: all source clusters are repaired, such that no adapted loanword is cluster-initial. In contrast, in the patterns discussed below, either TR is repaired, while ST surfaces as such (§4.1), or vice versa (§4.2). As in the cases of asymmetrical cluster resolution discussed in §2, SR clusters show variable behavior in the data presented here, patterning either with ST or with TR.

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[27] Digueño (Langdon 1970; Lamontagne 1996), like Central Siberian Yupik, has lexical regularities suggestive of a historical pattern of prothesis before initial clusters, but Langdon (1970) reports that English and Spanish loanwords are produced without modification of initial clusters.

4.1. *Repair of obstruent + sonorant clusters only*

In each of the patterns described below, TR clusters are repaired through anaptyxis while ST clusters are produced as such; SR clusters pattern either with TR or with ST, allowing anaptyxis or not. Like the anaptyxis-prothesis asymmetries discussed in §2.2, the loanword adaptation patterns presented in this section illustrate restricted intrusion: OR clusters permit the insertion of a cluster-internal vowel, but ST clusters do not—only here, unlike in anaptyxis-prothesis asymmetries, ST clusters do not trigger any repair. As in §2.2, I suggest that anaptyxis into OR clusters minimizes the perceptual difference between the adapted loanword and its cluster-initial source form: if OR clusters are to be repaired through vowel epenthesis, anaptyxis is the least costly strategy available. Further, SR clusters are less likely than TR clusters to license anaptyxis, because $S_1R_2V_3$–$S_1V_4R_2V_3$ are less similar than $T_1R_2V_3$–$T_1V_4R_2V_3$.

The English-based creole described by Nagara (1972), spoken in Hawai'i by native Japanese speakers, allows only ST clusters, as shown in the following data from Nagara's speaker AM:

(23) Hawai'ian Creole (data from Nagara 1972)

a. OR: [purantèːʃon] 'plantation', [purántiː] 'plenty'

b. ST: [steː] 'stay', [stópː] 'stop', [skuːruː] 'school'

c. STR: [storéːtaː] 'straight', [sturíːto] 'street'

TR clusters are broken by anaptyctic vowels (a,c); although no examples are provided, Nagara's description implies that SR clusters trigger anaptyxis as well. In contrast, ST clusters surface without epenthesis (b,c).[28]

Similarly, the treatment of Russian loanwords in several dialects of Central Yup'ik (Hammerich 1954)[29] suggests that only ST is a permissible initial cluster:

(24) Central Yup'ik (data from Hammerich 1954)

a. TR: [kənuːtaq] < [knut] 'whip', [pəlaːtoq] < [platók] 'kerchief'

b. ST: [stikəloq] < [stekló] 'glass', [stiːnaq] < [stená] 'wall'

As shown in (24), TR clusters in loans trigger anaptyxis, but ST clusters do not; Hammerich (1954) does not provide data bearing on the epenthesis behavior of SR clusters.

Finally, in Fijian (Schütz 1978), anapytxis applies to all clusters in English loanwords:

(25) Fijian (data from Schütz 1978)

a. TR: [peleni] 'plan', [tiripu] 'trip', [vuloa] 'floor'

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[28] Nagara (1972) claims that anaptyxis may apply to ST but very frequently does not; but in 28 pages of transcribed conversations with five consultants, no initial ST cluster is ever realized with epenthesis, and STR clusters are always realized with a single epenthetic vowel between the stop and the liquid. Further, Nagara refutes the argument that epenthesis might fail to apply in ST clusters owing to the influence of Japanese phonology—in which vowels between voiceless consonants are often devoiced or deleted—claiming that most of the consultants speak a dialect of Japanese in which vowel devoicing is not robust, that devoicing is not observed elsewhere in the data, and that consultants' speech rates seem in general too slow to be conducive to devoicing.

[29] Hammerich (1954) identifies the language in question as Alaskan Eskimo; locations of data collection were used to establish classification as Central Yup'ik, following Krauss (1980). The data in (24) are from Sleitmuit, Alaska, in the Kuskokwim dialect region; similar patterns are evident in data collected on Nunivak Island and Nelson Island.

b. SN: [sunuka] 'snooker (chaps)'

c. ST: [sipana] 'spanner', [sitaile] 'style', [sitima] 'steamer'

However, Schütz (1978:14) notes that syllables consisting of [s] followed by an epenthetic vowel, as in [**su**.nu.ka] (b) and [**si**.pa.na], [**si**.tai.le], and [**si**.ti.ma] (c), "can be reduced to the extent that they become (phonetically) lengthened consonants." At least to some extent, then, Fijian can be said to allow SR and ST clusters—albeit with long sibilants—and to repair only TR clusters through anaptyxis.

Patterns in which only ST (as in Hawai'ian Creole), or only ST and SR (as in Fijian), surface as clusters, while only TR, or both TR and SR, are repaired through anaptyxis, are the loanword adaptation equivalents of Dorsey's Law phenomena (Miner 1979; Steriade 1990; Hall 2003), in which underlying prevocalic *obstruent* + *sonorant* sequences are realized with an anaptyctic vowel.

Finally, note the similarity between the loanword adaptation patterns above and sufficient copy reduplication (Chapter 2), in which OR clusters are simplified while non-OR clusters are copied in full—the crucial difference being that in sufficient copy, OR clusters are simplified by skipping, while in loanword adaptation, OR clusters are simplified by insertion of a cluster-internal vowel. I have not found an example of a loanword adaptation pattern directly analogous to sufficient copy (i.e., source forms *pra*, *sta* → loanwords *pa*, *sta*). This difference between loanword adaptation and reduplication patterns in which only OR is simplified echoes a general difference in cluster simplification strategies across the two domains: I am not aware of any reduplication pattern in which base clusters are simplified in the reduplicant by vowel epenthesis (e.g., base *pra* → reduplicated *pəra-pra*) rather than consonant deletion, while vowel epenthesis seems to be preferred over consonant deletion as a loanword adaptation strategy for initial clusters (Hancin-Bhatt and Bhatt 1997).

4.2. *Repair of sibilant + stop clusters only*

In the loanword adaptation patterns discussed below, only ST, or ST and SR, are phonotactically impossible—and these clusters provoke a variety of repair strategies: vowel epenthesis, with the inserted vowel located either before or inside the cluster (§4.2.1); and consonant deletion, which always targets the sibilant of ST and SR (§4.2.2). Note the contrast here with the previous section: in the three examples discussed above in §4.1 of languages which repair only OR, only one cluster simplification strategy—namely, anaptyxis—is employed. In principle, all of the strategies used for repairing ST should be available for OR, but in practice, they are not—a difference that I suggest is tied to the fact that for $O_1R_2V_3$-initial source forms, $O_1V_4R_2V_3$ is a very good facsimile; whereas for $S_1T_2V_3$-initial forms, there is no one method of resolving the cluster that results in an especially close match to the sound of the source form, a state of affairs which, in effect, allows constraints like CONTIGUITY greater freedom to express their preferences.

4.2.1. *Vowel epenthesis*

When only ST clusters, or only ST and SR, are repaired by vowel epenthesis, the epenthetic vowel may be inserted before the cluster, or inside it.

In French-based Haitian Creole (Tinelli 1981), initial ST clusters are repaired by prothesis, while all OR clusters, including SR, are produced without epenthetic vowels:

(26) Haitian Creole (data from Tinelli 1981)

a. OR: [swa] 'silk', [flɛ] 'flower', [prizɔ̃] 'prison'

b. ST: [estati] 'statue', [eskãdal] 'scandal'

Catalan, unlike Haitian Creole, disallows both SR and ST initial clusters (Jiménez 1999), but as in Haitian Creole, Catalan repairs illegal clusters in loanwords with a prothetic schwa: e.g., [əzlam] 'slam', [əsputnik] 'sputnik' (Bonet and Lloret 1998). Similarly, in Spanish adapted loanwords and interlanguage pronunciations, a prothetic [e] appears before SR and ST clusters: e.g., *esmóquin* 'smoking jacket', [esnob] 'snob', [estek] 'steak' (Eddington 2001).[30] As noted in the discussion of anaptyxis-prothesis asymmetries in §2.2, for ST—but not for SR—prothesis, rather than anaptyxis, is the vowel epenthesis strategy resulting in the least dissimilarity between cluster-initial source form and adapted loanword. Prothesis also allows the source-initial cluster to be repaired without intrusion or skipping.

In Kamtok, or Cameroon Pidgin English (Tinelli 1981; Alber and Plag 2000), as in Haitian Creole, only ST clusters are repaired—but in Kamtok, the resolution strategy employed is anaptyxis, rather than prothesis: e.g., [sitón] 'stone', [sipún] 'spoon', but [blɛn] 'blind'. This is a poor strategy in terms of achieving maximal similarity between

[30] Note, too, that Spanish words like *estructura* 'structure', *eslabon* 'link' reflect a historical pattern of prothesis before proto-Romance */s/* + *consonant* clusters (Eddington 2001).

source form and adapted loanword—as shown in Chapter 4, $S_1T_2V_3$–$S_1V_4T_2V_3$ are quite dissimilar—but it has the virtue of providing correspondents in the loanword for both members of the source cluster, while at the same time obeying what seems to be a general preference (but not an absolute requirement) in Kamtok for consonants to be prevocalic (Todd, Jumbam and Wamey n.d.).

4.2.2. *Consonant deletion*

As in Haitian Creole and Kamtok, in the English-based creole Sranan (Alber and Plag 2000), only ST clusters are repaired—but here, through deletion of the /s/:

(27) Sranan (data from Alber and Plag 2000)

a. OR: [smoko] 'smoke', [trobi] 'trouble'

b. ST: [tori] 'story', [piki] 'speak'

c. STR: [tranga] 'strong', [krebi] 'scrape'

As shown by the adapted forms in (a) and (c) above, SR and TR onsets are permitted in Sranan.[31] Initial /s/ deletes in source ST and STR clusters, leaving behind singleton stop (b) and *stop + liquid* (c) onsets, respectively—although Alber and Plag (2000) note that many ST-initial forms, especially later borrowings, do not show /s/-deletion: e.g. [skin] < *skin*, [ston] < *ston*.

The Sranan pattern of repairing only ST clusters, and always by deletion of the /s/, is characteristic of the English-based creoles Krio and Guyana (Tinelli 1981) as well:

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[31] Indeed, obstruent + liquid onsets seem to be actively preferred: many source forms with coda liquids undergo vowel–liquid metathesis, such that the liquids become part of onset clusters—e.g. [srapu] < *sharp*, [krutu] < *court* (Alber and Plag 2000).

e.g., Krio [pun] 'spoon', [trit] 'street]; Guyana [tɔ́ri] 'story', [traŋ] 'strong'. It may also be characteristic of English-based Belizean Creole (Greene 1999), at least at some stage in that language's history: Greene (1999:30) reports words like [pun] 'spoon', [koːti] 'skirt', "from lexicon [sic] labeled as 'broad' or as older forms", but also provides examples of unrepaired ST clusters: e.g., [s̗tu] 'stew', [skal] 'scald'. Somewhat similarly, Dutch-based Negerhollands Creole (Sabino 1993) has seven etymologically ST-initial forms that have both full (ST-) and /s/-deletion (T-) variants, with the /s/-deletion variants being more frequent (accounting for about 75% of all tokens in the corpus of transcribed speech analyzed by Sabino (1993))—but there are also 34 Negerhollands Creole words with invariant ST clusters.

Finally, in English-based Jamaican Creole (Akers 1981), neither ST nor SN are phonotactically possible. Both cluster types may be repaired by what Akers (1981:31) describes as "/s/-syllabification", transcribed [s̩]—meaning, presumably, that as in Fijian (§4.1), [s]-initial clusters are pronounceable in Jamaican Creole as long as the [s] is relatively long and not coarticulated with the following consonant. However, ST and SN also allow repairs by two different, cluster-specific strategies:

(28) Jamaican Creole (Akers 1981)[32]

a. SN: [suːmaːt] ~ [s̩maːt] 'smart', [siːniek] ~ [s̩niek] 'snake'

[32] I constructed the /s/-syllabification examples in ((28)b,c); Akers (1981) does not provide an example of both /s/-syllabification and /s/-deletion applying to the same ST(R)-initial word, but his exposition suggests that, as in the case of SN, they are alternatives in free variation.

b. ST: [t̲oːriː] ~ [s̩toːriː] 'story', [k̲in] ~ [s̩kin] 'skin'

c. STR: [k̲w̲iːz] ~ [s̩kwiːz] 'squeeze', [p̲r̲ed] ~ [s̩pred] 'spread'

ST clusters may be repaired by deletion of the /s/, as in Sranan and the other languages cited above (b,c). In contrast, SN clusters allow anaptyxis in addition to /s/-syllabification (a).

Deletion of /s/ from ST clusters in Jamaican Creole, as in Sranan and the other languages cited just above, is not a strategy that maximizes similarity between source form and adapted loanword: as shown in Chapter 4, $S_1T_2V_3$–T_2V_3 are less similar than $S_1T_2V_3$–S_1V_3. It may reflect the preference to avoid skipping, as in Finnish (§3.1.2), since deletion of the segment at the left edge results in an adapted loanword that corresponds to a contiguous substring of the source form; or it may reflect phonotactic preference for less sonorous singleton onsets over more sonorous ones, as in Telugu (§3.1.1).

The question raised by Jamaican Creole, though, is why SN clusters should trigger anaptyxis while ST clusters trigger /s/-deletion. I suggest that anaptyxis is licensed for source SN clusters for many good reasons: anaptyxis allows both members of the source cluster to be represented in the adapted loanword, allows /s/ to be prevocalic—and probably most importantly, the result of anaptyxis sounds like the intact SN cluster; as shown in Chapter 4, $S_1N_2V_3$–$S_1V_4N_2V_3$ are fairly similar. In contrast, $S_1T_2V_3$–$S_1V_4T_2V_3$ are dissimilar enough that anaptyxis is not a viable cluster resolution strategy, and another solution—namely, /s/-deletion—is sought instead.

5. *Summary*

The table below in (29) summarizes the loanword adaptation patterns described in this chapter:

(29) Summary of loanword adaptation patterns

		$S_1T_2V_3 \rightarrow$?				
		No Simplification $S_1T_2V_3$	***Prothesis*** $V_4S_1T_2V_3$	***Anaptyxis*** $S_1V_4T_2V_3$	***C_2-deletion*** S_1V_3	***C_1-deletion*** T_2V_3
$O_1R_2V_3 \rightarrow$?	***No Simplification*** $O_1R_2V_3$	(English)	Haitian Creole[1] §4.2.1	Kamtok §4.2.1	—	Sranan[2] §4.2.2
	Prothesis $V_4O_1R_2V_3$		Iraqi Arabic §3.2.2			
	Anaptyxis $O_1V_4R_2V_3$	Hawai'ian Creole[3] §4.1	Egyptian Arabic[4] §2.2	Korean §3.2.1	—	—
	C_2-deletion O_1V_3	—	—	Cantonese[5] §2.1	—	Telugu §3.1.1
	C_1-deletion R_2V_3					Finnish §3.1.2

Notes:

1 – SN and SL pattern with ST in Catalan and Spanish

2 – SN and ST both require simplification in Jamaican Creole, but SN triggers anaptyxis

3 – SN patterns with ST in Fijian

4 – SN patterns with ST in Kazakh; SN and SL pattern with ST in Farsi and Hindi; SN, SL, and SW pattern with ST in Wolof

5 – SN patterns with ST in Saramaccan; SN and SL pattern with ST in Cantonese and Thai

In the table in (29), the cells along the diagonal (indicated with heavy borders) enclose the symmetrical loanword adaptation patterns—i.e., those patterns in which all clusters are simplified in the same fashion: either no clusters are simplified (as, for example, in English), all clusters are simplified by insertion of prothetic vowels (as in Iraqi Arabic), all clusters are simplified by insertion of anaptyctic vowels (as in Korean), or all clusters are simplified by deletion of all but the rightmost consonant in the cluster (as in Finnish). An additional symmetrical pattern, off the diagonal in (29), is sonority-based cluster simplification, as in Telugu: although OR clusters are simplified by deletion of C_2, while ST clusters are simplified by deletion of C_1, this adaptation strategy is symmetrical in the sense that all clusters are resolved according to a single criterion (namely, preference for less sonorous onsets over more sonorous ones).

Dashes in the table indicate what are, in my opinion, probable accidental gaps: for example, although I have found no examples of languages in which all clusters are simplified by deletion of all but the leftmost cluster member (e.g., sources *pra*, *sta* → adapted loanwords *pa*, *sa*), or languages in which OR clusters are simplified by skipping while ST clusters are not simplified (e.g., sources *pra*, *sta* → adapted loanwords *pa*, *sta*), these patterns are attested as reduplicative onset transfer strategies (see Chapter 2). Note that all probable accidental gaps involve consonant deletion for at least one cluster type—and as suggested above, because vowel epenthesis seems to be preferred over consonant deletion as a general strategy for resolving initial clusters (Hancin-Bhatt and Bhatt 1997), accidental gaps involving consonant deletion are rather likely.

Shading in the table indicates what are, in my opinion, true gaps in the typology: that is, I claim that simplification of OR clusters through C_1-deletion or prothesis (i.e., $O_1R_2V_3 \rightarrow R_2V_3$ or $V_4O_1R_2V_3$) occurs only in the context of symmetrical cluster resolution, when forced by a high-ranking constraint like CONTIGUITY (see chapter 5). Skipping and intrusion (i.e., $O_1R_2V_3 \rightarrow O_1V_3$ and $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$) are, I suggest, the preferred resolution strategies for OR because they result in adapted loanwords that sound as much as possible like the source-initial cluster—and departures from these preferred strategies occur only under duress.

In contrast, when OR and ST are resolved asymmetrically, ST clusters permit a relatively broader range of solutions than OR: prothesis (as in Haitian Creole and Iraqi Arabic) as well as anaptyxis (as in Kamtok and Cantonese); and C_1-deletion (as in Sranan). (I am puzzled by the total absence of $S_1T_2V_3 \rightarrow S_1V_3$ patterns from the typology; as shown in Chapter 4, $S_1T_2V_3$–S_1V_3 are more similar than $S_1T_2V_3$–T_2V_3, so I would expect $S_1T_2V_3 \rightarrow S_1V_3$ to be at least as well attested as $S_1T_2V_3 \rightarrow T_2V_3$. I can suggest only that $S_1T_2V_3$–S_1V_3, although more similar than $S_1T_2V_3$–T_2V_3, are still fairly dissimilar, and thus perhaps $S_1T_2V_3 \rightarrow S_1V_3$ does not stand out as a noticeably good solution to ST, in the way that $O_1R_2V_3 \rightarrow O_1V_3$ does for OR.) I argue that the fact of increased resolution options for ST as against OR reflects the fact that no method of simplifying ST results in an adapted loanword that is particularly similar to the cluster-initial form—and thus, other constraints (e.g., CONTIGUITY, LEFT-ANCHOR, phonotactic constraints favoring prevocalic consonsonants over non-prevocalic ones, and favoring less sonorous onsets over more sonorous ones) have more freedom to express their preferences.

Finally, the numbered notes in the table in (29) summarize the variable behavior of SR clusters in the typology of loanword adaptation. SR clusters sometimes pattern with TR, and sometimes with ST—and the likelihood of ST-patterning increases as sonority of the sonorant decreases: SN is more likely to behave like ST than SL, and SL is more likely to behave like ST than SW. As shown in Chapter 4, $S_1R_2V_3$–S_1V_3 and $S_1R_2V_3$–$S_1V_4R_2V_3$ are somewhat less similar than $T_1R_2V_3$–T_1V_3 and $T_1R_2V_3$–$T_1V_4R_2V_3$, respectively—similarity differences that manifest themselves in the typology of loanword adaptation as relatively greater reluctance to resolve SR clusters through skipping and intrusion.

CHAPTER 4

Similarity evidence

1. *Introduction*

This chapter examines evidence bearing on the perceptual similarity of onset consonant clusters and their counterparts affected by consonant deletion and vowel insertion: that is, $C_1C_2V_3$ vs. C_2V_3 (C_1-deletion), $C_1C_2V_3$ vs. C_1V_3 (C_2-deletion), and $C_1C_2V_3$ vs. $C_1V_4C_2V_3$ (vowel insertion).

The evidence presented here comes from two major sources: linguistic acts—namely, alliteration and imperfect puns—which, I argue below, reflect speakers' judgments of relative similarity; and experimental studies of relative similarity, both indirect (in which similarity is assumed to correlate with the time needed to discriminate stimuli pairs) and direct (in which listeners provide explicit similarity judgments). Leaving the details for the sections below, the evidence converges on the following two similarity scales (S = sibilant fricative, T = stop, O = obstruent, R = sonorant):

(1) Consonant deletion

$$\{\Delta(S_1T_2V_3–T_2V_3), \Delta(O_1R_2V_3–R_2V_3)\} > \Delta(S_1T_2V_3–S_1V_3) > \Delta(S_1R_2V_3–S_1V_3) > \Delta(T_1R_2V_3–T_1V_3)$$

(2) Vowel insertion

$$\{\Delta(S_1T_2V_3–S_1V_4T_2V_3), \Delta(T_1R_2V_3–V_4T_1R_2V_3)\} > \{\Delta(S_1T_2V_3–V_4S_1T_2V_3), \Delta(S_1R_2V_3–V_4S_1R_2V_3)\} > \Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$$

(Again, the statement Δ(X-Y) > Δ(P-Q) is read "the perceptual difference between X and Y is greater than that between P and Q"; or "P and Q are more similar than X and Y".)

The scale in (1) states that for *sibilant* + *stop* and *obstruent* + *sonorant* clusters, $C_1C_2V_3$–C_2V_3 is less similar than $C_1C_2V_3$–C_1V_3 (thus, for example, *sta–ta*, *pra–ra* are less similar than *sta–sa* and *pra–pa* respectively); and among $C_1C_2V_3$–C_1V_3 pairs, $T_1R_2V_3$–T_1V_3 (e.g., *pra–pa*) is more similar than $S_1R_2V_3$–S_1V_3 (e.g., *sla–sa*), which are more similar than $S_1T_2V_3$–S_1V_3 (e.g., *sta–sa*). The scale in (2) states, among other facts, that the similarity of a cluster-initial form to a form in which that cluster is split by an intrusive vowel decreases across *sibilant* + *stop*, *sibilant* + *sonorant*, and *stop* + *sonorant* clusters: e.g., *sta–səta* is less similar than *sla–səla*, which is less similar than *pra–pəra*. It also states that for *sibilant* + *stop* clusters, $C_1C_2V_3$–$V_4C_1C_2V_3$ are more similar than $C_1C_2V_3$–$C_1V_4C_2V_3$, but the reverse is true for *obstruent* + *sonorant* clusters (e.g., *sta–əsta* are more similar than *sta–səta*, but *pra–pəra* are more similar than *pra–əpra*.)

These results thus support, at least in part, the claim developed in the preceding chapters: that *stop* + *sonorant* onsets, and to a lesser extent *sibilant* + *sonorant* onsets, are unusually vulnerable to C_2-skipping and vowel intrusion because the effects of skipping and intrusion in these cases are perceptually very similar to the intact cluster. The connection between the similarity results and the restricted skipping and restricted intrusion data is discussed in detail in Chapter 5.

Before presenting the similarity evidence, I speculate briefly on why $T_1R_2V_3$–T_1V_3 and $T_1R_2V_3$–$T_1V_4R_2V_3$, and to a lesser extent $S_1R_2V_3$–S_1V_3 and $S_1R_2V_3$–$S_1V_4R_2V_3$, are so similar, proposing what I will call the perceptual break theory.[33] Define "perceptual break" as a perceptual event coinciding with the onset of vowel-like formant structure; and assume that the strength of a perceptual break is enhanced both by relatively high-intensity formant structure, and by the presence of a stop closure preceding the onset of formant structure. This means that *obstruent + sonorant* clusters are unique among consonant clusters in containing a cluster-internal perceptual break; and further, that a *stop + sonorant* cluster contains a stronger break than a *sibilant fricative + sonorant* cluster, that a *sibilant + liquid* cluster contains a stronger break than a *sibilant + nasal* cluster, and so on. The argument follows a chain of reasoning: the obstruent–sonorant juncture is acoustically very similar to the obstruent–vowel juncture, in that both are characterized by offset of aperiodic noise, onset of formant structure, and a relatively rapid rise in intensity—and the more sonorous the post-obstruent sonorant is, the more vowel-like the obstruent–sonorant juncture is. The obstruent–vowel juncture, in turn, is known to be associated with a boost in auditory response relative to e.g. an obstruent-obstruent juncture—an effect that is maximized by the presence of stop closure (and thus, silence) preceding vowel onset, and driven down by the presence of frication noise preceding the vowel (Bladon 1986; Wright 1996). Increased auditory response at the obstruent–vowel juncture may serve as a landmark for speech segmentation (Wright 1996); further support for the obstruent–vowel boundary as an important perceptual

[33] This is a "theory" only in the plain English sense; it's not falsifiable (at least not yet), and I don't attempt to prove it. Further, the explanations of restricted skipping and restricted intrusion developed in Chapter 5 don't rest on it; they rest on the facts about similarity relationships which I address below.

breaking point comes from Treiman's (1983) novel word-game experiments: the preferred location for word-splitting is at an obstruent–vowel boundary.

I suggest that a perceptual break at the obstruent–sonorant boundary is exploited in restricted skipping and restricted intrusion phenomena, in which only *obstruent* + *sonorant* clusters allow C_2-deletion and cluster-internal vowel insertion. That is, I suggest that vowel insertion and consonant deletion that occur after a perceptual break have less noticeable effects than insertion and deletion elsewhere. In a cluster like */s/* + *stop*, for example, the first perceptual break occurs between the stop and the following vowel, so C_2-deletion ($S_1T_2V_3 \rightarrow S_1V$) or cluster-internal vowel insertion ($S_1T_2V_3 \rightarrow S_1V_4T_2V_3$) deforms a cluster whose members are bound tightly together perceptually, adding a break where there was none before, resulting in an extremely noticeable difference between the intact cluster and that cluster affected by insertion or deletion. In contrast, the members of an *obstruent* + *sonorant* cluster are less tightly bound, by virtue of the cluster-internal perceptual break, so the result of C_2-deletion ($O_1R_2V_3 \rightarrow O_1V$) or cluster-internal vowel insertion ($O_1R_2V_3 \rightarrow O_1V_4R_2V_3$) is less noticeably distinct from the sound of the intact cluster; this is more true for *stop* + *sonorant* clusters than for *sibilant* + *sonorant* clusters, as the cluster-internal perceptual break is stronger in the former case than in the latter. Again, this is speculative, but the similarity evidence holds good in any event.

2. *Consonant deletion*

This section reports evidence bearing on the relative perceptual similarity of $C_1C_2V_3$–C_2V_3 (C_1-deletion) and $C_1C_2V_3$–C_1V_3 (C_2-deletion) pairs. The evidence comes from alliteration (§2.1), imperfect puns (§2.3), and a discrimination experiment designed to gauge the perceptual distance between cluster-singleton pairs (§2.4).

2.1. *Alliteration*

2.1.1. *Germanic alliteration*

Alliteration is a major structural principle of early Germanic verse: each line consists of two half-lines, and the stressed syllables of half-lines must alliterate.[34] The Germanic alliteration rules are as follows:

(3) Germanic alliteration rules (Kuryłowicz 1971; Suzuki 1985)

a. Vowel-initial words alliterate with any vowel-initial word.

b. Words with initial /sp, st, sk/ alliterate only with words beginning with the same cluster.

c. Otherwise, consonant-initial words alliterate with any word beginning with the same consonant.

Thus, for example, as illustrated by the following lines from *Beowulf*, *br-* alliterates with *bl-* and prevocalic *b-* ((4)a), as well as with *br-* ((4)b); whereas *st-* alliterates only with *st-* ((4)c), and not with any other *s*-initial form—i.e., not with *s-*, *sp-*, *sk-*, s*m-*, *sn-*, *sl-*, or

[34] Contrast this with e.g. Shakespeare's sonnets, in which rhyme and meter are organizing principles, while alliteration is used only ornamentally.

sw-.

(4) Alliteration in *Beowulf* (translation by Francis B. Gummere)

a. brim-clifu blīcan, beorgas stēape

'sea-cliffs shining, steep high hills' (line 222)

b. beado-hrægl brōden on brēostum læg

'battle-sark braided my breast to ward ' (line 552)

c. stān-beorh stēapne; stīg under læg

'in the stone-barrow steep. A strait path reached it' (line 2213)

The Germanic alliteration facts have been cited as evidence that */s/* + *stop* clusters form a single phonological unit at some level of analysis (e.g., Kuryłowicz 1971; Davidsen-Nielsen 1974; Ewen 1982; Broselow 1992; van de Weijer 1996). To put it simply, this view holds that ST alliterates like a single segment because it is a single segment—or at the very least, because it is more like a single segment than fully-biconsonantal *obstruent* + *sonorant* onsets.

I propose an alternative interpretation of the Germanic alliteration system: that it reflects tacit judgments of relative similarity by the speakers who composed alliterative verse and, in so doing, established its rules. This view assumes that alliterative rules or constraints require words in certain metrical positions to begin with sequences that are sufficiently similar to signal an alliterative pairing—because if the listener is not convinced that alliteration has taken place, then the composer has failed to convey the verse's structure. If a cluster-singleton pair (i.e., C_1C_2V–C_1V or C_1C_2V–C_2V) does not alliterate, then that pair must be less similar than a cluster-singleton pair that does, since the alliterative standard of "similar enough" rules out alliteration in the first case but not the second.

Under this interpretation, Germanic alliteration supports the similarity scale in (5):

(5) $\{\Delta(S_1T_2V\text{–}T_2V), \Delta(O_1R_2V\text{–}R_2V), \Delta(S_1T_2V\text{–}S_1V)\} > \Delta(O_1R_2V\text{–}O_1V)$

That is, because only O_1R_2V–O_1V pairs alliterate, these must be more similar than other, non-alliterating cluster-singleton pairs.[35]

This interpretation of Germanic alliteration receives partial support from similarity judgments reported by Fleischhacker (2000). In this study, English speakers rated the similarity of word–non-word pairs like [bleim] *blame* vs. [breim] (liquid alternation) and [bleim] *blame* vs. [beim] (liquid deletion). Average ratings were 3.52 (out of 7) for liquid alternation, and 3.27 for liquid deletion—a non-significant difference ($p = .095$). That is, [bleim]–[breim]–[beim] are essentially perceptually equidistant. This is in accord with the fact that in Germanic, *obstruent* + *liquid* clusters alliterate with any cluster beginning with the same obstruent: e.g., *bl*- alliterates with *bl*-, *br*-, and *b*-.

2.1.2. *Irish alliteration*

The structural alliteration system of early Irish is quite similar to that of early Germanic, but with an important difference: *sm*- patterns with *sp*-, *st*-, *sk*-, allowing only self-alliteration (Murphy 1961).

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[35] Note, though, that there may be an "initiality" factor in alliteration – perhaps C_1C_2V–C_2V pairs never alliterate because that's just not the way alliteration works, and not because the pair is insufficiently similar.

I take this as evidence that the composers of early Irish verse judged *sm*V–*s*V to be less similar than any other O_1R_2V–O_1V pair—i.e., less similar than any of *sn*V–*s*V, *sl*V–*s*V, *sw*V–*s*V, or T_1R_2V–T_1V; thus, early Irish alliteration supports the similarity scale shown in (6):

(6) $\{\Delta(S_1T_2V–T_2V), \Delta(O_1R_2V–R_2V), \Delta(S_1T_2V–S_1V), \Delta(smV–sV)\} > \Delta(O_1R_2V–O_1V)$

(In (6), O_1R_2 is used to represent all *obstruent* + *sonorant* clusters except *sm*-.)

2.1.3. *Middle English alliteration*

Middle English verse (Golston 1998; Minkova 2003) innovates on Old English verse in two ways: alliteration is ornamental, rather than structural; and */s/* + *stop* clusters alliterate with all /s/-initial words—thus, all clusters may, in principle, alliterate with any word beginning with the same consonant. Nevertheless, Minkova's (2003) analysis of three Middle English poems, *Wynnere and Wastoure*, *The Wars of Alexander*, and *Piers Plowman* (B-text), found that */s/* + *consonant* clusters are more likely than other clusters to alliterate cohesively, i.e., with an identical cluster (C_1C_2V–C_1C_2V) as opposed to a singleton onset identical to C_1 (C_1C_2V–C_1V). Figure 1 shows, for individual clusters, cohesive alliteration as a percentage of all instances of alliteration, averaged across the three poems analyzed (in the graph, *thr* = [θr]):

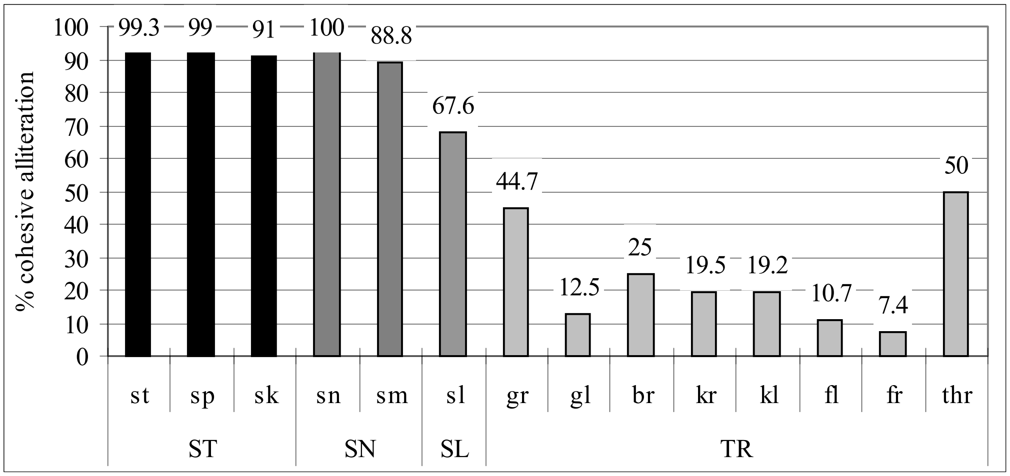

Figure 1. Cohesive alliteration in Middle English verse (Minkova 2003)

ST and SN clusters alliterate cohesively almost exclusively, and SL clusters alliterate cohesively very frequently. In contrast, no TR cluster alliterates with the identical cluster in more than half of all alliterative instances.

Again, I argue that alliterative choices reflect poets' judgments of relative similarity—that, for example, in choosing never to write a line in which *st*V- alliterates with *s*V-, the author of *The Wars of Alexander* reveals his intuition that *st*V- is not similar enough to *s*V- to alliterate with it; whereas, in placing *br*V- and *b*V- in an alliterative relationship fully 204 times, he indicates that *br*V- and *b*V- sound quite similar to him. Thus, the facts of Middle English alliteration, at least for the three poems analyzed by Minkova (2003), support the similarity scale shown in (7):

(7) $\{\Delta(S_1T_2V–T_2V), \Delta(O_1R_2V–R_2V)\} > \{\Delta(S_1T_2V–S_1V), \Delta(S_1N_2V–S_2V)\} >$

$\Delta(S_1L_2V–S_2V) > \Delta(T_1R_2V–T_1V)$

That is, because no C_1C_2V- ever alliterates with C_2V-, $C_1C_2V–C_2V$ are less similar than $C_1C_2V–C_1V$, for all cluster types. Further, because $S_1T_2V–S_1V$ and $S_1N_2V–S_2V$ alliterate less frequently than $S_1L_2V–S_2V$, they are less similar than $S_1L_2V–S_2V$; and because $S_1L_2V–S_2V$ alliterates less frequently than $T_1R_2V–T_1V$, $S_1R_2V–S_2V$ is less similar than $T_1R_2V–T_1V$.

2.2. *Summary: alliteration*

Taken together, the facts of early Germanic, early Irish, and Middle English alliteration support the similarity scale shown below in (8):

(8) Composite similarity scale based on alliteration

$\{\Delta(S_1T_2V–T_2V), \Delta(O_1R_2V–R_2V)\} > \Delta(S_1T_2V–S_1V) > \Delta(S_1R_2V–S_1V) >$
$\Delta(T_1R_2V–T_1V)$

$C_1C_2V–C_2V$, for all clusters in question (i.e., ST, SR, and TR), is at the top of this scale, because clusters never alliterate with C_2- singleton onsets. Below $C_1C_2V–C_2V$ are the $C_1C_2V–C_1V$ pairs, with similarity decreasing across ST, SR and TR. This ranking is established because */s/* + *stop* alliterates with singleton /s/ only in Middle English, and then only rarely; because *stop* + *liquid* clusters alliterate freely with singleton stops in Germanic, Irish, and Middle English; and because */s/* + *sonorant* clusters show more variable behavior with respect to alliteration with singleton /s/ (namely, *sm-* cannot alliterate with *s-* in Irish; in Middle English, *sm-* and *sn-* almost never alliterate with *s-*, and *sl-* rarely does).

2.3. *English imperfect puns*

A pun, broadly speaking, is a piece of wordplay relying on the phonological similarity or identity of two words. For example, consider the line "Come forth, Lazarus! And he came fifth and lost the job", from James Joyce's Ulysses. The humorous effect stems from the identity between the pun word *fourth* and the target word *forth*. This is a perfect pun, in which pun and target are phonologically identical but lexically distinct. By contrast, an imperfect pun, such as *Napoleon Blown-apart*, is one in which the pun word (here, *Blown-apart*) corresponds to a phonologically similar but non-identical target word (here, *Bonaparte*). I follow Zwicky and Zwicky (1986) in treating imperfect puns as a source of evidence bearing on phonological similarity; Zwicky and Zwicky concluded, based on an analysis of pun-target segment substitution frequencies, that e.g., /l/–/r/, /m/–/n/, and obstruents contrasting only in voice or place—all high-frequency substitutions—are very similar.

I make the following assumptions about the nature of imperfect puns. First, because the target word is usually not made explicit in the pun's context, the pun word must be sufficiently similar to the target that the target can be inferred—this is what makes the difference between an amusing pun and one that is just puzzling. Further, there is a positive correlation between pun-target similarity and the goodness of the pun: although puns may be bad for a variety of reasons (objectionable subject matter, artificial context, winking delivery, etc.), truly funny puns are generally those in which the phonological relationship between pun and target is unforced, subtle but quickly recognizable on examination. Finally, I assume that most puns are good-faith attempts at humor,[36] and that the goodness of a particular pun category can be roughly quantified by calculating its degree of representation in a large corpus of imperfect puns.

2.3.1. *Constructing the pun corpus*

A corpus of imperfect puns was constructed as follows. I obtained a set of 1,924 puns collected by Arnold and Elizabeth Zwicky, which had been preserved in the Arnold M. Zwicky papers at the Western Historical Manuscript Collection.[37] These puns appear to be exclusively from Crosbie (1977), a book of pun jokes organized in dictionary format.[38] 605 of these 1,924 were eliminated on the grounds that they were perfect puns, stress puns, clever definitions as opposed to puns, etc. I then added 645 imperfect puns that I collected from a variety of magazines, newspapers, novels, radio, television, and advertising materials, including two books of product slogans (Sharp 1984; Urdang and Robbins 1984). Thus, the corpus analyzed here contains a total of 1,964 imperfect puns.

The pun corpus was coded as illustrated by the examples below:

[36] This is not a unanimous view: Crosbie (1977), in his pun-filled (and in my opinion, spectacularly unfunny) introduction to a book of pun jokes, claims that pun-induced groans "can be gratifying to the author's ego."

[37] WHMC, 23 Ellis Library, University of Missouri-Columbia, Columbia, MO 65201. Many thanks to Arnold and Elizabeth Zwicky for allowing me to use their materials, and to Arnold Zwicky and WHMC reference librarian John Konzal for help in locating them.

[38] The puns' origins are not indicated in the materials I have, but in fairly extensive checking I have never failed to find a pun in my copy of Crosbie (1977).

(9) Corpus coding: examples relevant to cluster-singleton similarity

	pun word	**target word**	**pun segment**	**target segment**	**context**	**pun type**
a.	*Blown-apart*	*Bonaparte*	l	Ø	b_o	Ø~R/T_V
b.	*slalom*	*solemn*	l	Ø	s_ɑ	Ø~R/S_V
c.	*surgeon*	*sturgeon*	Ø	t	s_ɝ	Ø~T/S_V
d.	*raise*	*praise*	Ø	p	#_r	Ø~T/#_R
e.	*swish*	*wish*	s	Ø	#_w	Ø~S/#_R
f.	*Stabitha*	*Tabitha*	s	Ø	#_t	Ø~S/#_T

The examples in (9) show the six pun types that bear on the question of C_1C_2V–C_1V ((9)a,b,c) and C_1C_2V–C_2V ((9)d,e,f) similarity, for C_1C_2 clusters TR, SR, and ST. Thus, Ø~R/T_V puns (*Blown-apart–Bonaparte*) bear on the similarity of T_1R_2V to T_1V, Ø~T/#_R puns (*raise–praise*) bear on the similarity of T_1R_2V to R_2V, and so on.

A question that arose in coding the pun corpus was how to handle puns like *clods–gods*, *slips–ships*, and *spit–shit*, in which segment insertion or deletion cooccurs with a featural change in the immediate context. Certainly a strong argument could be made that, for example, *slips–ships* should be counted as an instance of Ø~R/S_V: [s] and [ʃ] are highly confusable in noise (Miller and Nicely 1955), and are judged quite similar by English-speaking listeners (Singh, Woods and Becker 1972), so it is reasonable to say that in *slips–ships*, [l] corresponds with zero in the sibilant–vowel context, and concomitantly, [s] corresponds with [ʃ].

However, I adopted the conservative strategy of classifying puns as examples of the pun types shown above in (9) only if the consonantal context of insertion or deletion was phonemically identical;[39] thus, *slalom–solemn* counts as an example of Ø~R/S_V, but *slips–ships* does not. This decision was motivated by the concern that allowing less-than-exact pun–target matches is a slippery slope: if *clods–gods* ([l]~Ø, and [k]~[g]) is an example of Ø~R/T_V, then what about *pranks–thanks* ([r]~Ø, and [p]~[θ]), or *try–buy* ([r]~Ø, and [t]~[b])? Lacking a principled, a priori method for deciding what kinds of pun–target featural correspondences should be allowed and which should not, I set the cut-off point at absolute identity. While this is almost certainly too restrictive (see discussion below on the apparent underrepresentation of S_1R_2V–S_1V puns), it at least sidesteps the problems inherent in drawing conclusions about relative similarity based on a pun corpus that itself contains built-in assumptions about relative similarity.[40]

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[39] Note that this strategy does not disallow differences elsewhere in the word: e.g., *flax–facts* is an example of Ø~R/T_V, even though pun and target also differ by [t]~Ø between [k] and [s].

[40] To see this, consider the arbitrary decisions involved in establishing a cut-off point for allowable pun–target featural mismatches based on an existing theory of similarity. First, one must decide how to define similarity: for example, as confusability in noise (e.g., Miller and Nicely (1955)), as an abstract property that experimental subjects can be asked to assess directly (e.g., Singh, Woods, and Becker (1972)), or as the ratio of shared natural classes to shared plus unshared natural classes (e.g., Frisch, Broe, and Pierrehumbert (1997)). This is not simply an ideological question; as shown by the table below, these definitions of similarity do not agree on whether, for example, [s]-[ʃ] are more similar than [t]-[d] (shading indicates the more similar pair):

Similiarity measure	[s]-[ʃ]	[t]-[d]	Source
# of shared natural classes / # of shared + # of unshared natural classes	.845	.566	FBP 1997
# of confusions at signal/noise ratio = -12 db	73	3	MN 1955
mean rating on 7-point scale (1 = most similar)	4.3	4.4	SWB 1972
mean length of lines drawn to represent difference (in inches)	11.4	10.6	SWB 1972
judged most similar pair of ABX triple (% of all ABX)	57	60	SWB 1972

Three puns in the corpus, *splendor–blender*, *strain–drain*, and *stress–dress*, in which a voiceless stop preceded by /s/ corresponds to a voiced stop, deserve special mention here. Because post-/s/ stops are voiceless and unaspirated in English, the featural match between pun stop and target stop is inexact in both puns like *skin–kin* and puns like *splendor–blender*. I counted as examples of Ø~S/#_T only *skin–kin* and other puns in which a stop preceded by /s/ corresponds to a voiceless stop; *splendor–blender*, and the other two puns like it, were not counted as examples of Ø~S/#_. (This decision was motivated only by expedience: as described below, degree of representation in the pun corpus was determined by comparing the number of examples of a pun type in the corpus with the number of like word–pairs in English, and the number of pairs like *skin–kin* occurring in the CELEX database (Baayen, Piepenbrock and van Rijn 1995) was easily discoverable.)

2.3.2. *Analysis of the pun corpus*

Following Frisch, Broe, & Pierrehumbert (1997), degree of representation in the pun corpus was determined by calculating the ratio of the frequency of a pun type observed in the corpus to the frequency that would be expected if pun types occurred at random, based on the number of relevant word pairs in English.

Once a definition of similarity has been adopted, there is still the problem of how to objectively select a criterion for determining acceptable pun–target featural mismatches. For example, mean ratings on Singh, Woods, and Becker's (1972) 7-point similarity scale range from 1.8 (for [f]-[θ]) to 5.8 (for [w]-[ʃ]); there seems to be no principled way to select a value between 1.8 and 5.8 below which pun–target correspondent segments are similar enough for the purposes of pun coding, and above which they are not.

Observed frequency in the pun corpus was calculated by dividing the number of instances of a particular pun type by the total number of instances of its general type. For example, the degree of representation of $T_1R_2V–T_1V$ puns was calculated by dividing the number of these puns by the total number of puns characterized by word-medial insertion or deletion of any segment:

(10) $$\left(\frac{\text{Ø~R/T\_V}}{\text{Ø~X/\#…\_…\#}}\right) = \text{observed frequency of } T_1R_2V–T_1V \text{ puns}$$

Note that the denominator of this fraction includes Ø~R/T_V, as well as Ø~R/S_V, Ø~T/S_V and puns like *sinned–singed*, *fanny–fancy*, *rose–roads*, etc. The observed frequencies of $S_1R_2V–S_1V$ and $S_1T_2V–S_1V$ puns were similarly determined, by dividing Ø~R/S_V and Ø~T/S_V, respectively, by Ø~X/#…_…#.

The frequency of $T_1R_2V–R_2V$ puns was determined by dividing the number of these puns by the number of puns characterized by word-initial insertion or deletion of any segment:

(11) $$\left(\frac{\text{Ø~T/\#\_R}}{\text{Ø~X/\#\_}}\right) = \text{observed frequency of } T_1R_2V–R_2V \text{ puns}$$

In this case the denominator includes all $T_1R_2V–R_2V$ puns, plus all $S_1R_2V–R_2V$ puns, all $S_1T_2V–T_2V$ puns, and all puns like *posing–opposing* and *bourbon–urban*. Likewise, the frequencies of $S_1R_2V–R_2V$ and $S_1T_2V–T_2V$ puns were calculated by dividing Ø~S/#_R and Ø~S/#_T, respectively, by Ø~X/#_.

Because most of the puns in the corpus are on pairs of words (as opposed to phrases, or nonce forms), it seems reasonable to expect that, all else being equal, degree of representation in the pun corpus should correspond to the number of word pairs available in English for the construction of any particular pun type. Thus, to determine the expected frequencies of the relevant pun types, I counted the number of English word pairs corresponding to each pun type—e.g., for T_1R_2V–T_1V puns, I counted the number of word pairs like *go–grow*, *pay–play*, etc., appearing in the CELEX database (Baayen, Piepenbrock and van Rijn 1995).[41] These counts were used to calculate expected frequencies, using the same formulas shown above in (10) and (11) for observed frequencies.

The table below shows the observed (O) and expected (E) frequencies, calculated as described above, for the four pun types of interest:

[41] Many thanks to Colin Wilson for writing and running the scripts necessary to make these counts. The scripting procedure resulted in two lists: one of all English words which differ only in the presence or absence of one word-initial segment, and one of all words which differ only in the presence or absence of one word-medial segment. I then hand-coded these lists and sorted them to count the sets of word-pairs corresponding to each pun type.

(12) Results: cluster-singleton puns

	comparison	*calculation*	O = *pun corpus*	E = *CELEX*	O/E
C_1C_2V–C_1V	**T_1R_2V–T_1V**	Ø ~ R / T_V ÷ Ø ~ X / #…_…#	105/265	736/2801	
		=	**39.62%**	**26.28%**	**1.51**
	S_1R_2V–S_1V	Ø ~ R / S_V ÷ Ø ~ X / #…_…#	11/265	187/2801	
		=	**4.15%**	**6.68%**	**0.62**
	S_1T_2V–S_1V	Ø ~ T / S_V ÷ Ø ~ X / #…_…#	7/265	226/2801	
		=	**2.64%**	**8.07%**	**0.33**
C_1C_2V–C_2V	**T_1R_2V–R_2V**	Ø ~ T / #_R ÷ Ø ~ X / #_	34/163	926/4286	
		=	**20.86%**	**21.61%**	**0.97**
	S_1R_2V–R_2V	Ø ~ S / #_R ÷ Ø ~ X / #_	7/163	199/4286	
		=	**4.29%**	**4.64%**	**0.92**
	S_1T_2V–T_2V	Ø ~ S / #_T ÷ Ø ~ X / #_	8/163	268/4286	
		=	**4.91%**[42]	**6.25%**	**0.79**

The last column in the table is the observed frequency divided by the expected frequency (O/E) for each pun type. These O/E values provide a measure of degree of representation in the corpus. When O/E = 1, the proportion of a pun type in the corpus is equivalent to the proportion of relevant word-pairs in English: thus, the pun type occurs with the frequency that would be expected if pun-target pairs were selected randomly from among English word pairs. When O/E is greater than 1, the pun type is overrepresented in the corpus with respect to the set of English word pairs of the relevant type—i.e., there are more of these puns in the corpus than expected, all else being equal. When O/E is less

[42] Adding in *splendor–blender*, *stress–dress*, and *strain–drain*, i.e., the three puns mentioned above in which a voiceless stop preceded by /s/ corresponds to a voiceless stop, this figure goes up to 6.75%.

than 1, the pun type is underrepresented in the corpus—i.e. there are fewer of these puns in the corpus than would be otherwise expected. Note that zero is the lower limit on O/E values.

The O/E values from (12) are displayed graphically in Figure 2:

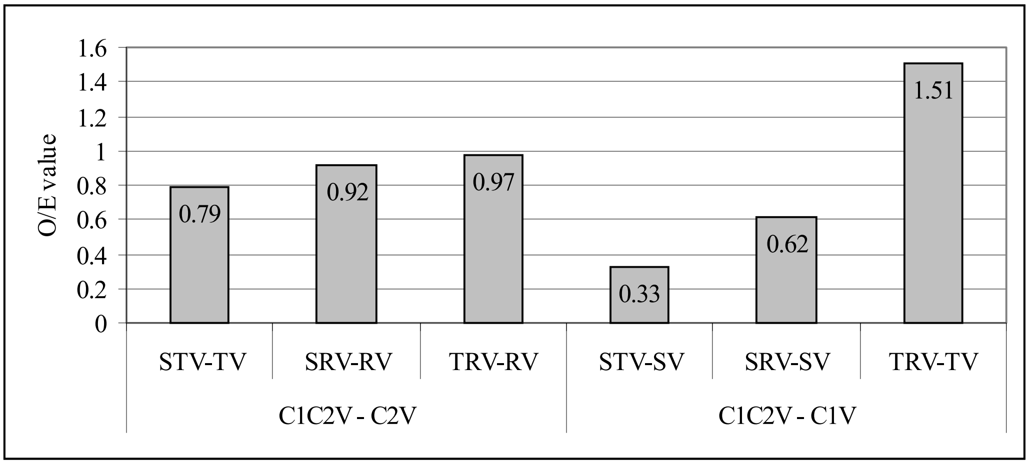

Figure 2. O/E values, by pun type

Consider first C_1C_2V–C_2V puns. For the O_1R_2V–R_2V pun types (i.e., T_1R_2V–R_2V and S_1R_2V–R_2V), O/E values are just below 1, meaning that these puns are just about as frequent as would be expected if pun choice was essentially random. S_1T_2V–T_2V puns are slightly underrepresented, at O/E = 0.79; the relatively lower frequency of S_1T_2V–T_2V as against other C_1C_2V–C_2V puns might plausibly be attibuted to the featural mismatch between word-initial and post-/s/ voiceless stops (i.e. [t^h] vs. [t]) assuming that less similar pun–target pairs are dispreferred.

Looking at the C_1C_2V–C_1V puns, we see that T_1R_2V–T_1V puns are noticeably overrepresented (O/E = 1.51), and S_1T_2V–T_1V puns are severely underrepresented (O/E =

0.33). S_1R_2V–S_1V puns are also underrepresented, at O/E = 0.62. However, it should be noted that S_1R_2V–S_1V puns were especially impacted by my decision to count as examples of pun types only those pun–target pairs in which the consonantal context of insertion/deletion was identical: in addition to the eleven S_1R_2V–S_1V puns counted, there were in the corpus nine puns like *slips–ships*, in which R~Ø and [s]~[ʃ]. (Contrast this with the situation for the seven S_1T_2V–S_1V puns, whose number would have increased by only one (*spit–shit*) had [s]~[ʃ] been an allowable pun–target mismatch.) Because these [s]~[ʃ] mismatch puns did not contribute to observed frequency, the O/E value for S_1R_2V–S_1V puns might be a bit lower than really does this pun type justice.

Assuming that degree of representation in the pun corpus correlates with pun goodness, and that more similar pun-target pairs are better than less similar ones, these results suggest the following scale of relative similarity:

(13) $\Delta(S_1T_2V–S_1V) > \Delta(S_1R_2V–S_2V) > \{\Delta(S_1T_2V–T_2V), \Delta(O_1R_2V–R_2V)\} >$
$\Delta(T_1R_2V–T_1V)$

Compare the similarity scale in (13) with that generated in §2.1 through analysis of alliteration in Germanic, Irish, and Middle English (repeated below as (14)):

(14) $\{\Delta(S_1T_2V–T_2V), \Delta(O_1R_2V–R_2V)\} > \Delta(S_1T_2V–S_1V) > \Delta(S_1R_2V–S_1V) >$
$\Delta(T_1R_2V–T_1V)$

The pun-generated and alliteration-generated scales agree that, for C_1C_2V–C_1V pairs, similarity increases across ST, SR, and TR. However, the scales differ in the ranking of C_1C_2V–C_2V with respect to C_1C_2V–C_1V. The alliteration facts—namely, that no C_1C_2V

ever alliterates with C_2V—suggest that C_1C_2V–C_2V is less similar than C_1C_2V–C_1V, for all cluster types;[43] but C_1C_2V–C_2V puns are better represented in the imperfect pun corpus than S_1T_2V–S_1V and S_1R_2V–S_1V puns. The experimental evidence presented in the following section further supports the conclusion suggested by the alliteration facts, that C_1C_2V–C_2V is less similar than C_1C_2V–C_1V for C_1C_2 = ST, SR, and TR.

Regarding this discrepancy between the pun corpus results and the other results, I suggest that there may be greater tolerance for pun–target dissimilarity when that dissimilarity is located at the word-edge, rather than word-internally. Note that in a pun like *raise–praise*, although onsets of pun and target are different, the pun word (*raise*) corresponds to an uninterrupted substring of the target word (*praise*); while in a pun like *pays–prays*, segments that are contiguous in the pun word are discontiguous in the target word. If respect for pun–target contiguity relationships is a factor in determining pun goodness, then C_1C_2V–C_2V puns may be represented in the corpus to a greater degree than expected based on perceptual similarity alone.

2.4. *Experimental evidence: discrimination task*

This section reports the results of a discrimination task designed to gauge the relative perceptual similarity of C_1V_3–$C_1C_2V_3$ and C_2V_3–$C_1C_2V_3$ pairs.[44] In this task, listeners were timed as they decided whether pairs like *kla–ka* and *kla–la* were the same

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[43] Although again, as noted above, an "initiality effect" in alliteration may also account for the impossibility of C_1C_2V–C_2V pairings.

[44] This section reports work done jointly with Keith Johnson, who generously volunteered to run the experiment using the laboratory facilities and subject pool at Ohio State University. Missteps in experimental design and any errors made in interpreting the data are solely my responsibility.

or different; time to decision (i.e., reaction time) is interpreted as a measure of the similarity of the pair in question, assuming the general psychological principle that the amount of time necessary to discriminate between two items is inversely correlated with the difference between them (e.g., Shepard 1987).

2.4.1. *Method*

The table below in (15) shows the cluster-initial stimuli used in the experiment, and the C_1- and C_2-initial forms they were compared against:

(15) Stimuli pairs: C_1C_2ɑ–C_1ɑ and C_1C_2ɑ–C_2ɑ

Cluster type		**C_1C_2ɑ**	*Comparison items =* **C_1ɑ**	**C_2ɑ**
TR	TN	[knɑ]	[kɑ]	[nɑ]
	TL	[klɑ]	[kɑ]	[lɑ]
	TW	[kwɑ]	[kɑ]	[wɑ]
SR	SN	[snɑ]	[sɑ]	[nɑ]
	SL	[slɑ]	[sɑ]	[lɑ]
	SW	[swɑ]	[sɑ]	[wɑ]
¬OR	TT	[ktɑ]	[kɑ]	[tɑ]
	NN	[mnɑ]	[mɑ]	[nɑ]
	TS	[ksɑ]	[kɑ]	[sɑ]
	ST	[skɑ]	[sɑ]	[kɑ]

Thus, for the purposes of the results reported below, TR = one example each of *stop* + *nasal*, *stop* + *liquid*, and *stop* + *glide*; SR = one example each of */s/* + *nasal*, */s/* + *liquid*, and */s/* + *glide*; and ¬OR = *stop* + *stop*, *nasal* + *nasal*, *stop* + */s/*, and */s/* + *stop*.

The stimuli were constructed using MBROLA (Dutoit, Pagel, Pierret, Bataille and van der Vreken 1996), a diphone synthesizer with a text interface that allows the user to specify phonemes, their durations, and a pitch pattern.[45] With several exceptions to be described below, the timing format for the stimuli is schematized below in (16); a H*L% pitch contour (Silverman, Beckman, John, Ostendorf, Wightman, Price, Pierrehumbert and Hirschberg 1992) was achieved by specifying a 200Hz pitch peak at 25% of [ɑ]'s duration, falling to 120 Hz aligned at 75% of [ɑ]'s duration.

(16) Basic stimuli format

segments	(C_1)	(C_2)	ɑ
duration (msec)	---------	---------	-------------------------
	90	90	250

Two different synthesis voices were used: a male speaker of American English (MBROLA's *us3*) for [kta], [ksa], [ska], [kna], and the C_1ɑ/C_2ɑ pairs associated with these; and a female speaker of American English (MBROLA's *us1*) for [mna], [sna], [sla], [swa], [kla], [kwa], and their associated C_1ɑ/C_2ɑ pairs. Different voices were used for different clusters because informal identification tasks with five listeners indicated that the male voice produced a more realistic-sounding and correctly-identifiable version

[45] Stimuli were synthesized, rather than produced naturally, in order to ensure fair comparisons for the task: the only differences between $C_1C_2V_3$ and C_1V_3/C_2V_3 should be the presence or absence of C_2/C_3, unconfounded by allophonic variation or production-specific differences in duration, amplitude, etc. Because MBROLA is a diphone synthesizer, it might be expected to build contextual variation into the stimuli; however, I examined spectrograms for each item and verified that [skɑ]–[kɑ] are matched for VOT (38 msec in both cases), that [l] is fully voiced in both [klɑ]–[lɑ], etc.

of [kta] than the female voice, that the female voice produced a better version of [mna], etc.

Departures from the timing format shown in (16) are as follows; these were arrived at through trial and error with feedback from the five test listeners. A "0 msec pause"[46] was inserted between the consonants in [ktɑ] and [knɑ], as listeners felt that this made [k] easier to hear; similarly, a "0 msec [ʌ]" was inserted between the consonants in [mnɑ]. Further, [s] was lengthened to 120 msec in [sna], [sla], and [swa] (i.e., in all SR-initial forms), because several test listeners perceived an intrusive stop between [s] and the following consonant (e.g., they heard [stlɑ] for intended [slɑ]) when [s] was only 90 msec.) This means that SR-initial forms are 30 msec longer than other C_1C_2ɑ items, a durational difference the impact of which on interpretation of reaction times I failed to anticipate during stimuli creation; see below.

With the 10 cluster-initial forms shown in (15), the experiment presented listeners with a total of 60 pairs to discriminate: 10 C_1C_2ɑ–C_1ɑ pairs, 10 C_1C_2ɑ–C_2ɑ pairs, and 10 C_1C_2ɑ–C_1əC_2ɑ pairs (these are discussed in §3.2.2); plus 30 filler items, in which the same item was paired with itself (thereby making the task of discrimination non-trivial). The 60 pairs were randomized for list order and order in pair, and repeated in 5 blocks, for a total of 300 pairs discriminated by each listener.

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[46] MBROLA allows the pattern fed to the synthesizer to contain phonemes and pauses with 0 duration. My (possibly incorrect) understanding of this feature is that these durationless segments determine the choice of the diphones that precede and follow them. The 0 msec pause is not an actual period of silence.

Listeners were 15 native English speakers recruited at Ohio State University, who were told that they would hear pairs of (non-English) nonsense words and should decide whether the two members of each pair were the same or different; they were specifically instructed to answer both as quickly and as accurately as possible. Listeners were seated in a sound-attenuated booth containing a display screen and response buttons labelled SAME and DIFFERENT; the stimuli were presented over headphones at a comfortable volume (~70 db).

Pair members were separated by an interstimulus interval of 300 msec. The reaction time clock began running at the onset of the second member of the pair, and timed out after 4 seconds. Correct answers resulted in a display of CORRECT and the reaction time (in seconds), while incorrect answers resulted in a display of WRONG; nothing was displayed if no answer was given within 4 seconds.

2.4.2. *Results*

The discussion below addresses first those generalizations that can be made from examining the data pooled within cluster types (i.e., ¬OR, SR, TR); and then reports results for individual clusters.

The graph in Figure 3 below shows average median reaction times (i.e., the average across the median RTs for each of the 15 listeners), calculated on correct responses only, for C_1C_2ɑ–C_1ɑ (dark gray) and C_1C_2ɑ–C_2a (light gray) pairs, pooling the data within cluster types; error bars show standard deviations:

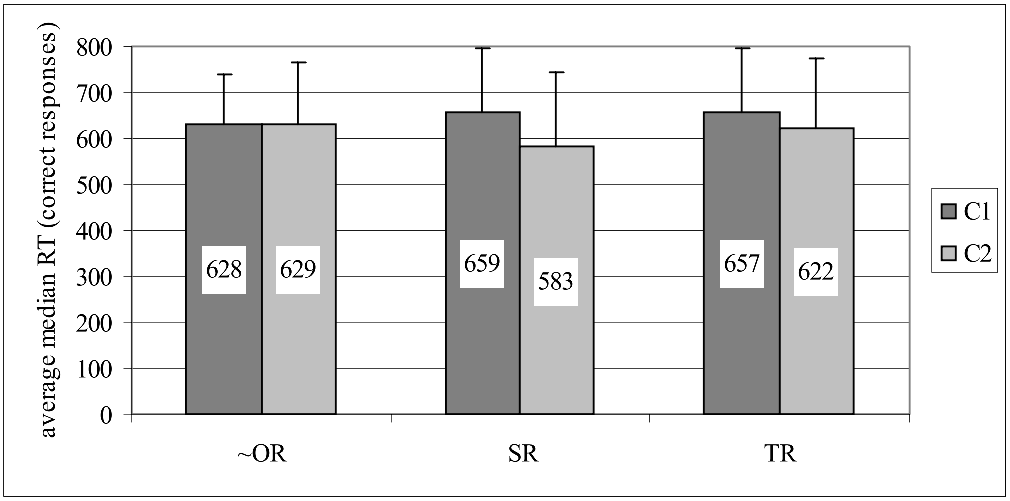

Figure 3. Average median RTs, by cluster type

As shown by the graph, for SR and TR cluster types, $C_1C_2\alpha$–$C_1\alpha$ pairs are discriminated more slowly—indicating greater similarity—than $C_1C_2\alpha$–$C_2\alpha$ pairs, a trend that persists to the level of individual clusters. (Note that reaction times for $S_1R_2\alpha$–$S_1\alpha$ and $T_1R_2\alpha$–$T_1\alpha$ are roughly equal; but as I explain below, this is confounded by the fact that SR-initial items were longer than TR-initial items.) For ¬OR clusters as a group, average reaction times are roughly identical for $C_1C_2\alpha$–$C_1\alpha$ and $C_1C_2\alpha$–$C_2\alpha$, but this is the result of opposing trends displayed by the individual ¬OR clusters cancelling each other when the data is pooled. Finally, note that the longest average median reaction times are for $S_1R_2\alpha$–$S_1\alpha$ and $T_1R_2\alpha$–$T_1\alpha$, indicating that, at the level of cluster type, these are the most similar of the cluster-singleton pairs examined. This observation largely holds up at the level of individual clusters, but exceptions are noted below.

The graph in Figure 4 below shows average median reaction times for individual SR and TR items, again calculated on correct responses only; error bars indicate standard deviations:

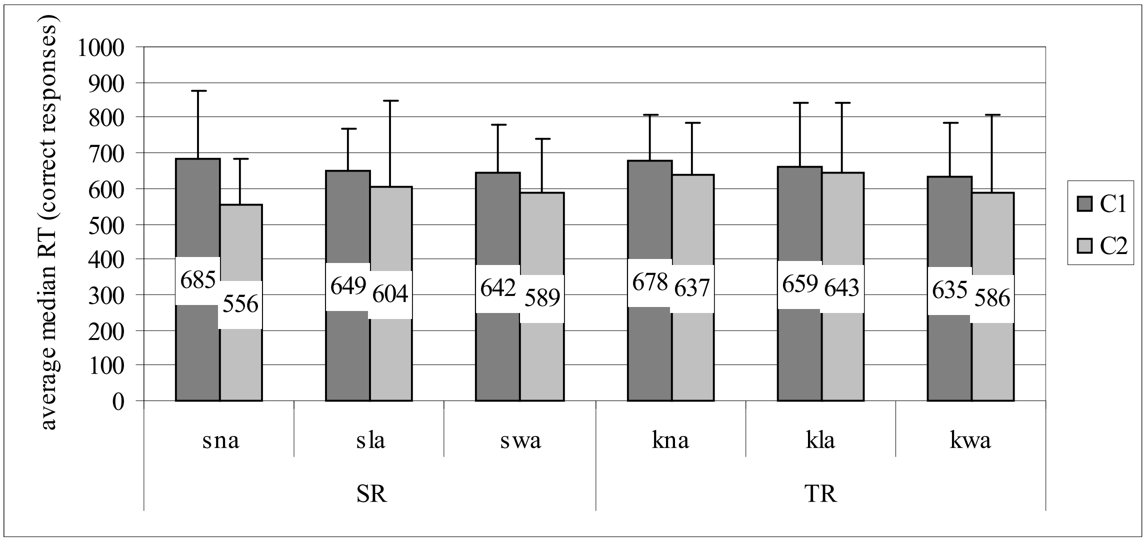

Figure 4. Average median RTs for SR and TR, $C_1C_2ɑ–C_1ɑ$ vs. $C_1C_2ɑ–C_2ɑ$

For every SR and TR cluster, the average median reaction time is greater for $C_1C_2ɑ–C_1ɑ$ than for $C_1C_2ɑ–C_2ɑ$, although this difference is much larger for some clusters than for others (e.g., 129 msec for [snɑ]–[sɑ] vs. [snɑ]–[nɑ]; cf. [knɑ]–[kɑ] vs. [knɑ]–[nɑ], 41 msec); and as shown by the error bars, for some clusters there is considerable overlap in reaction times across $C_1C_2ɑ–C_1ɑ$ and $C_1C_2ɑ–C_2ɑ$. Reaction time is significantly longer for $C_1C_2ɑ–C_1ɑ$ than $C_1C_2ɑ–C_2ɑ$ only in the case of [snɑ] and [swɑ] ($p = .004$ and .031, respectively, on paired-samples t-tests).

Note that C_1C_2ɑ–C_1ɑ reaction times are slightly longer for [snɑ], [swɑ] than for [knɑ], [kwɑ] (the difference is 7 msec in both cases), indicating that e.g., [snɑ]–[sɑ] are more similar than [knɑ]–[kɑ]. This is unexpected given the results from alliteration and imperfect puns, which suggested that $S_1R_2V_3$–S_1V_3 are less similar than $T_1R_2V_3$–T_1V_3. However, recall that because of an error in judgment in stimuli creation, SR-initial items are 30 msec longer than TR-initial items. Reaction time measurement began at the onset of the second pair member, meaning that when SR-initial items were presented second (i.e., in about half of all presentations, since items were randomized for order in pair), 30 msec of "reaction time" was actually taken up with stimuli presentation. Thus, reaction times for SR-initial items were actually a bit faster (by no more than 30 msec) than reflected by the measurements reported, suggesting that $T_1R_2V_3$–T_1V_3 is at least as similar as $S_1R_2V_3$–S_1V_3.

Note further that for both SR and TR, C_1C_2ɑ–C_1ɑ reaction times are slightly longer with decreasing sonority of C_2: e.g., [snɑ]–[sɑ] takes 685 msec to discriminate, while [slɑ]–[sɑ] requires only 649 msec—indicating that [snɑ]–[sɑ] are more similar than [slɑ]–[sɑ]. This result is surprising, at least with respect to SR: recall Minkova's (2003) finding that in Middle English verse, S_1N_2V–S_1V alliterate less frequently than S_1L_2V–S_1V; by hypothesis, this indicates that S_1N_2V–S_1V are less similar than S_1L_2V–S_1V. This discrepancy between the discrimination results and the alliteration results remains an open question.

In addition to reaction times, it is instructive to look at patterns of errors in listeners' responses to cluster–singleton pairs. When listeners incorrectly identify a cluster–singleton pair as being the same, rather than different, at a relatively high rate, this indicates that the pair in question is relatively similar—they were, after all, mistaken as identical. The graph below in Figure 5 shows average rates (as a percentage out of five responses) of incorrect SAME responses to $C_1C_2ɑ$–$C_1ɑ$ and $C_1C_2ɑ$–$C_2ɑ$ pairs for SR and TR clusters:

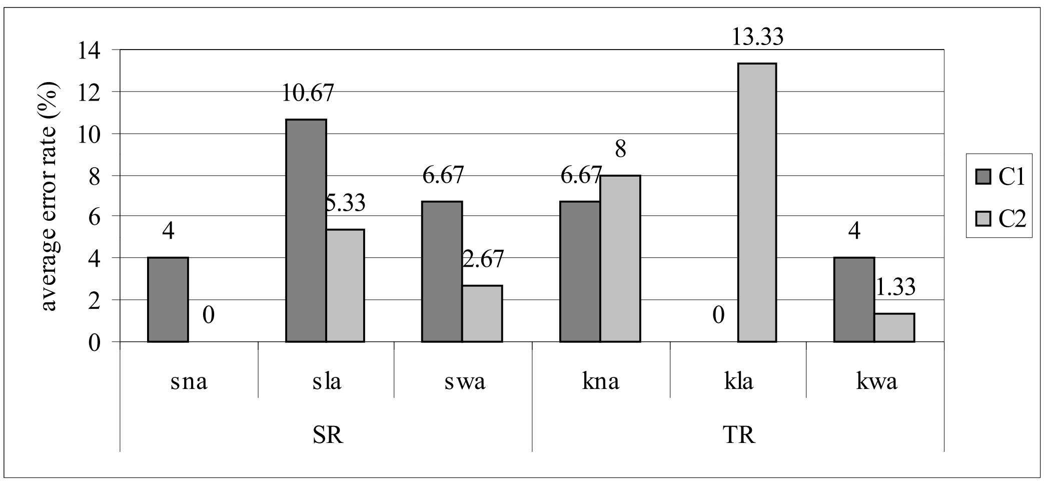

Figure 5. Incorrect SAME responses to $C_1C_2ɑ$–$C_1ɑ$ and $C_1C_2ɑ$–$C_2ɑ$

(To put these error rates in context, the average rate of incorrect DIFFERENT responses when the items in Figure 5 were paired with themselves (i.e., [snɑ]–[snɑ], [wɑ]–[wɑ], etc.) is 3.69%.) With the exception of [klɑ] and [knɑ], $C_1C_2ɑ$–$C_1ɑ$ pairs are confused more frequently than $C_1C_2ɑ$–$C_2ɑ$ pairs—a result that accords with longer reaction times for $C_1C_2ɑ$–$C_1ɑ$ than for $C_1C_2ɑ$–$C_2ɑ$, suggesting greater similarity of $C_1C_2ɑ$–$C_1ɑ$ for SR and TR clusters. The relatively high rates of confusion for [klɑ]–[lɑ] and [knɑ]–[nɑ], going against this general pattern, suggest that listeners may have had difficulty perceiving preconsonantal [k] in [klɑ] and [knɑ]; during stimuli creation, test listeners' trouble hearing the [k] in [knɑ] led me to specify a 0 msec pause between [k] and [n] in the input to synthesis, producing a somewhat more audible stop burst—but it was perhaps not audible enough.

The graph in Figure 6 below shows average median reaction times for individual ¬OR items, calculated on correct responses only; error bars indicate standard deviations:

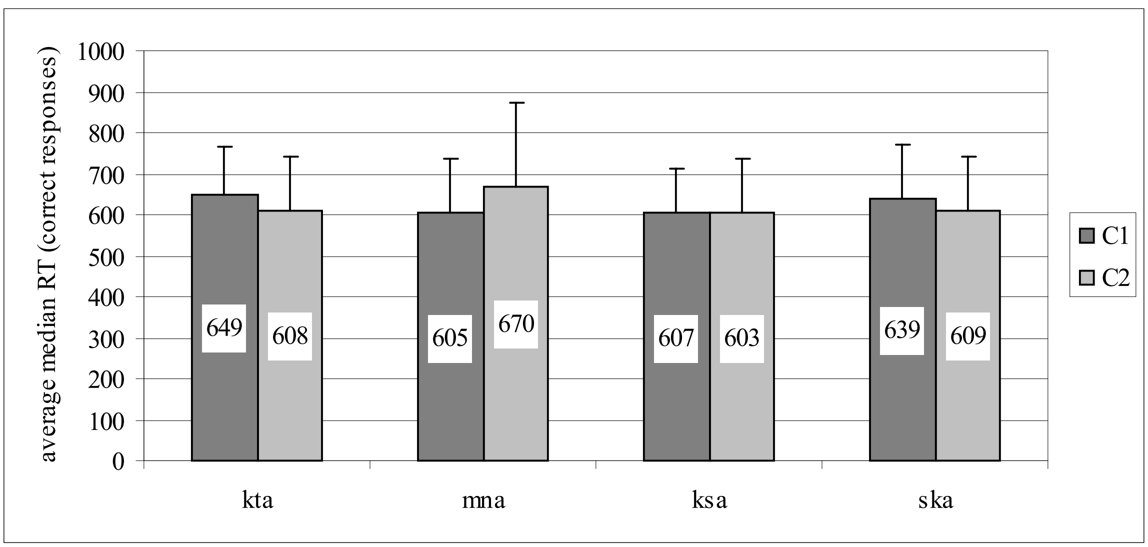

Figure 6. Average median RTs for ¬OR, $C_1C_2ɑ$–$C_1ɑ$ vs. $C_1C_2ɑ$–$C_2ɑ$

Average median reaction times are longer for $C_1C_2ɑ$–$C_1ɑ$ than for $C_1C_2ɑ$–$C_2ɑ$, for [ktɑ] and [skɑ]; this difference is significant only for [ktɑ] ($p = .044$). This trend is reversed for [mnɑ], but non-significantly; and reaction times are nearly equal for [ksɑ]–[kɑ] and [ksɑ]–[sɑ].

Average rates of incorrect SAME responses to ¬OR cluster-singleton pairs, however, suggest that [ksɑ]–[sɑ] are highly confusable:

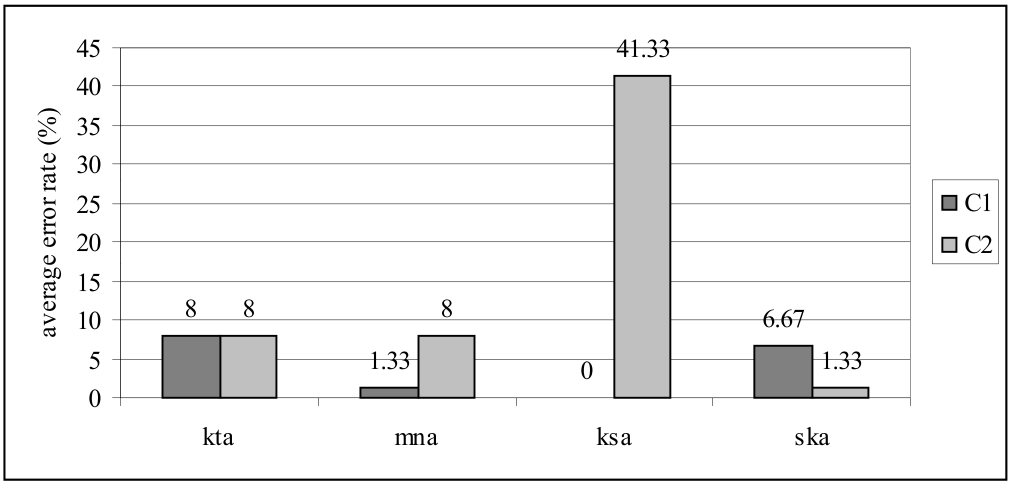

Figure 7. Incorrect SAME responses to $C_1C_2ɑ$–$C_1ɑ$ and $C_1C_2ɑ$–$C_2ɑ$

(As a baseline for the error rates shown in Figure 7, note that the average rate of incorrect DIFFERENT responses when these items were compared with themselves (i.e., [ktɑ]–[ktɑ], [sɑ]–[sɑ], etc.) is 4.15%.) [ksɑ] was confused with [sɑ] in fully 41.33% of all responses to this pair, suggesting, as in the case of [knɑ] and [klɑ] above, that listeners had considerable difficulty perceiving preconsonantal [k] in [ksɑ]. With the exception of [ksɑ]–[sɑ], error patterns are in the same direction as the reaction time results: for example, [skɑ]–[sɑ] are discriminated more slowly (30 msec) and confused more frequently (5.34%) than [skɑ]–[kɑ], both facts indicating that [skɑ]–[sɑ] are more similar than [skɑ]–[kɑ].

To develop an overall interpretation of the discrimination results, which are admittedly somewhat messy and flawed in various ways, it is helpful to compare them with the similarity results generated above through analysis of alliteration (§2.2) and imperfect puns (§2.3.2). These are repeated in (17) and (18) below:

(17) Similarity results from Germanic, Irish, and Middle English alliteration

$\{(\Delta S_1T_2V\text{–}T_2V), \Delta(O_1R_2V\text{–}R_2V)\} > \Delta(S_1T_2V\text{–}S_1V) > \Delta(S_1R_2V\text{–}S_1V) > \Delta(T_1R_2V\text{–}T_1V)$

(18) Similarity results from English imperfect puns

$\Delta(S_1T_2V\text{–}S_1V) > \Delta(S_1R_2V\text{–}S_2V) > \{\Delta(S_1T_2V\text{–}T_2V), \Delta(O_1R_2V\text{–}R_2V)\} > \Delta(T_1R_2V\text{–}T_1V)$

As I suggested in §2.3.2, the discrepancy betweeen (17) and (18)—i.e., the relative rankings of $\Delta(S_1T_2V\text{–}T_2V)$ and $\Delta(O_1R_2V\text{–}R_2V)$ with respect to the rest of the cluster–singleton pairs—may be attributable to a preference for puns in which the pun word forms a contiguous substring of the target word (or vice versa). Thus, the similarity scale I adopt here as a model against which to compare the discrimination results is that in (17); and as shown by the chart below in (19), this similarity scale is in basic agreement with the reaction time data:

(19) Reaction time data compared to existing similarity scale

		More similar pairs ------------------------- >					
Increasing RT ---------------- >		S_1R_2ɑ–R_2ɑ	T_1R_2ɑ–R_2ɑ	S_1T_2ɑ–T_2ɑ	S_1T_2ɑ–S_1ɑ	S_1R_2ɑ–S_1ɑ	T_1R_2ɑ–T_1ɑ
	685					snɑ–sɑ	
	678						knɑ–kɑ
	659						klɑ–kɑ
	649					slɑ–sɑ	
	643		klɑ–lɑ				
	642					swɑ-sɑ	
	639				skɑ-sɑ		
	637		knɑ–nɑ				
	635						kwɑ–kɑ
	609			skɑ–kɑ			
	604	slɑ–lɑ					
	589	swɑ–wɑ					
	586		kwɑ–wɑ				
	556	snɑ–nɑ					

(This chart omits results from [ktɑ], [mnɑ], and [ksɑ]—i.e., those ¬OR clusters not addressed by the alliteration or imperfect pun evidence; these are discussed further just below.) In the chart, reaction time, and therefore cluster–singleton similarity, decreases from top to bottom; similarity based on the established results of the scale in (17) increases from left to right. Applying a slight downward correction to SR reaction times (see above), and accepting a certain degree of overlap in reaction time ranges across different cluster types and consonant deletion patterns, the reaction time results accord roughly with what we would expect based on the similarity results discussed above: O_1R_2V–R_2V and S_1T_2V–T_2V are relatively dissimilar, S_1T_2V–S_1V are somewhat more similar, and O_1R_2V–O_2V are more similar still.

To see where the results for [ktɑ], [mnɑ], and [ksɑ] fit into this picture, the table below lists each cluster–singleton pair in order of descending average median reaction time—and therefore, decreasing similarity; [ktɑ], [mnɑ], and [ksɑ] pairs are shaded:

(20) Cluster–singleton pairs, in order of decreasing reaction time

Rank	*Pair*	*RT*	*Error*
1	snɑ–sɑ	685	4.00
2	knɑ–kɑ	678	6.67
3	mnɑ–nɑ	670	8.00
4	klɑ–kɑ	659	0.00
5	ktɑ–kɑ	649	8.00
5	slɑ–sɑ	649	10.67
7	klɑ–lɑ	643	13.33
8	swɑ-sɑ	642	6.67
9	skɑ-sɑ	639	6.67
10	knɑ–nɑ	637	8.00
11	kwɑ–kɑ	635	4.00
12	skɑ–kɑ	609	1.33
13	ktɑ–tɑ	608	8.00
14	ksɑ–kɑ	607	0.00
15	mnɑ–mɑ	605	1.33
16	slɑ–lɑ	604	5.33
17	ksɑ–sɑ	603	41.33
18	swɑ–wɑ	589	2.67
19	kwɑ–wɑ	586	1.33
20	snɑ–nɑ	556	0.00

[ktɑ]–[tɑ], [mnɑ–mɑ], [ksɑ]–[kɑ], and [ksɑ]–[sɑ] are all discriminated relatively quickly, at speeds indicating they are about as dissimilar as $S_1T_2ɑ–T_2ɑ$ and $O_1R_2ɑ–R_2ɑ$. In contrast, [mnɑ]–[nɑ] and [ktɑ]–[kɑ] have quite long reaction times, indicating that these pairs are about as similar as $S_1R_2ɑ$–$S_1ɑ$ and $T_1R_2ɑ$–$T_1ɑ$. However, it is not clear to me how seriously to take this result. Note that [ktɑ], [mnɑ], [ksɑ] and [knɑ] were the only items presented which contained initial clusters that are phonotactically illegal in English. It is possible that reaction times to pairs containing these clusters might be somewhat longer than reaction times to pairs containing only legal sound sequences, due to a puzzlement factor: listeners take longer to discriminate a pair containing an illegal consonant cluster because some reaction time is spent doing a phonotactic double-take. There is some evidence to support this claim: Tserdanelis (2001) asked English-speaking and Greek-speaking listeners to discriminate pairs like [ʔɑθfɑ]–[ʔɑxfɑ], [ʔɑθkɑ]–[ʔɑfkɑ], which contained intervocalic obstruent clusters that are legal and relatively common in Greek, but rare to non-existent in English (and in some cases, containing non-English segments like [x]). English-speaking listeners were slower and less accurate than Greek-speaking listeners in discriminating these pairs, suggesting that native language phonotactics do play a role in discrimination tasks. If listeners in the present experiment were slower to respond to all pairs containing non-English clusters, then the relatively long reaction times for [ktɑ]–[kɑ] and [mnɑ]–[nɑ] do not necessarily mean that these pairs are as similar as $S_1R_2ɑ$–$S_1ɑ$ and $T_1R_2ɑ$–$T_1ɑ$. Although it is still possible to conclude that, for example, [ktɑ]–[kɑ] (discriminated in 649 msec) are more similar than [ktɑ]–[tɑ] (discriminated in 608 msec), it is not possible to conclude that, because [ktɑ]–[kɑ] has the same reaction time as [slɑ]–[sɑ], these pairs are equally similar—the puzzlement factor is a confound in one case but not the other. (This also means that [knɑ]–[kɑ], with the longest reaction time among TR cluster–singleton pairs, is not necessarily the most similar of these pairs.)

2.5. *Summary of evidence regarding consonant deletion*

On balance, the evidence from Germanic, Irish, and Middle English alliteration (§2.1), English imperfect puns (§2.3), and the discrimination experiment (§2.4) tend to support the similarity scale shown in (21):

(21) $\{\Delta(S_1T_2V_3–T_2V_3), \Delta(O_1R_2V_3–R_2V_3)\} > \Delta(S_1T_2V_3–S_1V_3) > \Delta(S_1R_2V_3–S_1V_3) > \Delta(T_1R_2V_3–T_1V_3)$

This is, therefore, the similarity scale that I assume in Chapter 5, but it should be noted again that the discrimination experiment supports (21) only rather broadly, in part because of flaws in experimental design; and that the pun evidence disagrees with (21) with respect to the relative rankings of $S_1T_2V–T_2V$ and $O_1R_2V–R_2V$, perhaps because of a preference for puns in which the pun word forms a contiguous substring of the target, or vice versa. The relative similarity of cluster–singleton pairs for *non-obstruent* + *sonorant* clusters, other than */s/* + *stop*, remains unfortunately an open question: only the discrimination experiment bears on this issue, and as explained above, those results are confounded by the effects of listeners' phonotactics on time to discriminate.

3. *Similarity and vowel insertion*

This section examines evidence bearing on the relative perceptual similarity of $C_1C_2V_3$–$C_1V_4C_2V_3$ and $C_1C_2V_3$–$V_4C_1C_2V_3$ (vowel insertion) pairs. This evidence comes from imperfect puns (§3.1), based on analysis of the corpus described above in §2.3; and from two experimental studies (§3.2): the discrimination task described above in §2.4, and a task in which listeners were asked to directly assess the similarity of cluster-initial words and their vowel-inserted counterparts.

3.1. *English imperfect puns*

The relative perceptual similarity of $C_1C_2V_3$–$C_1V_4C_2V_3$ and $C_1C_2V_3$–$V_4C_1C_2V_3$ pairs, for C_1C_2 = TR, SR, and ST, was investigated using the pun corpus described above in §2.3. The table in (22) shows the six pun types of interest here, as they were coded in the pun corpus:

(22) Corpus coding: examples relevant to the similarity of vowel insertion

	pun word	**target word**	**pun segment**	**target segment**	**context**	**pun type**
a.	*baroque*	*broke*	ə	Ø	b_r	Ø~V/T_R
b.	*salaamed*	*slammed*	ə	Ø	s_l	Ø~V/S_R
c.	*support*	*sport*	ə	Ø	s_p	Ø~V/S_T
d.	*(praise)*	*(appraise)*	Ø	ə	#_pr	Ø~V/#_TR
e.	*(sleep)*	*(asleep)*	Ø	ə	#_sl	Ø~V/#_SR
f.	*esteemed*	*steamed*	ə	Ø	#_st	Ø~V/#_ST

Ø~V/S_T puns (*support–sport*) ((22)c) bear on the similarity of S_1T_2V to S_1VT_2V, Ø~V/#_ST puns (*esteemed–steamed*) ((22)f) bear on the similarity of S_1T_2V to VS_1T_2V, and so on. (The parenthesized puns in the table, *praise–appraise* ((22)d) and *sleep–*

asleep ((22)e), are hypothetical—no examples of these pun types were found in the corpus.)

For the reasons described above in §2.3, puns in the corpus were counted as examples of the pun types shown in (22) only if the consonantal context of vowel insertion/deletion was phonemically identical. Further, I counted as examples of Ø~V/S_T only those puns in which a voiceless stop preceded by /s/ corresponds to a voiceless stop; this excluded only one pun, *scar–cigar*, in which a post-/s/ voiceless stop corresponds to a voiced stop.

3.1.1. *Results of pun corpus analysis*

As described in §2.3, observed frequency in the pun corpus was calculated by dividing the number of instances of a particular pun type by the total number of instances of its general type. Thus, the frequency of S_1T_2V–S_1VT_2V puns was calculated by dividing the number of these puns in the corpus by the total number of puns characterized by word-medial insertion or deletion of any segment:

(23) $$\left(\frac{\text{Ø\textasciitilde V/S\_T}}{\text{Ø\textasciitilde X/\#\ldots\_\ldots\#}}\right) = \text{observed frequency of } S_1T_2V\text{–}S_1VT_2V \text{ puns}$$

(The denominator in this fraction is the same as was used in the calculation of observed frequencies for C_1C_2V–C_1V puns.) Similarly, the observed frequencies of S_1R_2V–S_1VR_2V and T_1R_2V–T_1VR_2V puns were calculated by dividing Ø~V/S_R and Ø~V/T_R, respectively, by Ø~X/#…_…#.

The frequency of S_1T_2V–VS_1T_2V puns was determined by dividing the number of these puns by the number of puns characterized by word-initial insertion or deletion of any segment:

(24) $$\left(\frac{\text{Ø\textasciitilde V/\#\_ST}}{\text{Ø\textasciitilde X/\#\_}}\right) = \text{observed frequency of } S_1T_2V\text{–}VS_1T_2V \text{ puns}$$

(The denominator in this fraction is the same as was used in the calculation of observed frequencies for C_1C_2V–C_2V puns.) Likewise, the frequencies of S_1R_2V–VS_1R_2V and T_1R_2V–VT_1R_2V puns were calculated by dividing Ø~V/#_SR and Ø~V/#_TR, respectively, by Ø~X/#_.

To determine the expected frequencies of the pun types in question, I counted the number of English word pairs corresponding to each pun type—e.g. for T_1R_2V–T_1VR_2V puns, I counted the number of word pairs like *prayed–parade*, *flay–filet*, etc. appearing in the CELEX database (Baayen, Piepenbrock and van Rijn 1995)—and used these counts to perform the calculations just as described above for the observed frequencies.

The table below shows the observed (O) frequencies in the corpus, and the expected (E) frequencies based on CELEX, for C_1C_2V–C_1VC_2V puns:

(25) Imperfect pun corpus results

	comparison	*calculation*	O = *pun corpus*	E = *CELEX*	O/E
$C_1C_2V–C_1VC_2V$	**$T_1R_2V–T_1VR_2V$**	Ø ~ V / T_R ÷ Ø ~ X / #…_…#	12 265	102 2801	
		=	**4.53%**	**3.64%**	**1.24**
	$S_1R_2V–S_1VR_2V$	Ø ~ V / T_R ÷ Ø ~ X / #…_…#	2 265	20 2801	
		=	**0.75%**	**0.71%**	**1.06**
	$S_1T_2V–S_1VT_2V$	Ø ~ V / S_T ÷ Ø ~ X / #…_…#	1 265	37 2801	
		=	**0.38%**[47]	**1.32%**	**0.29**
$C_1C_2V–VC_1C_2V$	**$T_1R_2V–VT_1R_2V$**	Ø ~ V / #_TR ÷ Ø ~ X / #_	0 163	69 4286	
		=	**0%**	**1.61%**	**0**
	$S_1R_2V–VS_1R_2V$	Ø ~ V / #_SR ÷ Ø ~ X / #_	0 163	2 4286	
		=	**0%**	**0.05%**	**0**
	$S_1R_2V–VS_1R_2V$	Ø ~ V / #_ST ÷ Ø ~ X / #_	1 163	23 4286	
		=	**0.61%**	**0.54%**	**1.13**

The O/E values from the last column of the table are represented graphically in Figure 8:

[47] Adding in *scar–cigar*, the excluded potential $S_1T_2V–S_1VT_2V$ pun mentioned above, this figure goes up to 0.75%.

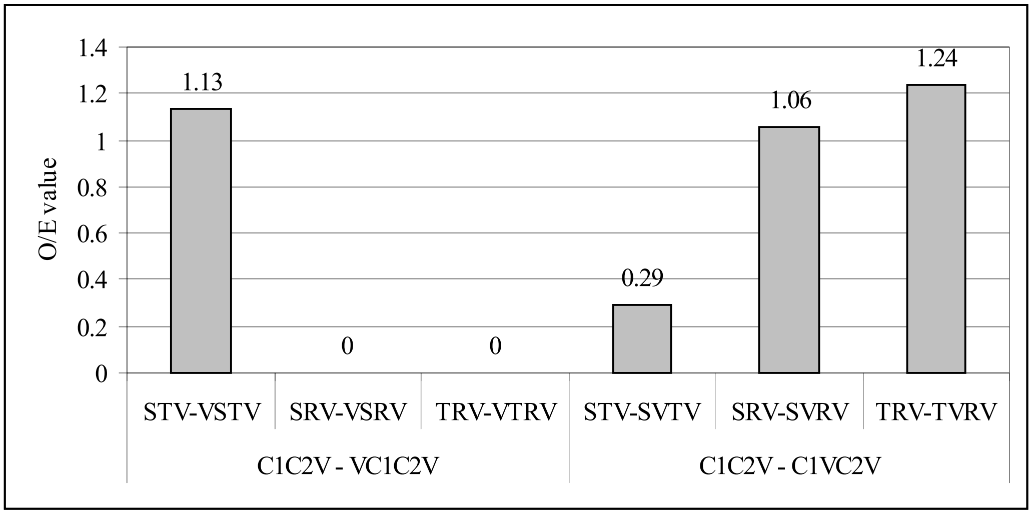

Figure 8. O/E values by pun type

Recall that an O/E value of 1 indicates that a pun type occurs in the corpus about as often as would be expected, given the number of existing English word pairs on which to form such puns; an O/E value of less than 1 indicates that the pun type occurs less frequently than expected, all else being equal; while an O/E value of greater than 1 indicates that the pun type occurs more frequently than expected.

Looking first at the C_1C_2V–VC_1C_2V puns, S_1T_2V–VS_1T_2V is mildly overrepresented, at O/E = 1.13; in contrast, O_1R_2V–VO_1R_2V puns are completely absent from the pun corpus.[48] Of the C_1C_2V–C_1VC_2V puns, S_1T_2V–S_1VT_2V are very dramatically underrepresented, at O/E = 0.29, while S_1R_2V–S_1VR_2V puns occur at just above expected frequency (O/E = 1.06), and T_1R_2V–T_1VR_2V puns are overrepresented, at

[48] The lack of O_1R_2V–VO_1R_2V puns in the corpus is a little surprising, given the finding in §2.3 that contiguity-respecting consonant-deletion puns (namely, C_1C_2V–C_2V) are more frequent than would be expected based on perceptual similarity alone.

O/E = 1.24. Assuming, again by the arguments stated in §2.3, that pun–target similarity is correlated with degree of representation in the pun corpus, the results in (25) support the scale of relative similarity shown below:

(26) $\Delta(O_1R_2V\text{–}VO_1R_2V) > \Delta(S_1T_2V\text{–}S_1VT_2V) > \Delta(S_1R_2V\text{–}S_1VR_2V) > \Delta(S_1T_2V\text{–}VS_1T_2V) > \Delta(T_1R_2V\text{–}T_1VR_2V)$

Thus, pairs like *broke–baroque*, characterized by an intrusive vowel inside an *obstruent + sonorant* cluster, are more similar than pairs like *claim–acclaim*, in which the cluster remains intact; but the reverse is true for */s/ + stop* clusters: pairs like *steamed–esteemed* are more similar than pairs like *sport–support*. Further, pairs like *slammed–salaamed*, characterized by an intrusive vowel inside a *sibilant + sonorant* cluster, are less similar than pairs like *broke–baroque*.

3.2. *Experimental evidence*

The data reported in this section come from two experiments: a study in which English speakers were specifically asked to judge the similarity of $C_1C_2V_3\text{–}C_1V_4C_2V_3$ and $C_1C_2V_3\text{–}V_4C_1C_2V_3$ pairs (§3.2.1); and a discrimination task in which reaction time is assumed to correlate with the perceived similarity of the $C_1C_2V_3\text{–}C_1V_4C_2V_3$ pair being discriminated (§3.2.2).

3.2.1. *Direct similarity judgments*

Fleischhacker (2001) asked English-speaking listeners to rate the similarity of English cluster-initial words to modifications of these words containing a word-initial or cluster-internal [ə]: for example, listeners provided judgments of how much *crave* [kreɪv] sounds like [kəˈreɪv], and how much *crave* sounds like [əˈkreɪv].[49] The results summarized below thus represent the considered opinions of 49 English speakers as to the relative similarity of $C_1C_2V_3$–$C_1V_4C_2V_3$ and $C_1C_2V_3$–$V_4C_1C_2V_3$ pairs, for C_1C_2 = ST, SR, and TR.

3.2.1.1. *Method*

Fleischhacker (2001)'s experiment 1 examined the relative similarity of word-initial and cluster-medial vowel insertion for ST, TR, STR, and a handful of SR clusters; experiment 2 looked more closely at $S_1R_2V_3$–ə$S_1R_2V_3$ and $S_1R_2V_3$–S_1əR_2V_3 pairs. The table below in (27) illustrates the word–modification pairs that listeners were asked to judge, and indicates the number of such pairs presented in experiments 1 and 2; (28) and (29) below list the English words on which the modifications were formed.

[49] A second group of listeners in these experiments heard the same items, and was asked to rate how much they liked the modifications for the purposes of a language game in which all words must be changed in some fashion. The ratings from this group are essentially identical to the similarity ratings reported below, but because the preference raters were not specifically asked to judge similarity, I do not discuss their results here.

(27) Stimuli examples

Cluster type		*Base word =* $\mathbf{C_1C_2V_3}$		*Comparisons =* $\mathbf{C_1əC_2V_3}$	$\mathbf{əC_1C_2V_3}$	*# of items* *Exp 1*	*Exp 2*
TR	TR	*pluck*	[plʌk]	[pəˈlʌk]	[əˈplʌk]	6	—
	STR	*strew*	[stru]	[stəˈru]	—	10	—
SR	SN	*snuff*	[snʌf]	[səˈnʌf]	[əˈsnʌf]	1	7
	SL	*schlep*	[ʃlɛp]	[ʃəˈlɛp]	[əˈʃlɛp]	1	5
	SW	*swerve*	[swɝv]	[səˈwɝv]	[əˈswɝv]	1	2
ST	ST	*stoke*	[stok]	[səˈtok]	[əˈstok]	9	—
	STR	*strew*	[stru]	[səˈtru]	[əˈstru]	10	

(28) Experiment 1 base words

a. TR = *pluck*, *pry*, *trounce*, *trudge*, *clinch*, *crave*

b. SR = *smirk* (SN), *slink* (SL), *swerve* (SW)

c. ST = *spar*, *spay*, *spurn*, *starve*, *stoke*, *stow*, *scald*, *scoff*, *scold*

d. STR = *splay*, *splice*, *splurge*, *sprawl*, *strew*, *strive*, *strum*, *scram*, *scrounge*, *scrub*

(29) Experiment 2 base words

a. SN = *smirch*, *smite*, *schmaltz*, *schmooze*, *snore*, *snuff*, *schnapps*

b. SL = *slake*, *slay*, *slink*, *schlep*, *schlock*

c. SW = *swear*, *swerve*

All cluster-initial base words ((28) and (29) above) are monosyllables, so all epenthesized comparison forms are disyllabic, with stress on the second syllable; no epenthesized form is an actual English word. Further, to discourage interpretation of word-initial inserted [ə] as the indefinite article, the cluster-initial words are primarily verbs; and all are relatively low-frequency words, to minimize possible bias from listeners' experience with non-standard or non-native pronunciations.

The stimuli were recorded by a male linguist for experiment 1, by a female linguist for experiment 2; both of these speakers were unaware of the purpose of the experiments. They were instructed to produce clean inserted schwas in the T_R context, rather than lengthening the sonorant; and their productions were monitored for disfluency and other factors which might unfairly affect listeners' judgments.[50]

All vowel-inserted modifications of a given cluster-initial word (for ST- and OR-initial bases, $C_1əC_2V_3$ and $əC_1C_2V_3$; for STR-initial bases, $əS_1T_2R_3V_4$, $S_1əT_2R_3V_4$, and $S_1T_2əR_3V_4$) were presented in a block, randomized for presentation order of the vowel-inserted forms, and separated one from another by a 5-second interval in experiment 1, by a 1-second interval in experiment 2.[51] The stimuli pairs were also randomized for list order, and separated by filler items.

Listeners were 49 native English speakers recruited at UCLA (26 participated in experiment 1, 23 participated in experiment 2), instructed to rate the similarity in sound between the modified forms and the English words they correspond to. The stimuli were

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[50] Of particular concern was that unintentional differences in the durations of inserted schwas might be a source of bias, such that stimuli containing shorter inserted vowels are rated more similar to the base word than stimuli containing longer inserted vowels. However, examination of the stimuli for experiment 1 shows that schwas are, on average, longer in those forms receiving higher similarity ratings: e.g., [ə] appearing before ST is longer than [ə] inserted inside ST, but əST- modifications are still rated more similar than SəT- modifications.

[51] Interstimulus interval was shortened in experiment 2 in an attempt to correct for the excessive boredom reported by listeners in experiment 1.

presented to small groups of listeners in quiet rooms over a portable tape player. Listeners marked their similarity ratings by circling a number between 1 and 7 on printed answer sheets (7 = most similar); in experiment 1, inserted schwas were represented orthographically with small handwritten carats just below the line of type, while in experiment 2, no modified form was given a written representation.

Before presenting the results, it should be noted that the aspiration facts of English are a confound in this experiment. In $S_1T_2V_3$–$S_1əT_2V_3$ pairs, a post-/s/ unaspirated stop corresponds to an aspirated stop, a mismatch that is not found in $S_1T_2V_3$–$əS_1T_2V_3$ pairs, and which may contribute to higher similarity ratings for $S_1T_2V_3$–$əS_1T_2V_3$ than for $S_1T_2V_3$–$S_1əT_2V_3$. (However, it is also true in English that VOT is longer before liquids than before vowels (Docherty 1992), meaning that, in terms of aspiration and liquid devoicing, there is a greater difference between $T_1R_2V_3$–$T_1əR_2V_3$ than between $T_1R_2V_3$–$əT_1R_2V_3$, but $T_1R_2V_3$–$T_1əR_2V_3$ are still rated more similar than $T_1R_2V_3$–$əT_1R_2V_3$.)

3.2.1.2. *Results*

Results for experiment 1 are summarized below in Figure 9, which compares the mean similarity ratings for $C_1C_2V_3$–$əC_1C_2V_3$ (dark gray bars) and $C_1C_2V_3$–$C_1əC_2V_3$ (light gray bars) for cluster types ST, SN, SL, SW, and TR; error bars represent standard deviations.

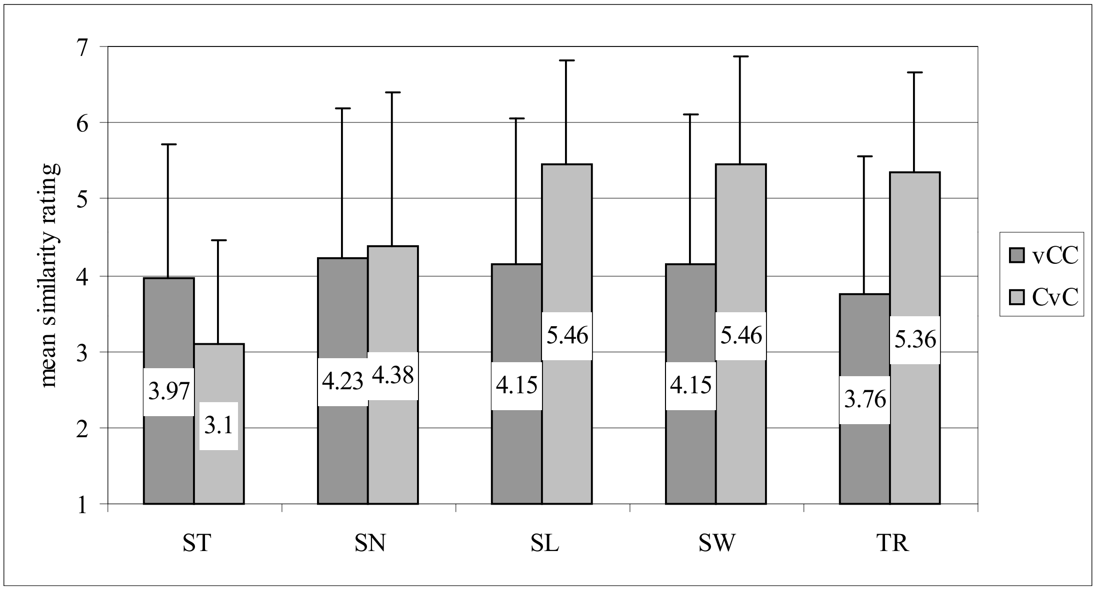

Figure 9. Mean similarity ratings: $C_1C_2V_3$– ə$C_1C_2V_3$ vs. $C_1C_2V_3$–C_1əC_2V_3 (Exp. 1)

The mean rating for əS_1T_2 (3.97) shown in Figure 9 pools the data for ə$S_1T_2V_3$ (e.g., [stok]–[əstok] and pairs like it; group mean = 3.974) and ə$S_1T_2R_3V_4$ (e.g., [stru]–[əstru] and pairs like it; group mean = 3.969). Likewise, the mean rating for S_1əT_2 (3.10) pools the data for S_1əT_2V_3 (group mean = 3.149) and S_1ə$T_2R_3V_4$ (3.050); and the mean rating for T_1əR_2 (5.36) pools the data for T_1əR_2V_3 (group mean = 5.213) and S_1T_2əR_3V_4 (group mean = 5.450).

As shown in Figure 9, $C_1C_2V_3$–C_1əC_2V_3 pairs are rated more similar than $C_1C_2V_3$– ə$C_1C_2V_3$ pairs for all *obstruent* + *sonorant* clusters, while the reverse is true for */s/* + *stop*: $S_1T_2V_3$– ə$S_1T_2V_3$ are more similar than $S_1T_2V_3$–S_1əT_2V_3. These differences are statistically significant for every cluster type except SN (on paired samples t-tests, $p < .001$ for SL, SW, TL; $p = .012$ for ST; $p = .627$ for SN). Note further that mean similarity ratings for $S_1L_2V_3$–$S_1əL_2V_3$ and $S_1W_2V_3$–$S_1əW_2V_3$ (5.46 in both cases) are higher than the mean rating for $S_1N_2V_3$–$S_1əN_2V_3$, indicating that the result of vowel insertion into an SR cluster is more similar to the original cluster when the sonorant is a liquid or glide.

Results for experiment 2 are summarized below in Figure 10; as above, dark gray bars represent mean similarity ratings for $C_1C_2V_3$–$əC_1C_2V_3$, light gray bars represent mean ratings for $C_1C_2V_3$–$C_1əC_2V_3$, and error bars represent standard deviations.

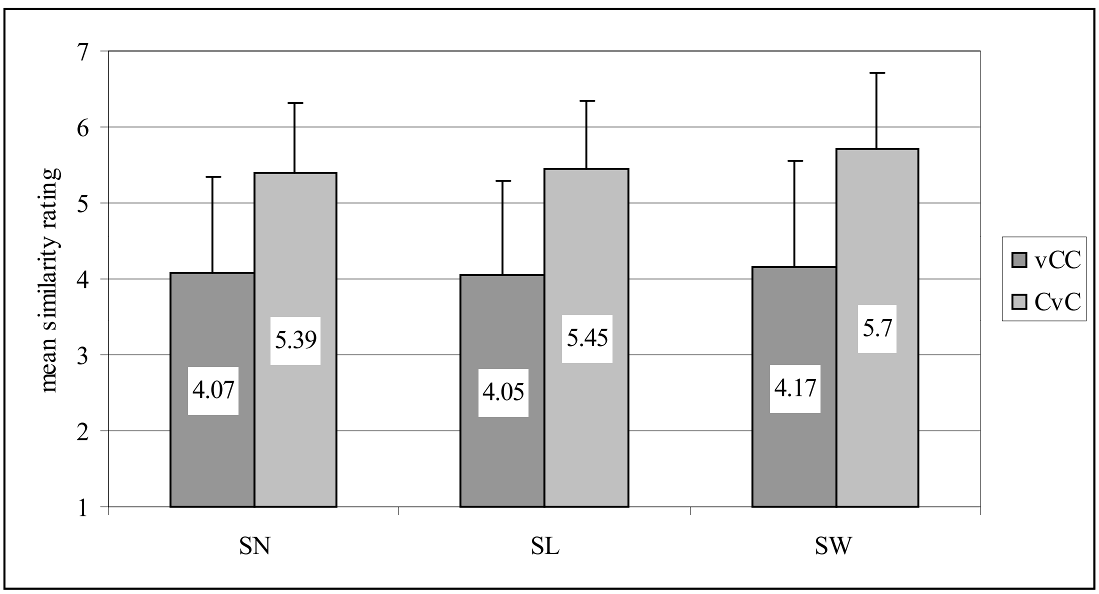

Figure 10. Mean similarity ratings: $C_1C_2V_3$– $əC_1C_2V_3$ vs. $C_1C_2V_3$–$C_1əC_2V_3$ (Exp. 2)

As is clear from the graph, $C_1C_2V_3$–$C_1\text{ə}C_2V_3$ pairs are rated more similar than $C_1C_2V_3$–$\text{ə}C_1C_2V_3$ pairs, for each of SN, SL, and SW; these differences are all statistically significant at $p < .001$. Thus, the results from experiment 2 differ from those for experiment 1 only with respect to SN: $S_1N_2V_3$–$S_1\text{ə}N_2V_3$ pairs are rated significantly more similar than $S_1N_2V_3$–$\text{ə}S_1N_2V_3$ pairs in experiment 2, but this is a non-significant trend in experiment 1. Note too that, similar to the findings for experiment 1, mean similarity ratings for $S_1R_2V_3$–$S_1\text{ə}R_2V_3$ increase with increasing sonority of the sonorant—i.e., across SN, SL, and SW.

To develop an overall picture of what these results tell us about the relative similarity of $C_1C_2V_3$– $\text{ə}C_1C_2V_3$ and $C_1C_2V_3$–$C_1\text{ə}C_2V_3$ pairs, consider the charts in (30) below:

(30) Summary of results

Experiment 1	
Pair	**Mean rating**
$S_1W_2V_3$–$S_1\text{ə}W_2V_3$	5.46
$S_1L_2V_3$–$S_1\text{ə}L_2V_3$	5.46
$T_1R_2V_3$–$T_1\text{ə}R_2V_3$	5.36
$S_1N_2V_3$–$S_1\text{ə}N_2V_3$	4.38
$S_1N_2V_3$–$\text{ə}S_1N_2V_3$	4.23
$S_1W_2V_3$–$\text{ə}S_1W_2V_3$	4.15
$S_1L_2V_3$–$\text{ə}S_1L_2V_3$	4.15
$S_1T_2V_3$–$\text{ə}S_1T_2V_3$	3.97
$T_1R_2V_3$–$\text{ə}T_1R_2V_3$	3.76
$S_1T_2V_3$–$S_1\text{ə}T_2V_3$	3.10

Experiment 2	
Pair	**Mean rating**
$S_1W_2V_3$–$S_1\text{ə}W_2V_3$	5.7
$S_1L_2V_3$–$S_1\text{ə}L_2V_3$	5.45
$S_1N_2V_3$–$S_1\text{ə}N_2V_3$	5.39
$S_1W_2V_3$–$\text{ə}S_1W_2V_3$	4.17
$S_1N_2V_3$–$\text{ə}S_1N_2V_3$	4.07
$S_1L_2V_3$–$\text{ə}S_1L_2V_3$	4.05

In these charts, boxes enclose those pairs (e.g., $S_1W_2V_3$–$S_1əW_2V_3$ and $S_1L_2V_3$–$S_1əL_2V_3$) whose mean similarity ratings are not significantly different ($p > .05$ on paired samples t-tests); pairs in different boxes (e.g., $S_1T_2V_3$–$əS_1T_2V_3$ and $T_1R_2V_3$–$əT_1R_2V_3$) have significantly different mean ratings. As indicated by the shading, the results from experiment 2 differs indicate that $S_1N_2V_3$–$S_1əN_2V_3$ pairs are just as similar as other $S_1R_2V_3$–$S_1əR_2V_3$ pairs, while the results from experiment 1 indicate that $S_1N_2V_3$–$S_1əN_2V_3$ are somewhat less similar; however, because experiment 2 examined seven SN-initial items, while experiment 1 examined only one, the case made by the experiment 2 results is rather stronger.

Grouping the data as shown by the charts in (30), the experiments together support the similarity scale shown in (31):

(31) $\Delta(S_1T_2V_3–S_1əT_2V_3) > \Delta(T_1R_2V_3–əT_1R_2V_3) > \{\Delta(S_1T_2V_3–əS_1T_2V_3), \Delta(S_1R_2V_3–əS_1R_2V_3)\} > \{\Delta(S_1R_2V_3–S_1əR_2V_3), \Delta(T_1R_2V_3–T_1əR_2V_3)\}$

Compare this result with that generated in §3.1 through analysis of the imperfect pun corpus, repeated as (32) below:

(32) $\{\Delta(S_1R_2V–VS_1R_2V), \Delta(T_1R_2V–VT_1R_2V)\} > \Delta(S_1T_2V–S_1VT_2V) > \Delta(S_1R_2V–S_1VR_2V) > \Delta(S_1T_2V–VS_1T_2V) > \Delta(T_1R_2V–T_1VR_2V)$

Both the pun evidence and the similarity judgments agree that for ST, $C_1C_2V_3$–$V_4C_1C_2V_3$ are more similar than C_1C_2V–$C_1V_4C_2V$, while the reverse is true for SR and TR. However, the pun evidence and direct similarity judgments disagree on several points;

based on evidence from both domains, I propose the composite similarity scale shown in (33):

(33) $\{\Delta(S_1T_2V_3\text{–}S_1V_4T_2V_3), \Delta(T_1R_2V_3\text{–}V_4T_1R_2V_3)\} > \{\Delta(S_1T_2V_3\text{–}V_4S_1T_2V_3),$
$\Delta(S_1R_2V_3\text{–}V_4S_1R_2V_3)\} > \Delta(S_1R_2V_3\text{–}S_1V_4R_2V_3) > \Delta(T_1R_2V_3\text{–}T_1V_4R_2V_3)$

Points of difference between the composite scale in (33) and the scales generated by imperfect puns and direct similarity judgments are as follows: First, the pun evidence indicates that $S_1T_2V_3$–$S_1V_4T_2V_3$ are more similar than $T_1R_2V_3$–$V_4T_1R_2V_3$, while similarity judgments indicate the opposite—although in both cases, these are the two least similar of the pairs for which there is evidence; I compromised and grouped $S_1T_2V_3$–$S_1V_4T_2V_3$ and $T_1R_2V_3$–$V_4T_1R_2V_3$ at the top of the similarity scale in (33). Second, the pun evidence indicates that $S_1T_2V_3$–$V_4S_1T_2V_3$ are more similar than $S_1R_2V_3$–$S_1V_4R_2V_3$, while direct similarity judgments suggest that $S_1T_2V_3$–$V_4S_1T_2V_3$ are rather less similar than that; I gave greater weight to the direct similarity evidence, placing $S_1T_2V_3$–$V_4S_1T_2V_3$ in a block with $S_1R_2V_3$–$V_4S_1R_2V_3$ in the similarity scale in (33), following the same argument proposed in §2.3: that contiguity-respecting puns may be better represented in the corpus than would be expected based on similarity alone—noting, of course, that in $S_1T_2V_3$–$V_4S_1T_2V_3$ puns, the pun word forms a contiguous substring of the target word, or vice versa. Third, I followed the direct similarity evidence in placing $S_1R_2V_3$–$V_4S_1R_2V_3$ above $S_1T_2V_3$–$S_1V_4T_2V_3$ and $T_1R_2V_3$–$V_4T_1R_2V_3$, on the logic that the absence from the pun corpus of $S_1R_2V_3$–$V_4S_1R_2V_3$ puns—which receive relatively high similarity ratings—could be an accidental gap; note that this does not hold for $T_1R_2V_3$–$V_4T_1R_2V_3$ puns, which are both absent from the pun corpus and rated very dissimilar by English-speaking listeners. Finally, there is the issue of the relative similarity of $S_1R_2V_3$–$S_1V_4R_2V_3$ and $T_1R_2V_3$–$T_1V_4R_2V_3$. Evidence from the pun corpus indicates that $T_1R_2V_3$–$T_1V_4R_2V_3$ are more similar than $S_1R_2V_3$–$S_1V_4R_2V_3$, but direct similarity judgments provide no evidence for this distinction (apart from lower ratings for the one $S_1N_2V_3$–$S_1V_4N_2V_3$ item judged by listeners in experiment 1). In the similarity scale in (33), I propose the ranking $\Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$, based on the pun evidence alone. This is pragmatic, rather than scientific: the similarity scale in (33) is the one I adopt in Chapter 5 to explain restricted skipping, and it is simply a fact that SR licenses intrusive vowel epenthesis less frequently than TR does, and only if TR does.

3.2.2. *Discrimination task*

The discrimination task described above in §2.4 also examined the relative similarity of C_1C_2ɑ–C_1əC_2ɑ pairs,[52] using the same cluster-initial items discussed above; these cluster-initial forms and their vowel-inserted counterparts are listed in the table below:

[52] The experiment did not examine C_1C_2ɑ–əC_1C_2ɑ pairs, largely to keep the task to a reasonable length; including 10 C_1C_2ɑ–əC_1C_2ɑ pairs would also have required the inclusion of 10 additional items in which the same form was paired with itself, in order to maintain an equal ratio of SAME to DIFFERENT—thus increasing the total number of items by 33%.

(34) Stimuli pairs: C_1C_2ɑ–C_1əC_2ɑ

Cluster type		**C_1C_2ɑ**	*Comparison* = **C_1əC_2ɑ**
TR	TN	[knɑ]	[kənɑ]
	TL	[klɑ]	[kəlɑ]
	TW	[kwɑ]	[kəwɑ]
SR	SN	[snɑ]	[sənɑ]
	SL	[slɑ]	[səlɑ]
	SW	[swɑ]	[səwɑ]
¬OR	TT	[ktɑ]	[kətɑ]
	NN	[mnɑ]	[mənɑ]
	TS	[ksɑ]	[kəsɑ]
	ST	[skɑ]	[səkɑ]

Like the C_1C_2ɑ items, the C_1əC_2ɑ items were constructed using the diphone synthesizer MBROLA (Dutoit et al. 1996). The timing format for these stimuli is schematized below in (35); a H*L% pitch contour was achieved by specifying a 150 Hz pitch target aligned at 25% of [ə]'s duration, rising to a 200Hz peak at 25% of [ɑ]'s duration, and then falling to 120 Hz aligned at 75% of [ɑ]'s duration.

(35) Basic stimuli format: C_1əC_2ɑ

segments	C_1	ə	C_2	ɑ
duration (msec)	---------	-----	---------	-------------------------
	90	50	90	250

As noted in §2.4, a male voice was used to synthesize [kta], [ksa], [ska], and [kna], while a female voice was used to synthesize [mna], [sna], [sla], [swa], [kla], and [kwa]; the C_1əC_2ɑ stimuli corresponding to these cluster-initial forms were created using the appropriate voice. I specified the inserted vowel in the synthesis input as either [ə] or [ʌ], based on the judgments of five test listeners as to which vowel sounded more schwa-like in a particular consonantal context; [ʌ] was used in all male-voice productions except [s_kɑ], while [ə] was used in all female-voice productions except [m_nɑ].

3.2.2.1. *Results*

The bars in the graph below shows average median reaction times, calculated on correct responses only, for C_1C_2ɑ–C_1əC_2ɑ pairs, for the clusters shown above in (34); error bars show standard deviations:

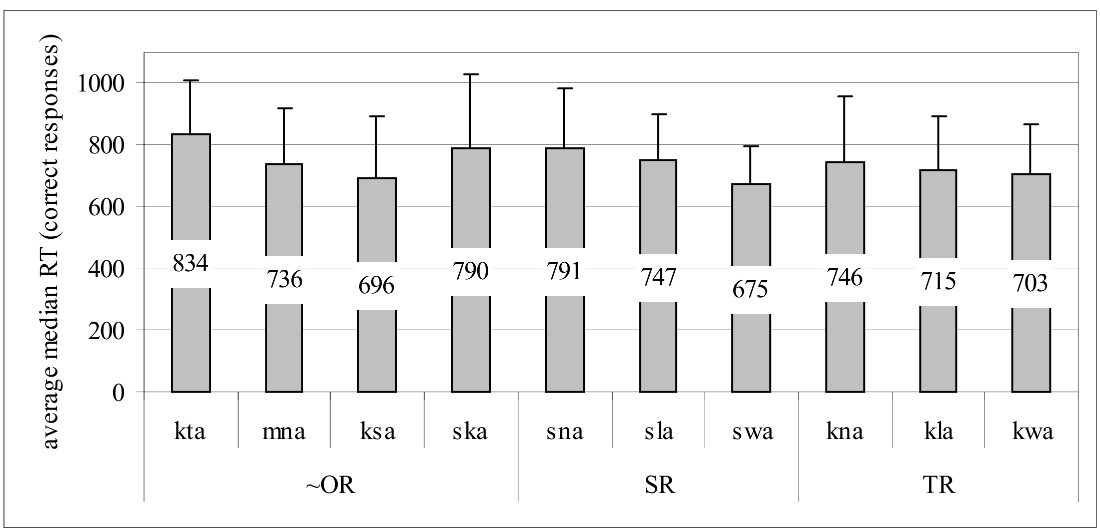

Figure 11. Average median RT by cluster: C_1C_2ɑ–C_1əC_2ɑ

To help put the results in Figure 11 in overall perspective, the chart below in (36) lists each C_1C_2ɑ–C_1əC_2ɑ pair in order of decreasing average median reaction time, and thus, decreasing similarity. The check marks in the columns labelled *Non-English?* and *Longer* C_1C_2a? indicate those pairs for which there is fairly good reason to believe that reaction times are artificially long: i.e, those pairs containing clusters that are phonotactically illegal in English, and which may therefore have been subject to a puzzlement factor contributing to reaction time; and those pairs containing SR-initial items, which are 30 msec longer than other C_1C_2ɑ items (§2.4 discusses these points in more detail).

(36) C_1C_2ɑ–C_1əC_2ɑ pairs in order of decreasing average median RT

Cluster type	*Non-English?*	*Longer* C_1C_2a?	*Pair*	*RT*
¬OR	✓		[ktɑ]–[kətɑ]	834
SR		✓	[snɑ]–[sənɑ]	791
¬OR			[skɑ]–[səkɑ]	790
SR		✓	[slɑ]–[səlɑ]	747
TR	✓		[knɑ]–[kənɑ]	746
¬OR	✓		[mnɑ]–[mənɑ]	736
TR			[klɑ]–[kəlɑ]	715
TR			[kwɑ]–[kəwɑ]	703
¬OR	✓		[ksɑ]–[kəsɑ]	696
SR		✓	[swɑ]–[səwɑ]	675

Even making a downward correction for those pairs adversely affected by reaction time confounds, the results from the discrimination task completely contradict those from the pun evidence (§3.1) and direct similarity judgments (§3.2.1), the results of which specific to C_1C_2ɑ–C_1əC_2ɑ are repeated below:

(37) Similarity of C_1C_2ɑ–C_1əC_2ɑ pairs: evidence from English imperfect puns

$\Delta(S_1T_2V_3–S_1V_4T_2V_3) > \Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$

(38) Similarity of C_1C_2ɑ–C_1əC_2ɑ pairs: evidence from direct similarity judgments

$\Delta(S_1T_2V_3–S_1V_4T_2V_3) > \{\Delta(S_1R_2V_3–S_1V_4R_2V_3), \Delta(T_1R_2V_3–T_1V_4R_2V_3)\}$

The scales in (37) and (38) agree that $S_1T_2V_3–S_1V_4T_2V_3$ are less similar than $O_1R_2V_3–O_1V_4R_2V_3$, and differ only on whether $S_1R_2V_3–S_1V_4R_2V_3$ are more similar than $T_1R_2V_3–T_1V_4R_2V_3$. In contrast, the discrimination results suggest that [skɑ]–[səkɑ] are quite similar: listeners needed fully 790 msec to decide whether this pair was the same or different, much more time than was needed to discriminate e.g. [klɑ]–[kəlɑ] (715 msec).

However, I suggest that the discrimination results for C_1C_2ɑ–C_1əC_2ɑ pairs may reflect a problem with the stimuli: at only 50 msec (cf. the durations for other segments: 90 msec for consonants other than [s], 120 msec for [s], 250 msec for [ɑ]), it is possible that the inserted schwas were not long enough to be reliably perceived by listeners. This claim receives some support from examination of patterns of errors in listeners' responses to C_1C_2ɑ–C_1əC_2ɑ pairs. The graph below in Figure 12 shows average rates (as a percentage out of five responses) of incorrect SAME responses to C_1C_2ɑ–C_1əC_2ɑ items:

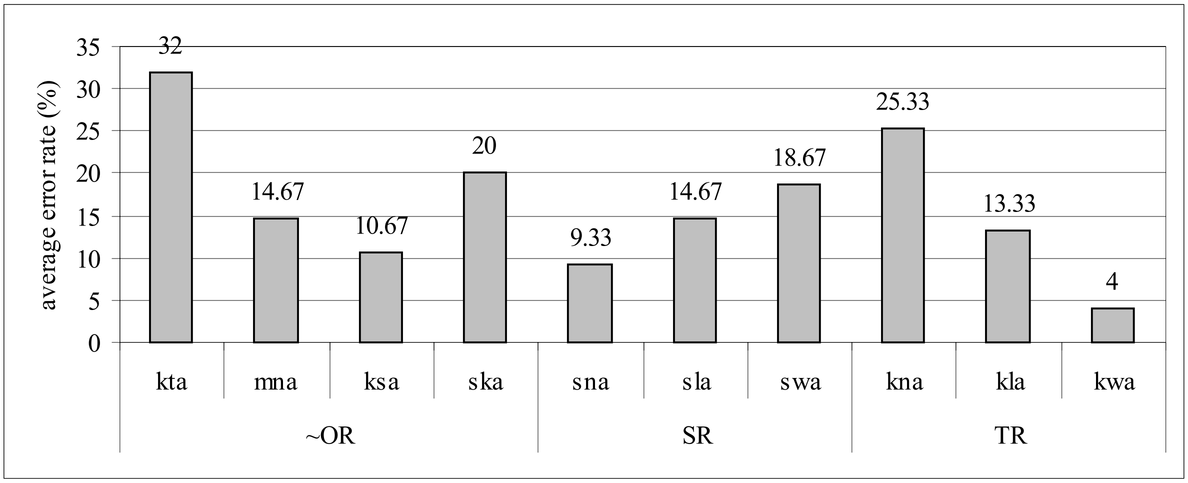

Figure 12. Incorrect SAME responses to C_1C_2ɑ–C_1əC_2ɑ

(To put these error rates in context, note that the average rate of incorrect DIFFERENT responses when the items in Figure 12 were paired with themselves (i.e., [ktɑ]–[ktɑ], [səwɑ]–[səwɑ], etc.) is 4.93%.) The error rates for C_1C_2ɑ–C_1əC_2ɑ pairs are noticeably higher than those for C_1C_2ɑ–C_1ɑ and C_1C_2ɑ–C_2ɑ: pooling across individual clusters, C_1C_2ɑ–C_1əC_2ɑ pairs are mistaken as identical at a rate of 16.27%, compared to 6.87% for C_1C_2ɑ–C_1ɑ and C_1C_2ɑ–C_2ɑ. Note further that, with the exception of the SR items (for which I can provide no explanation), the error rates pattern in the same direction, and with roughly the same differences in magnitudes, as the reaction times shown in Figure 11: e.g., both reaction times and error rates decrease across [ktɑ]–[kətɑ], [skɑ]–[səkɑ], [mnɑ]–[mənɑ], and [ksɑ]–[kəsɑ].

What I'm suggesting is that, because of problems with the stimuli, the C_1C_2ɑ–C_1əC_2ɑ discrimination results tell us nothing generalizable about the relative similarity of C_1C_2ɑ–C_1əC_2ɑ pairs. That is to say, I propose that listeners had enough trouble hearing 50-msec schwas and interpreting them as vowels that the results reported above are stimuli-specific. This is, of course, more than a little tricky: if [skɑ]–[səkɑ] are discriminated more slowly (790 msec) and confused more frequently (20%) than [klɑ]–[kəlɑ] (discriminated in 715 msec, confused at a rate of 13.33%), does that mean that [skɑ]–[səkɑ] are truly, abstractly, more similar than [klɑ]–[kəlɑ], or does it mean that in this experiment, with these stimuli and their possibly too-short inserted schwas, [skɑ]–[səkɑ] are accidentally more similar than [klɑ]–[kəlɑ]? With qualms, but supported by the results from imperfect puns and direct similarity judgments, I adopt the latter interpretation.

3.3. *Summary of evidence regarding vowel insertion*

With the source-specific discrepancies noted in §3.2.1.2, the evidence from English imperfect puns (§3.1) and direct similarity judgments by English-speaking listeners (§3.2.1) support the similarity scale shown in (39):

(39) $\{\Delta(S_1T_2V_3–S_1V_4T_2V_3), \Delta(T_1R_2V_3–V_4T_1R_2V_3)\} > \{\Delta(S_1T_2V_3–V_4S_1T_2V_3), \Delta(S_1R_2V_3–V_4S_1R_2V_3)\} > \Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$

Disregarding the contradictory and perhaps fatally flawed discrimination results presented in §3.2.2, this is the similarity scale that I assume in Chapter 5 as the basis of the explanation of restricted intrusion. The relative similarity of $C_1C_2V_3$–$C_1V_4C_2V_3$ and $C_1C_2V_3$–$V_4C_1C_2V_3$ pairs for *non-obstruent* + *sonorant* clusters other than */s/* + *stop* remains, unfortunately, an open question, as the imperfect pun corpus and direct similarity study do not bear on this issue. Finally, special notice should again be taken that only the pun corpus supports the claim that $S_1R_2V_3$–$S_1V_4R_2V_3$ are less similar than $T_1R_2V_3$–$T_1V_4R_2V_3$; as noted above in §3.2.1.2, my decision to adopt the ranking $\Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$ is more influenced by the restricted skipping data that I propose to explain in terms of perceptual similarity, than by the balance of the similarity evidence itself.

4. *Summary of chapter*

I repeat below the primary conclusions reached in this chapter regarding the relative similarity of $C_1C_2V_3$–C_1V_3, $C_1C_2V_3$–C_2V_3, and $C_1C_2V_3$–$C_1V_4C_2V_3$ pairs, for C_1C_2 = ST, SR, TR:

(40) Consonant deletion

$$\{\Delta(S_1T_2V_3–T_2V_3), \Delta(O_1R_2V–R_2V_3)\} > \Delta(S_1T_2V_3–S_1V_3) > \Delta(S_1R_2V_3–S_1V_3) > \Delta(T_1R_2V_3–T_1V_3)$$

(41) Vowel insertion

$$\{\Delta(S_1T_2V_3–S_1V_4T_2V_3), \Delta(T_1R_2V_3–V_4T_1R_2V_3)\} > \{\Delta(S_1T_2V_3–V_4S_1T_2V_3), \Delta(S_1R_2V_3–V_4S_1R_2V_3)\} > \Delta(S_1R_2V_3–S_1V_4R_2V_3) > \Delta(T_1R_2V_3–T_1V_4R_2V_3)$$

CHAPTER 5

Analysis

1. *Introduction*

The previous chapters described the typologies of onset tranfer in reduplication and cluster simplification in loanword adaption, and argued that perceptual similarity was crucial to their explanation.

In this chapter, I make the following assumption: if correspondence constraints are to serve the purpose of holding mutilations to inputs (bases, etc.) in check, so that ultimately the output is recognizable as belonging to its input, the constraints must assess violations in proportion with the perceived difference between input and output.

Standard correspondence theory is string-based: a constraint like CONTIGUITY (McCarthy and Prince 1995) looks at input and output (or base and reduplicant, or other correspondent strings), determines whether segments have been added or removed, and assesses violations accordingly. Under this theory of CONTIGUITY, all insertions and deletions are equal. But because sounds affect and are affected by their neighbors, string-identical additions and deletions are not of perceptually equal significance. To account for the facts of restricted skipping and restricted intrustion, I propose that CONTIGUITY must be augmented with two families of ranked constraints which penalize skipping and splitting in proportion to the resulting magnitude of perceptual difference between correspondent strings. These constraint families impose a harmonic ordering on CONTIGUITY-violating candidates, penalizing $O_1R_2V_3 \rightarrow O_1V_3$ maps less harshly than other $C_1C_2V_3 \rightarrow C_1V_3$ maps, and $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$ maps less harshly than other

$C_1C_2V_3 \rightarrow C_1V_4C_2V_3$ maps, in virtue of the fact that they are—perceptually speaking—relatively faithful ones.

In §2 , I present a sketch of an analysis of reduplicative onset transfer in terms of perceptual similarity within the framework of Optimality Theory. In §3, I summarize Fleischhacker (2001)'s proposed analysis of vowel epenthesis in loanword adaptation, and show that one pattern not accounted for by that analysis argues for greater markedness of ST over TR clusters. I also argue that the similarity-based correspondence constraints proposed here do not replace CONTIGUITY as a member of the universal constraint set.

2. *Reduplicative onset transfer*

This section presents an attempt to model the typology of reduplicative onset transfer using similarity-sensitive correspondence constraints. Recall from Chapter 2 that the facts to be explained are as follows. There are two major patterns of reduplicative onset transfer: restricted skipping patterns, in which *obstruent* + *sonorant* onsets behave differently under reduplication than other complex onsets; and cluster-blind simplification strategies, in which all complex onsets are simplified in the same way. In restricted skipping patterns, some or all OR onsets—i.e., just TR, or both SR and TR—are simplified by failure to copy the sonorant; in sufficient copy patterns, simplification of OR onsets cooccurs with full copy of other complex onsets, while in selective copy patterns, simplification of OR cooccurs with no copy of either member of other complex onsets. In cluster-blind simplification patterns, all complex onsets are simplified by copy of either the leftmost, rightmost, or less sonorous member of the base cluster.

2.1. *The constraints*

The sections below introduce the constraints that figure in the analysis: correspondence constraints sensitive to the similarity of correspondent strings (§2.1.1), which penalize $O_1R_2V_3 \rightarrow O_1V_3$ maps less harshly than other cluster simplification maps (i.e., $C_1C_2V_3 \rightarrow C_2V_3$ for all C_1C_2 clusters, and $C_1C_2V_3 \rightarrow C_1V_3$ for C_1C_2 other than *obstruent* + *sonorant*); the correspondence constraints responsible for the cluster-blind simplification strategies (§2.1.2); the markedness constraints which drive cluster simplification under reduplication, favor less sonorous onsets over more sonorous ones, etc. (§2.1.4); and the morphological constraints which trigger reduplication in the first place (§2.1.3).

2.1.1. *Similarity-sensitive correspondence constraints*

As shown in Chapter 4, evidence from alliteration in early Germanic, early Irish, and Middle alliteration; English imperfect puns; and experimental similarity studies converges on the following scale of relative similarity for cluster-singleton pairs:

(1) $\{\Delta(S_1T_2V_3–T_2V_3), \Delta(S_1R_2V_3–R_2V_3), \Delta(T_1R_2V_3–R_2V_3)\} > \Delta(S_1T_2V_3–S_1V_3) > \Delta(S_1R_2V_3–S_1V_3) > \Delta(T_1R_2V_3–T_1V_3)$

For the purposes of this analysis, an extension beyond (1) must be accepted. Although the reliable evidence presented in Chapter 4 applies only to OR and ST clusters,[53] it must be assumed that $O_1R_2V_3$–O_1V_3 pairs are more similar than any other $C_1C_2V_3$–C_1V_3 or $C_1C_2V_3$–C_2V pair—that is, not just more similar than $S_1T_2V_3$–S_1V_3 and $S_1T_2V_3$–T_2V_3. This is because in the data to be explained, OR clusters pattern differently than all non-OR clusters, not just ST.

The expanded similarity scale that I assume below is in (2):

(2) $\{\Delta(C_1C_2V_3–C_1V_3), \Delta(C_1C_2V_3–C_2V_3)\} > \Delta(S_1R_2V_3–S_1V_3) > \Delta(T_1R_2V_3–T_1V_3)$

That is, $S_1R_2V_3$–S_1V_3 and $T_1R_2V_3$–T_1V_3 are more similar than any other cluster-singleton pair.

The similarity scale in (2) can be rewritten as follows, separating difference from context:

(3) Similarity scale (2), transformed

a.	$\Delta(C_1C_2V_3–C_1V_3)$,	$\Delta(C_1C_2V_3–C_2V_3)$	>	$\Delta(S_1R_2V_3–S_1V_3)$	>	$\Delta(T_1R_2V_3–T_1V_3)$
	=	=		=		=
b.	Δ(C-Ø)/C_V,	Δ(C-Ø)/#_C	>	Δ(R-Ø)/S_V	>	Δ(R-Ø)/T_V

That is to say, the difference between a sonorant and nothing in the T_V context is smaller than the difference between a sonorant and nothing in the S_V context, and so on. Adopting Steriade's (2001) P-map proposal, I assume that similarity scales such as the

[53] The discrimination experiment presented in Chapter 5 found that [ktɑ]–[kɑ] and [mnɑ]–[nɑ] have reaction times comparable to $O_1R_2V_3$–O_1V_3 pairs; however, as noted in Chapter 5, that does not necessarily mean that [ktɑ]–[kɑ] and [mnɑ]–[nɑ] are as similar as $O_1R_2V_3$–O_1V_3 pairs: reaction times to items with non-English onset clusters may be slowed by a phonotactic double-take effect.

one in ((3)b) project correspondence constraints and their rankings, as shown by the diagram in (4):

(4) Projection of correspondence constraints

similarity scale	Δ(C-Ø)/C_V , Δ(C-Ø)/#_C > Δ(R-Ø)/S_V > Δ(R-Ø)/T_V
correspondence constraints	MAX-C/C_V , MAX-C/#_C » MAX-R/S_V » MAX-R/T_V

The context-sensitive MAX-C constraints shown in (4) penalize correspondence relationships between consonants and zero—i.e., in reduplication, they penalize failure to copy base segments—in specific segmental contexts, with the penalty proportionate to the perceptual difference resulting from failure to copy. The table in (5) illustrates violation and satisfaction of each context-sensitive MAX-C constraint:

(5) Violation patterns: context-sensitive MAX-C constraints

Outputs	MAX$_{BR}$-C/C_V	MAX$_{BR}$-C/#_C	MAX$_{BR}$-R/S_V	MAX$_{BR}$-R/T_V
a. $[[p_1a_3]_R[p_1r_2a_3]_B]$				*
b. $[[r_2a_3]_R[p_1r_2a_3]_B]$		*		
c. $[[s_1a_3]_R[s_1l_2a_3]_B]$			*	
d. $[[l_2a_3]_R[s_1l_2a_3]_B]$		*		
e. $[[s_1a_3]_R[s_1t_2a_3]_B]$	*			
f. $[[t_2a_3]_R[s_1t_2a_3]_B]$		*		

MAX$_{BR}$-R/T_V is violated only by the form in (a), which maps base T_1R_2V into reduplicant T_1V. MAX$_{BR}$-R/S_V is violated only by the form in (c), which maps S_1R_2V into S_1V. MAX$_{BR}$-C_V is violated by every form which maps general-case C_1C_2V (i.e. C_1C_2V other than S_1R_2V and T_1R_2V) into C_1V; the only such form shown in (5) is (e). Finally, MAX$_{BR}$-C/#_C is violated by any form that maps C_1C_2V onto C_2V: here, these are (b), (d), and (f).

Note that the constraints in (4) represent only the fragment of the context-sensitive MAX family relevant to the analysis of partial onset transfer; definition of context-sensitive MAX constraints on other sound sequences, and their rankings, is left for further work.

In addition to the context-sensitive MAX-C constraints, I assume that the constraint set includes non-context-sensitive MAX-C, which promotes copy of all base consonants:

(6) MAX-BR-CONSONANT (cf. McCarthy and Prince 1995): Every [-syllabic] element of the base has a correspondent in the reduplicant.

MAX-C assesses a violation for every consonant in the base that does not have a correspondent in the reduplicant. Thus, $[[C_1V_3]_R[C_1C_2V_3]_B]$ and $[[C_2V_3]_R[C_1C_2V_3]_B]$ both violate MAX-C once, while $[[V_3]_R[C_1C_2V_3]_B]$ violates MAX-C twice. (The full copy candidate, $[[C_1C_2V_3]_R[C_1C_2V_3]_B]$, does not violate MAX-C, and neither does non-reduplicated $[[V_4][C_1C_2V_3]]$.)

Note that MAX-C establishes a harmonic ordering across output candidates having one instance of failure to copy, two instances, and so on. MAX-C does not distinguish between candidates having an equal number of instances of failure to copy—this is the work of the context-specific MAX-C constraints.

2.1.2. *Other correspondence constraints*

Leftmost copy and rightmost copy are attributable, respectively, to the demands of LEFT-ANCHOR-BR and CONTIGUITY-BR:

(7) LEFT-ANCHOR-BR (McCarthy and Prince 1995): Any element at the left edge of the base has a correspondent at the left edge of the reduplicant.

L-ANCHOR assesses a violation when the leftmost elements of base and reduplicant are not in correspondence. Thus, L-ANCHOR is violated by $[[C_2V_3]_R[C_1C_2V_3]_B]$ and $[[V_3]_R[C_1C_2V_3]_B]$, but not by $[[C_1V_3]_R[C_1C_2V_3]_B]$ or $[[C_1C_2V_3]_R[C_1C_2V_3]_B]$; and of course, not by non-reduplicated forms.

Rightmost copy is attributable to the "no skipping" clause of CONTIGUITY-BR:

(8) I-CONTIGUITY (McCarthy and Prince 1995)

a. I-CONTIG ("No Skipping"): The portion of S_1 standing in correspondence forms a contiguous string. Domain of correspondence relation is a single contiguous string in S_1.

b. O-CONTIG ("No Intrusion"): The portion of S_2 standing in correspondence forms a contiguous string. Range of correspondence relation is a single contiguous string in S_2.

(Because reduplicative cluster simplification seems never to involve vowel insertion rather than failure to copy, I assume undominated DEP-BR-VOWEL and ignore CONTIGUITY's "no intrusion" clause in the present discussion.) CONTIGUITY is violated by $[[C_1V_3]_R[C_1C_2V_3]_B]$, in which C_2 of the base is skipped, while its neighbors C_1 and V_3 are copied.

Finally, note that all constraints not specifically mentioned above are presumed inviolable: for example, I do not consider candidates in which consonant clusters are simplified in the base, as these would be ruled out by undominated MAX$_{IO}$-C.

2.1.3. *Enforcing reduplication*

Recall from Chapter 2 that in selective copy reduplication, of which Ancient Greek is the only example I know, only the obstruent of an OR-initial base is copied, while for bases with initial clusters other than OR, neither member of the base cluster is copied: e.g., [ge-grap^{h}a] 'wrote', [ke-klop^{h}a] 'stole', but [e-ktona] 'killed', [e-sparmai] 'sowed'. I assume, uncontroversially, that forms like [ge-grap^{h}a] and [ke-klop^{h}a] are correctly analyzed as $[[g_1e_3]_R[g_1r_2a_3p^h{}_4a_5]_B]$, $[[k_1e_3]_R[k_1l_2o_3p^h{}_4a_5]_B]$: as indicated by the coindexing, the vowel appearing in the reduplicant corresponds to the vowel in the first syllable of the base. The fact that the reduplicant vowel is always [e], no matter what the quality of the base vowel, is presumably an emergence of the unmarked effect: IDENT-BR constraints on vowel features are interleaved with vowel markedness constraints such that, in Ancient Greek, [e] emerges as the optimal reduplicative correspondent for any base vowel (Alderete, Beckman, Benua, Gnanadesikan, McCarthy and Urbanczyk 1997).

However, the emergence of fixed segmentism in obviously reduplicated forms like [ge-grap^{h}a], [ke-klop^{h}a] ambiguates the analysis of forms like [e-ktona] and [e-sparmai], in which no member of the base cluster is copied. If [e-ktona] and [e-sparmai] cooccurred with forms like *[ga-grap^{h}a], *[ko-klop^{h}a], in which the base vowel is copied exactly, it would be clear that [e-ktona] and [e-sparmai] are not reduplicated, but rather forms containing a non-reduplicative prefix [e-]; and of course, if [e-ktona] and [e-sparmai] were instead *[o-ktona] and *[a-sparmai], it would be clear that they are reduplicated forms. As it stands, though, [e-ktona] and [e-sparmai] are justifiably analyzed either as $[[e_3]_R[k_1t_2o_3n_4a_5]_B]$, $[[e_3]_R[s_1p_2a_3r_4m_5a_6i_7]_B]$—i.e., reduplicated forms, with fixed reduplicant vowel quality as in $[[g_1e_3]_R[g_1r_2a_3p^h{}_4a_5]_B]$, $[[k_1e_3]_R[k_1l_2o_3p^h{}_4a_5]_B]$; or as $[[e_6][k_1t_2o_3n_4a_5]]$, $[[e_8][s_1p_2a_3r_4m_5a_6i_7]]$—i.e., forms containing a non-reduplicative prefix which happens to be [e-].

The analysis presented here is constructed such that the constraints decide whether [e-ktona] and [e-sparmai] are reduplicated, or non-reduplicated prefixed forms: e.g., $[[e_{\mathbf{3}}]_R[k_1t_2o_{\mathbf{3}}n_4a_5]_B]$ and $[[e_{\mathbf{6}}][k_1t_2o_{\mathbf{3}}n_4a_5]]$ are both candidates for the output of perfect-inflected /ktona/. The morphological theory I assume (MacBride 2004) is one in which affixes are encoded in constraints sensitive to the syntactic properties of a form; a constraint X:Y is violated if an output candidate bears syntactic feature X but fails to display phonological property Y. Since these morphological constraints are violable, the presence in the grammar of multiple constraints with the same syntactic trigger X can lead to allomorphy: constraints X:Y and X:Z may not simultaneously be satisfiable, and which is satisfied in a particular form is determined by the relative ranking of the morphological constraints, and their ranking with respect to markedness or faithfulness constraints that phonological properties Y and Z may violate.

The particular morphological constraints included in this analysis are in (9) and (10):

(9) X:RED$[_{stem}$: An output with syntactic feature X contains the prefix RED followed by a stem boundary.

(10) X:e$[_{stem}$: An output with syntactic feature X contains the prefix [e-] followed by a stem boundary.

(For the purposes of this typological analysis, I use X to name the syntactic feature triggering reduplication or prefixation; in Ancient Greek, it is PERFECT.) X:RED$[_{stem}$ penalizes non-reduplicated outputs bearing syntactic feature X; it is violated by Greek $[[e_{6}][k_{1}t_{2}o_{3}n_{4}a_{5}]]$ but not by $[[e_{3}]_{R}[k_{1}t_{2}o_{3}n_{4}a_{5}]_{B}]$. X:e$[_{stem}$ has exactly opposite priorities: it is violated by $[[e_{3}]_{R}[k_{1}t_{2}o_{3}n_{4}a_{5}]_{B}]$ but not by $[[e_{6}][k_{1}t_{2}o_{3}n_{4}a_{5}]]$. With the fixed ranking X:RED$[_{stem}$ » X:e$[_{stem}$, reduplication is the preferred realization of the morphological category in question, with non-reduplicated [e-] the allomorph that surfaces when reduplication is rendered untenable by higher-ranking constraints.

Note that the definition of X:RED$[_{stem}$ specifies that RED is a prefix. I assume that an undominated constraint RED=σ limits the size of the reduplicant to a single syllable, and that failure to copy beyond the first vowel of the base is the result of a phonotactic constraint banning coda consonants dominating MAX-BR-C.

2.1.4. *Markedness constraints*

The phonotactic constraint driving cluster simplification under reduplication is C/V:

(11) C/V: Every consonant is prevocalic.

C/V assesses a violation for every consonant in the output that precedes another consonant. Thus, forms of shape [CCVCCV] violate C/V twice; forms of shape [CVCCV] and [VCCV] violate C/V only once. For the theoretical context of C/V, as opposed to *COMPLEX (Prince and Smolensky 1993), see Steriade (1997).

Copy of a consonant is favored by the phonotactic ONSET:

(12) ONSET (cf. Prince and Smolensky 1993): Every vowel is preceded by a consonant.

ONSET is violated by the vowel-initial forms $[[V_3]_R[C_1C_2V_3]_B]$ and $[[V_4][C_1C_2V_3]]$.

2.1.4.1. *On deriving sonority-based copy*

Sonority-driven cluster simplification, as in Sanskrit, is typically analyzed as an emergence of the unmarked effect in reduplication, with preference for less sonorous onsets over more sonorous ones driven by the action of a margin hierarchy like *SONORANTONSET » *FRICATIVEONSET » *STOPONSET (in the spirit of Prince and Smolensky 1993), or similar proposals by Gnanadesikan (1995) and Morelli (1999).

The difficulty with margin hierarchies is that they have extremely undesirable consequences for the factorial typology of reduplicative onset transfer, a fact that is seen most clearly when an onset markedness hierarchy is incorporated into a classical and uncontroversial analysis of reduplication along the lines of Kager (1999). For the purposes of this example, assume inputs /RED+C_1a_2/, for /C_1a_2/ = /pa/, /sa/, /la/, and /RED+$C_1C_2a_3$/, for /$C_1C_2a_3$/ = /pra/, /sla/, /sta/. Candidate outputs for /RED+C_1a_2/ are [C_1a_2-C_1a_2] and [a_2-C_1a_2], and for /RED+$C_1C_2a_3$/, [$C_1C_2a_3$-$C_1C_2a_3$], [C_1a_3-$C_1C_2a_3$], [C_2a_3-$C_1C_2a_3$], [a_3-$C_1C_2a_3$]. When the constraint set contains just the markedness constraints

*COMPLEX and ONSET, and base-reduplicant correspondence constraints MAX-C, L-ANCHOR, and CONTIGUITY, the factorial typology (calculated with constraint ranking software, Hayes 1999) contains just three languages:

(13) Factorial typology of *COMPLEX, ONSET, MAX-C, L-ANCHOR, CONTIGUITY

a. *Full copy*: [pra-pra], [sla-sla], [sta-sta], [pa-pa], [sa-sa], [la-la]

MAX-C, ONSET, L-ANCHOR, CONTIGUITY » *COMPLEX

b. *Leftmost copy*: [pa-pra], [sa-sla], [sa-sta], [pa-pa], [sa-sa], [la-la]

*COMPLEX, ONSET, L-ANCHOR » MAX-C, CONTIGUITY

c. *Rightmost copy*: [ra-pra], [la-sla], [ta-sta], [pa-pa], [sa-sa], [la-la]

*COMPLEX, ONSET, CONTIGUITY » MAX-C, L-ANCHOR

In addition to full copy of all base clusters (a), these constraints generate two of the three cluster-blind simplification strategies identified in Chapter 2, namely leftmost copy (b) and rightmost copy (c).[54] When the margin hierarchy *SONORANTONSET » *FRICATIVEONSET » *STOPONSET, which penalizes singleton onsets in proportion to their sonority, is added to the constraint set in (13), the factorial typology expands to include, in addition to the three languages in (13), sonority-based simplification as in Sanskrit (by the ranking *COMPLEX, ONSET » MAX-C, *SONONS » CONTIGUITY, *FRICONS » L-ANCHOR, *STOPONS)—and fully 24 additional languages in which forms reduplicate or do not, or simplify or do not, based solely on whether to do so would result in a reduction

[54] Tangentially, note that in the absence of similarity-sensitive correspondence constraints (see §2.1.1. sufficient copy and selective copy are not predicted as possible reduplicative onset transfer patterns.

in the number of onsets that are undesirable on sonority grounds. These include such oddities as a language in which only stops are reduplicated:

(14) *COMPLEX, *SONONS, *FRICONS » L-ANCHOR, ONSET, MAX-C » CONTIGUITY, *STOPONS

a. Stops are reduplicated: [pa-pra], [ta-sta], [pa-pa]

b. Fricatives, sonorant consonants aren't reduplicated: [a-sla], [a-sa], [a-la]

Similar results obtain if *SONORANTONSET » *FRICATIVEONSET » *STOPONSET is replaced by, for example, the μ/X family of constraints proposed by Gnanadesikan (1995), which requires segment classes to be parsed as moras, and thereby penalizes consonants filling onset (i.e., nonmoraic) slots in proportion to their sonority; or by a single onset sonority constraint that assesses more violations as the sonority of an onset consonant increases.

I do not propose to solve this problem here. Instead, I offer something of a stopgap alternative to margin hierarchies, in which the choice of which segment to copy in order to minimize onset sonority is relativized to those segments actually present in the base:

(15) BESTONSET: For two syllables σ_α, σ_β with onset consonants standing in base-reduplicant correspondence, the onset of the reduplicant must contain a consonant in correspondence with the least sonorous consonant of the onset of the base.

BESTONSET is violated by $[[C_1V_3]_R[C_1C_2V_3]_B]$ when C_1 is more sonorous than C_2, and by $[[C_2V_3]_R[C_1C_2V_3]_B]$ when C_2 is more sonorous than C_1. BESTONSET is satisfied by

$[[C_1C_2V_3]_R[C_1C_2V_3]_B]$—if both members of the base cluster are copied, the reduplicant onset will contain a consonant in correspondence with the less sonorous member of the base onset.

The BESTONSET proposal is not a solution to the overgeneration problem raised by margin hierarchies. When added to the constraint set in (13)—i.e., *COMPLEX, ONSET, L-ANCHOR, CONTIGUITY, MAX-C—BESTONSET is responsible for the prediction of three unexpected languages in addition to full copy, leftmost copy, rightmost copy, and sonority-based copy:

(16) Overgenerations by BESTONSET

a. [pa-pra], [sla-sla], [ta-sta], [pa-pa], [sa-sa], [la-la]

ONSET, CONTIGUITY, BESTONSET » *COMPLEX » MAX-C, L-ANCHOR

b. [a-pra], [a-sla], [ta-sta], [pa-pa], [sa-sa], [la-la]

*COMPLEX, CONTIGUITY, BESTONSET » *COMPLEX, MAX-C, L-ANCHOR

c. [pa-pra], [sa-sla], [sta-sta], [pa-pa], [sa-sa], [la-la]

ONSET, L-ANCHOR, BESTONSET » *COMPLEX » CONTIGUITY, MAX-C

The unattested languages in (a) and (b) are also generated by the *SONORANTONSET » *FRICATIVEONSET » *STOPONSET analysis; the language in (c) is not—but note that this actually sufficient copy reduplication, as in Gothic, and thus, strictly speaking, not an overgenerated pattern.

The overgeneration problem gets worse when more constraints, and more input cluster types, are included in factorial typology calculation. In the discussion below, I suppress those patterns which are generated only when BESTONSET is present in the constraint set. These patterns, and the rankings which generate them, are presented in the Appendix.

2.2. *Factorial typology*

The constraints defined in the sections above were submitted to factorial typology calculation with a priori rankings for the context-sensitive MAX-C constraints and the morphological constraints X:RED$[_{stem}$ » X:e$[_{stem}$. The inputs and output candidates included in this calculation are in (17):

(17) Inputs

a. Schematic: /$C_1C_2a_3$/, [+X]

b. Actual: /pra/, /sla/, /sta/, /ksa/, /kta/, /mna/

Inputs are marked with the syntactic feature [+X], which triggers prefixation of the reduplicative prefix RED, or the non-reduplicative prefix *e*-. Inputs /pra/ and /sla/ represent all TR- and SR-initial bases, respectively. Inputs /sta/, /ksa/, /kta/, and /mna/ represent initial non-OR clusters.

(18) Outputs

a. Full transfer = [$C_1C_2a_3$-$C_1C_2a_3$]

b. C_1-copy = [C_1a_3-$C_1C_2a_3$]

c. C_2-copy = [C_2a_3-$C_1C_2a_3$]

d. Vowel copy = [a_3-$C_1C_2a_3$]

e. Non-reduplicative prefixation = [e_4-$C_1C_2a_3$]

Assuming that clusters in the base can't be simplified (by the ranking MAX-IO-C » C/V » MAX-BR-C), and that vowel epenthesis is not a possible cluster resolution strategy in reduplication (by the ranking DEP-BR-V » C/V), etc., these are the logically possible output forms. Note that for reasons of readability, all reduplicated outputs have a copy vowel, [a], while the outputs with non-reduplicated prefixes the affixal vowel [e]. Vowel quality is not at issue here; the [a]/[e] distinction is employed only to make it easier to distinguish on the page the vowel copy forms ([a_3-$C_1C_2a_3$]) from the prefixed forms ([e_4-$C_1C_2a_3$]).

Also included in the typology was an input with a singleton onset, /C_1a_2/, with three possible outputs: copy of the base consonant ([C_1a_2-C_1a_2]), vowel copy ([a_2-C_1a_2]), and prefixation ([e_3-C_1a_2]). Only [C_1a_2-C_1a_2] ever surfaces as the optimal candidate, regardless of constraint ranking—the right result, given the data presented in Chapter 2—and thus /C_1a_2/ inputs are not discussed further.

Excluding the anomalous results for which only BESTONSET is responsible (see the Appendix for these), the factorial typology calculation produced 13 outcomes, which are summarized in the sections below.

2.2.1. *Sufficient copy*

The constraint ranking for the sufficient copy pattern exemplified by Klamath, in which TR clusters are simplified while SR clusters are not, is shown below. Here and below, "»" separates constraints belonging to different ranking strata; stratum-internal ranking is non-crucial.

(19) Klamath = [pa-pra] but [sla-sla], [sta-sta], [ksa-ksa], [kta-kta], [mna-mna]

X:red[, Onset, BestOnset, L-Anchor,
Max-C/C_V, **Max-C/#_C**, **Max-R/S_V**
»
X:e[, **C/V**
»
Max-C, Contiguity, **Max-R/T_V**

With X:red[and Onset undominated, the only realistically possible outputs are reduplicated, and with at least a singleton onset: i.e., the viable candidates are [C_1a-C_1C_2a], [C_2a-C_1C_2a], and [C_1C_2a-C_1C_2a]. The question of which complex onsets emerge in the reduplicant, and which complex onsets are simplified, is settled by the relative ranking of C/V with respect to the context-sensitive Max-C constraints (these constraints are highlighted in the diagram above). When C/V dominates only Max-R/T_V, as in Klamath, only TR clusters are compelled to simplify under reduplication, while all other onsets are fully copied:

(20) Only TR onsets are simplified

		MAX-C/#_C	MAX-C/C_V	MAX-R/S_V	C/V	MAX-R/T_V
/sta/, [+X]	☞ sta-sta				**	
	sa-sta		*!		*	
	ta-sta	*!			*	
/sla/, [+X]	☞ sla-sla				**	
	sa-sla			*!	*	
	la-sla	*!			*	
/pra/, [+X]	pra-pra				**!	
	☞ pa-pra				*	*
	ra-pra	*!			*	

High-ranking MAX-C/#_C and MAX-C/C_V protect all clusters other than TR from the demands of C/V. However, because C/V dominates MAX-R/T_V, C/V has the power to assert its preference for simple onsets in just the case of base TR: it is satisfied at the cost of violating only the low-ranked correspondence constraint regulating preservation of a sonorant in the T_V context.

The difference between Klamath, in which only TR is simplified, and Gothic, in which all OR onsets are simplified, is only the reranking of MAX-R/S_V with respect to C/V:

(21) Gothic = [pa-pra], [sa-sla] but [sta-sta], [ksa-ksa], [kta-kta], [mna-mna]

X:RED[, ONSET, BESTONSET, L-ANCHOR,
MAX-C/C_V, MAX-C/#_C
»
X:e[, C/V
»
MAX-C, CONTIGUITY, **MAX-R/S_V**, MAX-R/T_V

With MAX-R/S_V now ranked below C/V, all OR clusters are simplified under reduplication:

(22) All OR onsets are simplified

		MAX-C/#_C	MAX-C/C_V	C/V	MAX-R/S_V	MAX-R/T_V
/sta/, [+X]	☞ sta-sta			**		
	sa-sta		*!	*		
	ta-sta	*!		*		
/sla/, [+X]	sla-sla			**!		
	☞ sa-sla			*	*	
	la-sla	*!		*		
/pra/, [+X]	pra-pra			**!		
	☞ pa-pra			*		*
	ra-pra	*!		*		

With both MAX-R/S_V and MAX-R/T_V dominated by C/V, no OR cluster is protected from cluster simplification; thus, the $O_1R_2V_3 \rightarrow O_1V_3$ mapping is obligatory. As in Klamath, clusters other than OR are protected from the demands of C/V by the high-ranking constraints MAX-C/#_C and MAX-C/C_V, which prohibit failure to copy either C_1 or C_2 for base non-OR clusters.

In contrast, the difference between sufficient copy and full transfer of all base clusters is a reranking in the other direction—promotion of MAX-R/S_V and MAX-R/T_V above C/V:

(23) Full copy = [pra-pra], [sla-sla], [sta-sta], [ksa-ksa], [kta-kta], [mna-mna]

X:RED[, ONSET, BESTONSET, L-ANCHOR, CONTIGUITY,
MAX-C/C_V, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V
»
X:e[, C/V

With C/V ranked below all of the context-sensitive MAX-C constraints, all base clusters are reduplicated in full:

(24) Full copy of all base clusters

		MAX-C/#_C	MAX-C/C_V	MAX-R/S_V	MAX-R/T_V	C/V
/sta/, [+X]	☞ sta-sta					**
	sa-sta		*!			*
	ta-sta	*!				*
/sla/, [+X]	☞ sla-sla					**
	sa-sla			*!		*
	la-sla	*!				*
/pra/, [+X]	☞ pra-pra					**
	pa-pra				*!	*
	ra-pra	*!				*

With this constraint ranking, all base clusters are protected from simplification, and full onset transfer is observed across the board.

2.2.1.1. *Selective copy I: all forms are reduplicated*

As noted above in §2.1.3, forms like Ancient Greek [e-ktona] can be analyzed as either $[[e_3]_R[k_1t_2o_3n_4a_5]_B]$, with reduplication of the base vowel only, or as $[[e_6][k_1t_2o_3n_4a_5]]$, with a non-reduplicative prefix. This section presents the analysis in which all forms are reduplicated—i.e., the analysis in which the morphological constraint X:RED[is always satisfied; the following section presents the non-reduplicative prefix analysis.

The constraint ranking for selective copy as in Ancient Greek, in which only TR clusters are simplified under reduplication, while no member of other base clusters is copied, is shown below:

(25) Ancient Greek = [pa-pra] but [a-sla], [a-sta], [a-ksa], [a-kta], [a-mna]

X:RED[, C/V, BESTONSET,
MAX-C/C_V, **MAX-C/#_C**, **MAX-R/S_V**
»
MAX-C, X:e[, **ONSET**, **L-ANCHOR**
»
CONTIGUITY, **MAX-R/T_V**

With X:RED[and C/V undominated, the only viable candidates are those that are reduplicated, and in which the reduplicant has a simple onset or is onsetless: i.e., [C_1a-C_1C_2a], [C_2a-C_1C_2a], and [a-C_1C_2a]. The question of which clusters are copied in part, and which are not copied at all, is settled by the ranking of ONSET and L-ANCHOR with respect to the context-sensitive MAX-C constraints (the crucial constraints are highlighted in the diagram above):

(26) Only TR is simplified; other clusters aren't reduplicated

		MAX-C /#_C	MAX-C /C_V	MAX-R /S_V	ONSET	L-ANCHOR	MAX-R /T_V
/sta/, [+X]	sa-sta		*!				
	ta-sta	*!				*	
	☞ a-sta				*	*	
/sla/, [+X]	sa-sla			*!			
	la-sla	*!				*	
	☞ a-sla				*	*	
/pra/, [+X]	☞ pa-pra						*
	ra-pra	*!				*	
	a-pra				*!	*!	

With ONSET and L-ANCHOR ranked above MAX-R/T_V, TR clusters reduplicate in order to provide an onset consonant for the reduplicant—and the consonant copied, C_1, ensures satisfaction of L-ANCHOR. Clusters other than TR are protected from the demands of

ONSET and L-ANCHOR by higher-ranked context-sensitive MAX-C constraints, and thus no portion of these clusters is copied.

As noted in Chapter 2, there is an affinity between the reduplication patterns of Ancient Greek and Klamath: in Greek, only TR clusters reduplicate, and the remaining OR clusters—i.e. SR—do not; in Klamath, only TR clusters simplify, while the remaining OR clusters do not. In both cases, X:RED[is top-ranked in the fragment of the constraint hierarchy considered here; in Klamath, ONSET and L-ANCHOR are also top-ranked, and the ranking of C/V with respect to the context-sensitive MAX-C system determines the reduplicative behavior of individual clusters. In Ancient Greek, C/V is top-ranked, and it is the ranking of ONSET and L-ANCHOR with respect to the context-sensitive MAX-C constraints which determines the reduplicative behavior of individual clusters.

Given the existence of this parallel between Ancient Greek and Klamath, and the observation that in Gothic, all OR clusters simplify while non-OR clusters are fully copied, it seems quite reasonable to predict a selective copy language in which all and only OR clusters and singleton onsets reduplicate. I'll call this language "pseudo-Greek"; it emerges when MAX-R/S_V is demoted below ONSET and L-ANCHOR:

(27) Pseudo-Greek = [pa-pra], [sa-sla] but [a-sta], [a-ksa], [a-kta], [a-mna]

X:RED[, C/V, BESTONSET,
MAX-C/C_V, MAX-C/#_C
»
MAX-C, X:e[, ONSET, L-ANCHOR
»
CONTIGUITY, **MAX-R/S_V**, MAX-R/T_V

With this constraint ranking, all OR clusters reduplicate via the skipping map:

(28) All OR onsets are simplified; other clusters aren't reduplicated

		MAX-C /#_C	MAX-C /C_V	ONSET	L-ANCHOR	MAX-R /S_V	MAX-R /T_V
/sta/, [+X]	sa-sta		*!				
	ta-sta	*!			*		
	☞ a-sta			*	*		
/sla/, [+X]	☞ sa-sla					*	
	la-sla	*!			*		
	a-sla			*!	*!		
/pra/, [+X]	☞ pa-pra						*
	ra-pra	*!			*		
	a-pra			*!	*!		

Finally, consider the result when ONSET and L-ANCHOR dominate none of the context-sensitive MAX-C constraints. In this case, no portion of any base cluster is copied, and only the base vowel has a correspondent in the reduplicant:

(29) Vowel copy = [a-pra], [a-sla], [a-sta], [a-ksa], [a-kta], [a-mna]

X:RED[, C/V, BESTONSET, CONTIGUITY,
MAX-C/C_V, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V
»
X:e[, ONSET, L-ANCHOR, MAX-C

With ONSET powerless to compel reduplication of any consonant belonging to a base cluster, only base vowels are reduplicated:

(30) No cluster is reduplicated

		MAX-C /#_C	MAX-C /C_V	MAX-R /S_V	MAX-R /T_V	ONSET	L-ANCHOR
/sta/, [+X]	sa-sta		*!				
	ta-sta	*!					*
	☞ a-sta					*	*
/sla/, [+X]	sa-sla			*!			
	la-sla	*!					*
	☞ a-sla					*	*
/pra/, [+X]	pa-pra				*!		
	ra-pra	*!					*
	☞ a-pra					*	*

2.2.1.2. *Selective copy II: reduplication plus prefixation*

We turn now to the prefixing analysis of Ancient Greek forms like [e-ktona]; the constraint ranking for Greek under this analysis is shown below:

(31) Ancient Greek = [pa-pra] but [e-sla], [e-sta], [e-ksa], [e-kta], [e-mna]

C/V, BESTONSET, L-ANCHOR,
MAX-C/C_V, **MAX-C/#_C**, **MAX-R/S_V**
»
X:RED[, **ONSET**,
»
MAX-C, X:e[, CONTIGUITY, **MAX-R/T_V**

With C/V and L-ANCHOR undominated, the only viable candidates are [C_1a-C_1C_2a] and [e-C_1C_2a]. That is, the output must be reduplicated, with a singleton onset that corresponds to the segment at the left edge of the base (thus simultaneously satisfying C/V and L-ANCHOR); or it must contain the non-reduplicative prefix [e-]—note that because [e-C_1C_2a] is not reduplicated, it vacuously satisfies L-ANCHOR. Which of these candidates surfaces as optimal for any individual base cluster depends on the relative rankings of X:RED[and ONSET with respect to the context-sensitive MAX-C constraints (the crucial constraints are highlighted in the diagram above):

(32) Only TR-initial bases trigger reduplication

		MAX-C /#_C	MAX-C /C_V	MAX-R /S_V	X:RED[	ONSET	MAX-R /T_V
/sta/, [+X]	sa-sta		*!				
	☞ e-sta				*	*	
/sla/, [+X]	sa-sla			*!			
	☞ e-sla				*	*	
/pra/, [+X]	☞ pa-pra						*
	e-pra				*!	*!	

High-ranking context-sensitive MAX-C constraints protect clusters other than TR from reduplication; thus, these forms surface with a non-reduplicative prefix. However, with MAX-R/T_V ranked below X:RED[and ONSET, TR clusters are compelled to reduplicate, thereby providing an onset for the reduplicative vowel.

Pseudo-Greek—in which all OR onsets, not just TR, are reduplicated—emerges when MAX-R/S_V is ranked below X:RED[and ONSET:

(33) Pseudo-Greek = [pa-pra], [sa-sla] but [e-sta], [e-ksa], [e-kta], [e-mna]

C/V, BESTONSET, L-ANCHOR,
MAX-C/C_V, MAX-C/#_C
»
X:RED[, ONSET,
»
MAX-C, X:e[, CONTIGUITY, **MAX-R/S_V**, MAX-R/T_V

Now all OR onsets reduplicate via the skipping map, while clusters other than OR trigger prefixation of a non-reduplicative morpheme:

(34) All OR-initial bases trigger reduplication

		MAX-C /#_C	MAX-C /C_V	X:RED[	ONSET	MAX-R /S_V	MAX-R /T_V
/sta/, [+X]	sa-sta		*!				
	☞ e-sta			*	*		
/sla/, [+X]	☞ sa-sla					*	
	e-sla			*!	*!		
/pra/, [+X]	☞ pa-pra						*
	e-pra			*!	*!		

Finally, when X:RED and ONSET are both outranked by all context-sensitive MAX-C constraints, no member of any base cluster is reduplicated—non-reduplicative prefixation applies across the board. (Of course, singleton onsets are reduplicated.)

(35) Non-reduplicative prefixes only = [e-pra], [e-sla], [e-sta], [e-ksa], [e-kta], [e-mna]

C/V, BESTONSET, L-ANCHOR, CONTIGUITY, MAX-C,
MAX-C/C_V, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V
»
X:RED[, ONSET,
»
X:e[

The partial tableau below illustrates exactly how this outcome is derived:

(36) Prefixation only

		MAX-C /#_C	MAX-C /C_V	MAX-R /S_V	MAX-R /T_V	X:RED[	ONSET
/sta/, [+X]	sa-sta		*!				
	☞ e-sta					*	*
/sla/, [+X]	sa-sla			*!			
	☞ e-sla					*	*
/pra/, [+X]	pa-pra				*!		
	☞ e-pra					*	*

Here, with all context-sensitive MAX-C constraints dominating X:RED and ONSET, prefixation regardless of base cluster type becomes the strategy that best-satisfies the constraint hierarchy.

2.2.2. *Cluster-blind simplification*

Recall from Chapter 2 that in Sanskrit reduplication, the least sonorous member of the cluster is copied; or if the cluster members are equally sonorous, the leftmost cluster member is copied. The factorial typology predicts both the Sanskrit pattern and its logical alternative: i.e., the language in which sonority-based simplification is accompanied by rightmost copy in cases where the cluster members are equally sonorous. The rankings which generate the two patterns are shown below:

(37) Sonority-based/leftmost copy = [pa-pra], [sa-sla], [ta-sta], [ka-ksa], [ka-kta], [ma-mna]

X:RED[, C/V, ONSET, **BESTONSET**
»
L-ANCHOR, **MAX-C/#_C**, X:e[, MAX-C
»
CONTIGUITY, **MAX-C/C_V**, MAX-R/S_V, MAX-R/T_V

(38) Sonority-based/rightmost copy = [pa-pra], [sa-sla], [ta-sta], [ka-ksa], [ta-kta], [na-mna]

X:RED[, C/V, ONSET, **BESTONSET**
»
CONTIGUITY, **MAX-C/C_V**, X:e[, MAX-C
»
L-ANCHOR, **MAX-C/#_C**, MAX-R/S_V, MAX-R/T_V

In both rankings, X:RED[, C/V, ONSET, and BESTONSET are undominated; therefore, the winning candidate must be reduplicated, with a singleton onset corresponding to the least sonorous member of the base cluster. When there is no sonority difference between the base cluster members, the decision of which cluster member to copy falls to the relative rankings of L-ANCHOR and MAX-C/#_C with respect to CONTIGUITY and MAX-C/C_V:

(39) Sonority-based/leftmost copy

			BEST ONSET	L-ANCHOR	MAX-C#_C	CONTIG	MAX-C/C_V
/sta/, [+X]		sa-sta	*!			*	*
	☞	ta-sta		*	*		
/ksa/, [+X]	☞	ka-ksa				*	*
		sa-ksa	*!	*	*		
/kta/, [+X]	☞	ka-kta				*	*
		ta-kta		*!	*!		
/pra/, [+X]	☞	pa-pra				*	
		ra-pra	*!	*	*		
/sla/, [+X]	☞	sa-sla				*	
		la-sla	*!	*	*		

(40) Sonority-based/rightmost copy

			BEST ONSET	CONTIG	MAX-C/C_V	L-ANCHOR	MAX-C/#_C
/sta/, [+X]		sa-sta	*!	*	*		
	☞	ta-sta				*	*
/ksa/, [+X]	☞	ka-ksa		*	*		
		sa-ksa	*!			*	*
/kta/, [+X]		ka-kta		*!	*!		
	☞	ta-kta				*	*
/pra/, [+X]	☞	pa-pra		*			
		ra-pra	*!			*	*
/sla/, [+X]	☞	sa-sla		*			
		la-sla	*!			*	*

When L-ANCHOR and MAX-C/#_C dominate CONTIGUITY and MAX-C/C_V, the leftmost cluster member is copied in cases of equal sonority, as in Sanskrit; when those rankings are reversed, the rightmost cluster member is copied.

The constraint rankings for leftmost copy and rightmost copy are shown below in (41) and (42):

(41) Leftmost copy = [pa-pra], [sa-sla], [sa-sta], [ka-ksa], [ka-kta], [ma-mna]

X:RED[, C/V, ONSET, **L-ANCHOR**, **MAX-C/#_C**
»
X:e[, MAX-C, BESTONSET, **CONTIGUITY**, **MAX-C/C_V**, MAX-R/S_V, MAX-R/T_V

(42) Rightmost copy = [ra-pra], [la-sla], [ta-sta], [sa-ksa], [ta-kta], [na-mna]

X:RED[, C/V, ONSET, **CONTIGUITY**, **MAX-C/C_V**,
»
X:e[, MAX-C, BESTONSET, **L-ANCHOR**, **MAX-C/#_C**, MAX-R/S_V, MAX-R/T_V

In both cases, C/V, ONSET, and X:RED[, are all undominated by any relevant constraints. Thus, the only viable candidates are reduplicated, and with a singleton onset in the reduplicant; that is, the only candidates which satisfy the top-ranked constraints are [C_1a-C_1C_2a] and [C_2a-C_1C_2a]. Exactly which member of the base cluster is copied is determined by the relative rankings of L-ANCHOR and MAX-C/#_C with respect to CONTIGUITY and MAX-C/C_V. When L-ANCHOR and MAX-C/#_C are ranked above CONTIGUITY and MAX-C/C_V, the leftmost member of any base cluster is copied:

(43) Leftmost copy

		L-Anchor	Max-C//#_C	Contiguity	Max-C/C_V
/sta/, [+X]	☞ sa-sta			*	*
	ta-sta	*!	*!		
/sla/, [+X]	☞ sa-sla			*	
	la-sla	*!	*!		
/pra/, [+X]	☞ pa-pra			*	
	ra-pra	*!	*!		

But when the rankings are reversed, as shown in the tableau in (44), the rightmost member of the cluster is copied:

(44) Rightmost copy

		Contiguity	Max-C//C_V	L-Anchor	Max-C/#_C
/sta/, [+X]	sa-sta	*!	*!		
	☞ ta-sta			*	*
/sla/, [+X]	sa-sla	*!			
	☞ la-sla			*	*
/pra/, [+X]	pa-pra	*!			
	☞ ra-pra			*	*

Finally, we come to the last pattern generated by the factorial typology: a language in which OR clusters simplify through skipping, while other clusters simplify through rightmost copy:

(45) [pa-pra], [sa-sla], but [ta-sta], [sa-ksa], [ta-kta], [na-mna]

X:red[, C/V, Onset, Max-C/C_V,

»

X:e[, Max-C, BestOnset, L-Anchor, Max-C/#_C

Contiguity, **Max-R/S_V**, **Max-R/T_V**

In this language, as in the rightmost copy pattern, X:RED[, C/V, and ONSET are all undominated, meaning that viable candidates are reduplicated, with singleton onsets. With MAX-C/C_V also undominated, non-OR clusters do not allow skipping, so rightmost copy is the only possible resolution strategy. However, MAX-R/S_V, MAX-R/T_V, and CONTIGUITY are sufficiently low-ranked to allow all and only OR clusters to simplify via skipping:

(46) Rightmost copy + skipping

		MAX-C /C_V	BEST ONS	L-ANCH	MAX-C /#_C	CONTIG	MAX-R /S_V	MAX-R /T_V
/sta/, [+X]	sa-sta	*!	*			*		
	☞ ta-sta			*	*			
/ksa/, [+X]	ka-ksa	*!				*		
	☞ sa-ksa		*	*	*			
/kta/, [+X]	ka-kta	*!				*		
	☞ ta-kta			*	*			
/pra/, [+X]	☞ pa-pra					*		*
	ra-pra		*!	*!	*!			
/sla/, [+X]	☞ sa-sla					*	*	
	la-sla		*!	*!	*!			

This language is not attested in the factorial typology presented in Chapter 2. It is not clear to me whether this is properly attributable to an accidental gap (or an incomplete inventory of reduplicative simplification strategies), or to overgeneration by the constraint set.

3. *Cluster simplification in loanword adaptation*

Fleischhacker (2001) presents an analysis of the core facts presented in Chapter 3 of cluster-simplifying vowel epenthesis in loanword adaptation. I summarize that proposal here, and then turn to two remaining issues. First, I discuss the one attested vowel insertion pattern – namely, that in which only ST clusters are repaired, while OR clusters surface as such – which is not predicted by Fleischhacker (2001)'s analysis. I argue that this pattern reveals the action of a markedness constraint specifically targeting ST clusters. Second, I show that one pattern of cluster-resolving vowel epenthesis argues crucially for CONTIGUITY as a member of the universal constraint set.

Fleischhacker (2001) assumes the similarity scale shown below in (47); recall that this is at least partially supported by the similarity evidence presented in Chapter 4:

(47) Similarity scale for vowel insertion

$\Delta(S_1T_2V_3–S_1V_4T_2V_3) > \Delta(S_1N_2V_3–S_1V_4N_2V_3) > \Delta(S_1L_2V_3–S_1V_4L_2V_3) >$

$\Delta(T_1R_2V_3–T_1V_4R_2V_3)$

This scale can be transformed as shown in (48)

(48) Similarity scale (47), transformed

a.	$\Delta(S_1T_2V_3–S_1V_4T_2V_3)$	>	$\Delta(S_1N_2V_3–S_1V_4N_2V_3)$	>	$\Delta(S_1L_2V_3–S_1V_4L_2V_3)$	>	$\Delta(T_1R_2V_3–T_1V_4R_2V_3)$
	=		=		=		=
b.	{ Δ(V-Ø)/S_T	>	Δ(V-Ø)/S_N }	>	Δ(V-Ø)/S_L	>	Δ(V-Ø)/T_R

That is, the difference between a vowel and nothing in the T_R context is smaller than the difference between a vowel and nothing in the S_L context, which is smaller than the difference between a vowel and nothing in the S_N context, which is smaller than the difference between a vowel and nothing in the S_T context. This transformed scale projects the fragment of a context-sensitive DEP-V hierarchy shown in (49):

(49) Projection of correspondence constraints (see Steriade 2001)

similarity scale	Δ(V-Ø)/S_T	>	Δ(V-Ø)/S_N	>	Δ(V-Ø)/S_L	>	Δ(V-Ø)/T_R
correspondence constraints	DEP-V/S_T	»	DEP-V/S_N	»	DEP-V/S_L	»	DEP-V/T_R

The effect of the context-sensitive DEP-V constraints and their fixed ranking is to penalize more severely epenthesis which results in greater perceptual dissimilarity between the cluster-initial source form and the adapted loanword: epenthesis inside a *sibilant* + *stop* cluster is more severely penalized than epenthesis inside an *sibilant* + *nasal* cluster, which is more severely penalized than epenthesis inside a *sibilant* + *liquid* cluster, which is more severely penalized than epenthesis inside a *stop* + *sonorant* cluster.

In addition to the context-sensitive DEP-V constraints shown in (49), Fleischhacker (2001) assumes the correspondence constraint DEP-V/#_, which penalizes word-initial vowel epenthesis, as well as CONTIGUITY and LEFT-ANCHOR. The analysis also assumes the markedness constraints ONSET; C/V, which demands that consonants be prevocalic; and C//V (Steriade 2001), which demands that consonant be adjacent to a vowel. C//V effectively bans initial and final consonant clusters, while C/V bans medial clusters as well.

A factorial typology was computed on these constraints, for the inputs and output pairs shown in (50) and (51):

(50) Inputs

a. /C_1C_2V/, where C_1C_2 = ST, SN, SL, TR

b. /STRV/

(51) Outputs (v = epenthetic vowel)

a. [C_1C_2V], [vC_1C_2V], [C_1vC_2V], [vC_1vC_2V]

b. [STRV], [vSTRV], [SvTRV], [STvRV], [vSvTRV], [vSTvRV],

[SvTvRV], [vSvTvRV]

The outcome of the factorial typology is summarized in the table below:

(52) Factorial typology: Fleischhacker (2001) – page references to Chapter 3

anaptyxis-prothesis	vST, SvN, SvL, TvR, vSTvR	Egyptian Arabic (p. 40)
	vST, SvN, SvL, TvR, vSTvR	Kazakh (p. 42)
	vST, vSN, vSL, TvR, vSTvR	Farsi (p. 43)
anaptyxis only	ST, SvN, SvL, TvR, STvR	Hawai'ian Creole (p. 57)
	ST, SN, SvL, TvR, STvR	~Fijian (p. 58)
	ST, SN, SL, TvR, STvR	~Fijian (p. 58)
symmetrical epenthesis	vST, vSN, vSL, vTR, SvTR	Iraqi Arabic (p. 55)
	vST, vSN, vSL, vTR, vSTR	?
	vST, vSN, vSL, vTR, vSTvR	?
	SvT, SvN, SvL, TvR, SvTvR	Korean (p. 54)
	SvT, SvN, SvL, TvR, SvTR	Punjabi (p. 54)
	STv, SNv, SLv, TRv, STRv	English

(See Fleischhacker (2001) for a detailed discussion of the contraint rankings that generate these patterns.) Overall, the computed factorial typology is a good fit for the epenthesis facts presented in Chapter 3. All observed varieties of anaptyxis-prothesis asymmetries are generated: the canonical pattern, as in Egyptian Arabic, in which only ST clusters are repaired with prothetic vowels, while all OR clusters are repaired via anaptyxis; and patterns like Kazakh and Farsi, in which some or all SR clusters also trigger prothesis. All of the symmetrical epenthesis patterns are generated: across-the-board prothesis, as in Iraqi Arabic; across the board anaptyxis, as in Korean and Punjabi (Punjabi allows medial clusters, while Korean does not); and no epenthesis with respect to initial clusters. Finally, all observed varieties of anaptyxis-only systems are generated: both those in which all and only OR clusters participate in epenthesis, as in Hawai'ian Creole, and those in which some or all SR clusters pattern with ST clusters, as in Fijian. However, one major class of epenthesis patterns is not generated: those in which only ST clusters are simplified through the insertion of prothetic vowels. These are the subject of the next section.

This typology does not, of course, account for any loanword adaptation pattern in which clusters are repaired through consonant deletion. I suggest that an analysis of these patterns would work along much the same lines as the analysis proposed above for reduplicative onset transfer, but the specifics must be left for future work.

3.1. *Cluster markedness and the context-sensitive correspondence constraints*

A prediction of the context-sensitive DEP-V and MAX-C constraint hierarchies adopted here is that, when given the opportunity – as in reduplication or loanword simplification – TR clusters should be the first clusters to simplify. Because DEP-V/T_R and MAX-R/T_V are the lowest-ranked of the context-sensitive DEP-V and MAX-C constraints, repairs to TR clusters are always less costly than repairs to SR, ST, and other clusters. Thus, we should see languages in which only TR clusters are simplified, and languages in which only TR and SR clusters are simplified; but we should not see languages in which, for example, only ST clusters are simplified. Consider the three languages shown below:

(53) [pira], but [sla], [sta]

			ONSET	L-ANCH	DEP-V S_T	DEP-V /S_R	C/V	C//V	DEP-V /T_R	CONTIG
/pra/		pra					*!	*!		
	☞	pira							*	*
		ipra	*!	*!			*			
/sla/	☞	sla					*	*		
		sila				*!				*
		isla	*!	*!			*			
/sta/	☞	sta								
		sita			*!					
		ista	*!	*!						

(54) [pira], [sila], but [sta]

			ONSET	L-ANCH	DEP-V S_T	C/V	C//V	DEP-V /S_R	DEP-V /T_R	CONTIG
/pra/		pra				*!	*!			
	☞	pira							*	*
		ipra	*!	*!		*				
/sla/		sla				*!	*!			
	☞	sila						*		*
		isla	*!	*!		*				
/sta/	☞	sta								
		sita			*!					
		ista	*!	*!						

(55) [pira], [sila], [sita]

			ONSET	L-ANCH	C/V	C//V	DEP-V S_T	DEP-V /S_R	DEP-V /T_R	CONTIG
/pra/		pra			*!	*!				
	☞	pira							*	*
		ipra	*!	*!	*					
/sla/		sla			*!	*!				
	☞	sila						*		*
		isla	*!	*!	*					
/sta/		sta			*!	*!				
	☞	sita					*			*
		ista	*!	*!						

When the anti-cluster constraints C/V and C//V dominate only DEP-V/T_R, only TR clusters are simplified with epenthetic vowels (53); when both DEP-V/T_R and DEP-V/S_R are dominated by C/V and C//V, both SR and TR clusters are simplified (54). If ST clusters are also simplified, then C/V and C//V must also dominate DEP-V/S_T – and by transitivity, DEP-V/S_R and DEP-V/T_R (55); thus, /sta/ surfaces as [sita] only if /sla/ surfaces as [sila], and /pra/ surfaces as [pila].

The prediction that TR clusters should be the first clusters to simplify, and that we should not see cases where only non-OR clusters are simplified, is entirely correct for onset transfer in reduplication. As shown in Chapter 2, OR onsets are more free to simplify than other onset clusters in reduplicative onset transfer. The typology of onset transfer breaks down into two primary cases: either all complex onsets are simplified, via a cluster-blind simplification strategy (leftmost copy, rightmost copy, or sonority-based copy); or only OR onsets are simplified, while other clusters either aren't simplified (as in sufficient copy), or aren't copied at all (as in selective copy). Further, TR clusters are more free to simplify than SR clusters: for example, in Klamath reduplication, only TR clusters are simplified, while SR clusters are copied in full; whereas in Gothic, both SR and TR are simplified.

But this prediction is wrong for cluster resolution in loanword adaptation. As shown in Chapter 3, there are certainly loanword adaptation patterns in which only OR clusters are simplified; in the languages known to me, these repairs always take the shape of anaptyxis (presumably this at least in part because deletion is a relatively uncommon strategy in loanword adaptation). For example, in Hawai'ian Creole, all OR clusters are simplified through insertion of anaptyctic vowels, while ST clusters are not simplified (e.g. [pu̲ránti:] 'plenty', [sku:ru:] 'school'); in Fijian, TR clusters are simplified, while ST and SR clusters surface without epenthetic vowels, albeit with phonetically long [s]'s (e.g., [peleni] 'plan', [s:nuka] 'snooker').

However, there are also loanword adaptation patterns in which only ST, or only ST and SR, are repaired. Here the attested repairs strategies are more varied: prothesis, as in Haitian Creole (e.g., [prizɔ̃] 'prison', [e̲stati] 'statue'); anaptyxis, as in Kamtok (e.g., [blɛn] 'blind', [si̲tón] 'stone'); and *s*-deletion, as in Sranan (e.g., [trobi] 'trouble', [tori] 'story').

I believe that this stems from a crucial difference between loanword adaptation and reduplication. Clusters that are simplified under reduplication are obviously not illegal in the language in general; rather, simplification in reduplication is a TETU effect (McCarthy and Prince 1995), emerging when markedness constraints disfavoring clusters are ranked below the input-output correspondence constraints preserving consonants, but above the relevant constraints on base-reduplicant correspondence. Reduplicative cluster simplification does not appear to be done in response to the markedness of specific clusters. For example, *stop* + *stop* clusters are more marked than *stop* + *liquid* clusters (Morelli 1999), but if reduplicative cluster simplification specifically targetted bad clusters, we should see languages in which *stop* + *stop* clusters simplify, while *stop* + *liquid* clusters do not. We do not; in Klamath, for example, *stop* + *stop* clusters are reduplicated in full, while only the *stop* + *sonorant* clusters are simplified. The implication is that, in reduplication, cluster simplification reflects only a general preference for cluster reduction – those clusters which can be simplified and still sound much like their unmodified forms (i.e., the OR clusters) will be simplified, while others will not.

In contrast, cluster simplification in loanword adaptation is driven by phonotactics that are always surface-true: the clusters of the source language are unpronounceable in the target language, and must be repaired in some fashion. An attempt to model the full range of cluster resolution in loanword adaptation leads to the following conclusion: ST clusters are more marked than OR clusters, but because they are also less repairable than OR clusters, in the sense that no method of simplifying the cluster produces an adapted form that is particularly similar to the source form, we will see more marked clusters displaying a stability that less marked clusters do not.

On first examination, the loanword adaptation data do not argue for any difference in the markedness of ST and OR clusters. The presence of ST clusters does not imply the presence of OR clusters, and vice versa – there are languages (e.g., Hawai'ian Creole) in which only OR clusters are repaired, while ST clusters surface as such; and there are languages (e.g., Haitian Creole) in which only ST clusters are repaired, while OR clusters surface as such. The presence of SR implies either ST or TR: there are no languages in which only SR clusters are repaired, but there are languages which allow only SR and TR, but not ST (e.g., Hawai'ian Creole), and there are languages which allow only TR, but not SR or ST (e.g., Spanish).

Support for the claim that there is no implicational relationship between ST and OR also comes from native cluster inventories. For example, Haida (Sapir 1923) has only */s/* + *stop* and */ɬ/* + *stop* clusters, even though, given the Haida segment inventory, *obstruent* + *sonorant* clusters like *stop* + *liquid*, */s/* + *nasal*, etc. are possible in principle. The only initial clusters of Misantla Totonac (MacKay 1994) are *sibilant fricative* + *consonant* (i.e., */s, ʃ/* + *stop* and */s, ʃ/* + *sonorant*) and */ɬ/* + *consonant*—again, even though *stop* + *sonorant* clusters are possible in principle. Similarly, the initial clusters of Havasupai (Kozlowski 1976) are */s, θ, h/* + *consonant*, to the exclusion of potential *stop* + *glide*, *stop* + *liquid*, and *stop* + *nasal* clusters.

But even though there is no implicational relationship between ST and OR, an attempt to model the full facts of vowel insertion in loanword adaptation suggests that ST clusters must be more marked than OR clusters. The reasoning is as follows. Recall that the factorial typology of cluster-resolving vowel epenthesis presented Fleischhacker (2001) and summarized above predicts those patterns in which only OR clusters are repaired through the insertion of anaptyctic vowels, while ST clusters surface as such. It does not predict those patterns in which only ST clusters are repaired – either by prothesis or anaptyxis. This is a consequence of the structure of the context-sensitive DEP-V system; because DEP-V/T_R is the lowest ranked of the context-sensitive DEP-V constraints, we will see repairs of ST only when OR clusters are also repaired.

As a first attempt to fill this predictive gap, suppose that there are cluster-specific markedness constraints *TR and *ST, which ban onset TR and ST clusters, respectively (here and below, I ignore the issue of SR clusters for the sake of simplicity.) There is no inherent ranking between *TR and *ST, since there is no implicational relationship between TR and ST. Assume other markedness constraints ONSET, C/V, and C//V, and the correspondence constraints CONTIGUITY, LEFT-ANCHOR, and DEP-V/S_T » DEP-V/T_R. For the inputs /pra/, /sta/, and outputs [C_1C_2a], [iC_1C_2a], [C_1iC_2a], and [iC_1vC_2a], the factorial typology generated is as shown in the table below:

(56) Factorial typology: *TR, *ST

	sta	ista	sita
pra	no simplification	Haitian Creole	Kamtok
ipra	!	Iraqi Arabic	--
pira	Hawai'ian Creole	Egyptian Arabic	Korean

The problematic outcome is the language in which TR clusters are repaired with prothetic vowels (/pra/ → [ipra]), while ST clusters aren't simplified (/sta/ → [sta]). The data presented in Chapter 3 indicate that prothesis only applies to TR clusters if it also applies to ST clusters as well, as in Iraqi Arabic. The tableau below shows how this incorrect pattern is derived:

(57) [i̲pra], but [sta]

			*TR	DEP-V S_T	DEP-V /T_R	CONTIG	ONS	L-ANCH	C/V	C//V	*ST
/pra/		pra	*!						*	*	
		pira			*!	*!					
	☞	ipra					*	*	*		
/sta/	☞	sta							*	*	
		sita		*!		*!					
		ista					*	*!			

The culprit responsible for this result is *TR. When both *TR and DEP-V/T_R are highly ranked, TR clusters must be repaired, but anaptyxis is not a viable repair strategy – and thus, the result is prothesis for TR clusters. In the same system, *ST can be ranked low enough to require no repair, and thus ST clusters surface as clusters.

When *TR is removed from the constraint set, this incorrect prediction – and only this incorrect prediction – disappears. What remains is the correct factorial typology shown below, which correctly accounts for the facts presented in Chapter 3.

(58) Factorial typology: *ST only

	sta	i̲sta	si̲ta
pra	no simplification	Haitian Creole	Kamtok
i̲pra	--	Iraqi Arabic	--
pi̲ra	Hawai'ian Creole	Egyptian Arabic	Korean

The implication, then, if only ST is targetted by a cluster-specific markedness constraint, is that ST is in fact more marked than TR. But because there is no particularly low-cost strategy for repairing ST clusters – i.e., because the result of neither anaptyxis nor prothesis sounds particularly like the unmodified form – ST clusters may be tolerated even when the less marked TR clusters are repaired, because in the case of TR clusters, the anaptyctic solution is one that still results in an adapted form that sounds much like the unmodified source form.

3.2. *An argument for* CONTIGUITY

Recall that the data discussed in Chapters 2 and 3 are cases of restricted skipping and intrusion, schematized in (59) and (60):

(59) Restricted skipping: * $C_1C_2V_3 \rightarrow C_1V_3$, except $O_1R_2V_3 \rightarrow O_1V_3$

(60) Restricted intrusion: * $C_1C_2V_3 \rightarrow C_1V_4C_2V_3$, except $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$

Restricted skipping is seen in reduplicative onset transfer (Chapter 2): in Klamath and Gothic, *obstruent* + *sonorant* clusters simplify via the skipping map, while other clusters are not compelled to simplify; in Ancient Greek, clusters other than OR are not reduplicated at all, while OR clusters reduplicate via the skipping map. Restricted intrusion is seen in cluster simplification in loanword adaptation (Chapter 3): for example, in anaptyxis-prothesis asymmetries, vowels are inserted inside OR clusters, but before *sibilant* + *stop* clusters.

Taken at face value, these cases seem to form the basis of an argument for eliminating CONTIGUITY as stated in (61) from the set of correspondence constraints assumed to be active in shaping phonological behavior.

(61) CONTIGUITY (McCarthy and Prince 1995)

a. I-CONTIG ("No Skipping"): The portion of S_1 standing in correspondence forms a contiguous string. Domain of correspondence relation is a single contiguous string in S_1.

b. O-Contig ("No Intrusion"): The portion of S2 standing in correspondence forms a contiguous string. Range of correspondence relation is a single contiguous string in S_2.

CONTIGUITY penalizes equally all skipping and intrusion maps: I-CONTIG is violated by any $xyz \rightarrow xz$ mapping, in which y is present in the input (base, source form, etc.) but not in the output (reduplicant, loanword, etc.); O-CONTIG is violated by any $xy \rightarrow xay$ mapping, in which a is present in the output but not in the input. However, the evidence from Chapters 2 and 3 suggests that some instantiations of skipping and splitting—namely, $O_1R_2V_3 \rightarrow O_1V_3$ and $O_1R_2V_3 \rightarrow O_1V_4R_2V_3$—are routinely tolerated in a variety of languages and linguistic phenomena, while others are not.

The obvious question, then, is whether CONTIGUITY as stated in (61) should be removed from the inventory of universal constraints. I think the answer is no, for one reason: the pattern of cluster resolution seen in Iraqi Arabic loanword adaptation seems to require CONTIGUITY in order to be explained.

Recall from Chapter 3 the facts of vowel epenthesis in Iraqi Arabic:

(62) Iraqi Arabic (Broselow 1983, 1992b)

a. CC-initial native forms: [qmaaʃ] ~ [iqmaaʃ] 'cloth'

b. CC-initial loanwords: [istadi] 'study', [isnoo] 'snow, [ibleen] 'plane'

c. STR-initial loanwords: [sitrit] 'street', [siblaʃ] 'splash'

Initial biconsonantal clusters in native forms are optionally repaired with a prothetic vowel (a), and prothesis is mandatory for borrowed words with initial CC clusters (b); but in loanwords with an initial triconsonantal cluster—always */s/* + *stop* + *liquid* in the data reported by Broselow (1983; 1992b)— the vowel is inserted between /s/ and the following stop (c). These facts taken together make Iraqi Arabic an example of why an independent CONTIGUITY constraint is needed, and the reasoning is as follows.

Recall from above the hierarchy of context-sensitive DEP-V constraints, repeated in (63), which penalize vowel insertion in specific segmental contexts:

(63) DEP-V/S_T » DEP-V/S_N » DEP-V/S_L » DEP-V/T_R

Ranked appropriately, this hierarchy alone—without any contribution from CONTIGUITY—can account for true across-the-board prothesis, i.e. cases in which a prothetic vowel is inserted before both biconsonantal and triconsonantal clusters (specifically, given the nature of the hierarchy, ST, SN, SL, TR, and STR):[55]

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[55] I don't know if the language shown in (64), or the similar one in (65), actually exists. Certainly there are other languages which, like Iraqi Arabic, show evidence of prothesis before initial biconsonantal clusters: On the basis of comparative reconstruction, Holmer (1947) argues that Ofo (now extinct) had, at one stage in its history, prothetic vowels ([a] before labials, [i] elsewhere) before initial biconsonantal clusters. Digueño (Langdon 1970; Lamontagne 1996) has lexical regularities suggestive of prothesis, at least historically: initial clusters are not allowed, and many lexical items begin ʔəCC-, with the [ə] subject to deletion in connected speech; but Langdon (1970) reports that English and Spanish loanwords are produced without modification of initial clusters. Central Siberian Yupik (Krauss 1975; Lamontagne 1996)

(64) True prothesis (word-medial STR clusters okay)

	/CCV/			/STRV/				
	☞ iCCV	CiCV	CCV	SiTRV	iSTiRV	☞ iSTRV	STiRV	STRV
DEP-V/S_T		(*!)		*!				
DEP-V/T_R		(*!)			*!		*!	
CONTIGUITY		*!		*!	*!		*!	
C/V	*		*	*	*	**	*	**
C//V			*!			*	*	**!
ONSET	*				*	*		
L-ANCHOR	*				*	*		
DEP-V/#_	*				*	*		

(In this tableau and the ones that follow, I show only the endpoints of the context-sensitive DEP-V hierarchy; parenthesized violations indicate that either DEP-V/S_T or DEP-V/T_R will be violated by the candidate, depending on the input cluster.) Ranked above the phonotactics C/V and C//V, which demand cluster simplification by calling for consonants to be prevocalic and vowel-adjacent, respectively, the context-sensitive DEP-V hierarchy protects all initial clusters from being split by an inserted vowel; instead, a prothetic vowel is inserted to best-satisfy C//V. As indicated by the shading, CONTIGUITY—although never violated by a winning candidate, and thus in the top stratum of constraints—is not necessary to predict across-the-board prothesis.

CONTIGUITY is also unnecessary to predict a variation on the outcome in (65), one in which STR-initial forms surface with a vowel before S and another between T and R:

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is like Digueño in having lexical regularities suggestive of prothesis, and also employs prothesis in fixing initial biconsonantal clusters in loanwords (e.g. [avlawa] 'flour' (Jacobson 1977)), but I can find no mention of the treatment of STR-initial loans.

(65) Prothesis plus anaptyxis (word-medial STR clusters fixed)

	/CCV/			/STRV/				
	☞ iCCV	CiCV	CCV	SiTRV	☞ iSTiRV	iSTRV	STiRV	STRV
DEP-V/S_T		(*!)		*!				
C//V			*!			*!	*!	*!*
CONTIGUITY		*!		*	*		*	
DEP-V/T_R		(*!)			*		*	
ONSET	*				*	*		
C/V	*		*	*	*	**	*	**
L-ANCHOR	*				*	*		
DEP-V/#_	*				*	*		

The crucial difference between the tableaux in (64) and (65) is the relative ranking of DEP-V/T_R and C//V: with DEP-V/T_R » C//V, as in (64), medial STR clusters surface as such; but with the reverse ranking, as in (65), C//V can be surface-true by taking advantage of the epenthesis-friendly T_R environment.

Like the language in (64), Iraqi Arabic allows maximally two consonants intervocalically. However, rather than fixing initial STR with two epenthetic vowels (*[iSTiRV]), Iraqi Arabic inserts only one, between the /s/ and the stop. This behavior, in concert with the fact that prothesis applies before all initial biconsonantal clusters, is what requires the action of an independent CONTIGUITY constraint:

(66) Iraqi Arabic: prothesis before CCV, anaptyxis into STR

	/CCV/			/STRV/				
	☞ iCCV	CiCV	CCV	☞ SiTRV	iSTiRV	iSTRV	STiRV	STRV
C//V			*!			*!	*!	*!*
CONTIGUITY		*!		*	*		*	
ONSET	*				*!	*		
C/V	*		*	*	*	**	*	**
L-ANCHOR	*				*!	*		
DEP-V/#_	*				*!	*		
DEP-V/S_T		(*)		*				
DEP-V/T_R		(*)			*		*	

DEP-V/S_T, and by transitivity, the rest of the context-sensitive DEP-V hierarchy, are clearly dominated by (among other constraints) C//V, ONSET and L-ANCHOR, since epenthesis into the S_T context is tolerated in the case of initial STR. ONSET and L-ANCHOR favor anaptyxis over prothesis in the case of initial biconsonantal clusters as well—and without the DEP-V hierarchy in a position to protect these clusters, some other constraint must. That constraint is, I think, unavoidably CONTIGUITY: [iCCV…] has little else going for it other than that it keeps input segments contiguous at output.

Note that all of the other languages in Fleischhacker's (2001) typology of epenthesis sites are predicted if CONTIGUITY is removed from the constraint set (verified with factorial typology calculating software (Hayes 1999)).

A second case which may argue for CONTIGUITY as stated in (61) is Finnish cluster simplification in loanword adaptation (Young-Scholten and Archibald 2000). Recall from Chapter 3 that Finnish has no native cluster-initial words, and fixes loanwords with initial clusters by deleting all but the final consonant in the cluster:

(67) Finnish loanword adaptation (Young-Scholten and Archibald 2000)

a. CC-initial: Swedish *stol* 'chair' → *tuoli*, Sw. *klister* 'paste' → *liisteri*

b. STR-initial: Sw. *strand* 'waterfront' → *ranta*

Note that this pattern of cluster simplification is precisely what top-ranked CONTIGUITY would favor: given that initial consonant clusters are impossible, deleting consonants at the word edge means that the segments of the adapted loanword form a contiguous substring of the source word. However, it is also the pattern that would be predicted by a top-ranked constraint MAX-C/_V, which protects prevocalic consonants (i.e., those with the best cue support) from deletion; the effect of such a constraint, in the realm of cluster-simplifying deletion, is the same as CONTIGUITY.

The final conclusion, then: Context-sensitive DEP-V and MAX-C constraints, which reference insertion and deletion sites and thus do some of the work of CONTIGUITY, are necessary to explain restricted skipping and splitting; but monolithic CONTIGUITY is an essential component in the analysis of Iraqi Arabic. The former cannot replace the latter.

CHAPTER 6

Conclusions

This dissertation has examined the role of perceptual similarity in shaping patterns of onset cluster simplification, and proposed an extension of the correspondence constraints of Optimality Theory to account for these patterns.

I looked at restricted skipping and restricted intrusion in the domains of reduplicative onset transfer and loanword adaptation, and showed that *obstruent* + *sonorant* clusters are more vulnerable than other clusters to cluster-internal deletion and insertion. I argued that these facts reflect demands of perceptual similarity, such that skipping and splitting are possible to the extent that the modified form sounds enough like its unmodified counterpart.

The claims about perceptual similarity were supported with evidence from linguistic phenomena and experimental work. The linguistic evidence included analysis of the alliteration facts of Germanic, Middle English, and Old Irish, as well as analysis of a large corpus of English imperfect puns. The experimental work included speed-of-discrimination tasks and direct similarity judgments. This evidence all converged on a picture that mirrors the restricted skipping and restricted intrusion facts: *obstruent* + *sonorant* clusters sound more like their skipped and intruded counterparts than other cluster types do.

I proposed that the perceptual similarity facts should be included in the grammar in the form of context-sensitive correspondence constraints which penalize skipping and intrusion less severely in the context of *obstruent* + *sonorant* clusters than for other clusters. An Optimality Theoretic analysis of the facts of reduplicative onset transfer and vowel insertion in loanword adaptation showed that this mechanism is able to account for the linguistic data.

Looking more broadly, the project here provides another example in which incorporating considerations of perceptual similarity into the explanation and analysis of particular phonological phenomena has a positive result—better coverage of the linguistic data, and a more global and unified understanding of what might otherwise appear to be separate and unrelated processes.

Of course, this work leaves many questions unanswered and unexplored. There may be other cases of restricted intrusion and restricted skipping, examination of which could illuminate the questions explored here: for example, Hebrew denominal verb formation (Bat-El 1994; Ussishkin 1998) and Tagalog infixation (Zuraw 2003) may be possible areas in which to further explore restricted intrusion. More broadly, there is certainly more work to be done in establishing exactly what the facts of perceptual similarity are, and why they are what they are: that is, what perceptual, acoustic, or other factors shape judgments of relative similarity, and how the judgments are computed.

APPENDIX

Listed below are the nine patterns which complete the factorial typology of reduplicative onset transfer presented in Chapter 5. These are the patterns which are generated only when BESTONSET is included in the constraint set—note that in each case, BESTONSET is undominated. The BESTONSET languages find no correspondents in the typology of reduplicative onset transfer presented in Chapter 2. Again, as noted in Chapter 5, as a mechanism to account for sonority-based cluster simplification, BESTONSET reduces but clearly does not eliminate the typological overgenerations attributable to margin hierarchies; a resolution to this problem is left for future work.

(1) [pra-pra], [sla-sla], [ta-sta], [ksa-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, X:RED[, ONSET, CONTIGUITY

»

C/V, X:e[

»

MAX-C, L-ANCHOR, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

(2) [pa-pra], [sa-sla], [sta-sta], [ka-ksa], [ka-kta], [ma-mna]

BESTONSET, MAX-C/#_C, X:RED[, L-ANCHOR, ONSET

»

C/V, X:e[

»

MAX-C, MAX-C/C_V, MAX-R/S_V, MAX-R/T_V, CONTIGUITY

(3) [pa-pra], [sa-sla], [ta-sta], [ksa-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, X:RED[, ONSET

»

C/V, X:e[

»

MAX-C, L-ANCHOR, CONTIGUITY, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

(4) [pa-pra], [sa-sla], [ta-sta], [a-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, X:RED[, C/V

»

MAX-C, L-ANCHOR, X:e[, ONSET

»

CONTIGUITY, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

(5) [pa-pra], [sa-sla], [ta-sta], [e-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, C/V

»

ONSET

»

MAX-C, L-ANCHOR, CONTIGUITY, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

»

X:RED[, X:e[

(6) [pa-pra], [sa-sla], [a-sta], [ka-ksa], [ka-kta], [ma-mna]

BESTONSET, MAX-C/#_C, X:RED[, C/V

»

MAX-C, L-ANCHOR, X:e[, ONSET

»

CONTIGUITY, MAX-C/C_V, MAX-R/S_V, MAX-R/T_V

(7) [pa-pra], [sa-sla], [e-sta], [ka-ksa], [ka-kta], [ma-mna]

BESTONSET, MAX-C/#_C, C/V, L-ANCHOR

»

X:red[, ONSET

»

MAX-C, X:e[, CONTIGUITY, MAX-C/C_V, MAX-R/S_V, MAX-R/T_V

(8) [a-pra], [a-sla], [ta-sta], [a-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, X:RED[, C/V, CONTIGUITY

»

L-ANCHOR, X:e[, ONSET, MAX-C

»

MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

(9) [e-pra], [e-sla], [ta-sta], [e-ksa], [ta-kta], [na-mna]

BESTONSET, MAX-C/C_V, C/V, CONTIGUITY

»

ONSET

»

MAX-C, L-ANCHOR, MAX-C/#_C, MAX-R/S_V, MAX-R/T_V

»

X:red[, X:e[

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