Partial Identity Avoidance as Cooperative Interaction

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1. Introduction

Consider the English past tense morpheme, with alternants [t], [d], and [əd]. The syllabic alternant [əd] is suffixed to verb stems ending in /t/ or /d/, consonants that are identical to the consonant of the past tense morpheme except that any difference in the value of a specific feature, voicing, is ignored. Borowsky (1986, 1987) identifies this example as a case of *antigemination*, McCarthy's (1986) term for a class of cases in which a regular vowel syncope process is blocked just in case the result would be a sequence of adjacent identical consonants — or, as in English, adjacent consonants that are identical enough.

Whether two adjacent consonants are identical enough must be determined by comparing certain features and ignoring certain others, a distinction that must apparently be stipulated for each feature. What it means for two adjacent consonants to be "basically the same type" (Langacker 1968:169-170) was thus correctly judged to be "an embarrassment to current theory" by Harms (1978:50). The representational advances of subsequent research in phonological theory did little to lessen this embarrassment; to date, there is still no principled explanation for the fact that voicing and only voicing can be ignored in the determination of adjacent consonant identity in English, leading to the selection of the syllabic alternant [əd] of the past tense morpheme after verb stems ending in the sufficiently identical consonants /t/ and /d/. But note that voicing is exactly the feature that governs the assimilatory distribution of the nonsyllabic alternants of the same morpheme: [t] is suffixed to verb stems ending in voiceless consonants *except /t/*, whereas [d] is suffixed to verb stems ending in voiced consonants *except /d/*. If not for the syllabic alternant, then, the result of suffixing one of these nonsyllabic alternants to a stem ending in /t/ or /d/ would be a sequence of *completely identical* adjacent consonants [tt] or [dd] due to the independently expected application of voicing assimilation word-finally in English. The distribution of [əd] should thus follow from some sort of *cooperation* between the avoidance of sequences that disagree in voicing word-finally and the avoidance of completely (i.e., not simply 'sufficiently') identical adjacent consonants.

I propose in this paper that the avoidance of sufficiently identical adjacent consonants is always the result of cooperative interactions of the kind just suggested, and that constraint interaction as defined in Optimality Theory (Prince & Smolensky 1993/2004, henceforth OT) is the necessary tool for expressing cooperative interaction. At the heart of the proposal is Rose's (2000) NO-GEM constraint, which strictly penalizes geminates. There is no need for a weaker version

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of this constraint to penalize adjacent consonants that share all but a specific, stipulated subset of features; this work is taken up by other active constraints in the grammar that independently penalize the relevant similar-but-not-identical alternatives. In the case of English, for example, the markedness constraint responsible for word-final voicing assimilation independently rules out the crucial [td] sequence. These constraints cooperate to enforce the avoidance of sufficiently identical adjacent consonants; violations of them are collectively circumvented by violating some crucially lower-ranked constraint(s).

The crux of this proposal is the necessary dependence of the analysis on independent aspects of the grammar of the language in question. In situations where NO-GEM is not at stake, the prediction is that candidates that violate the cooperating constraint(s) are necessarily suboptimal. By crucially invoking other active constraints in the grammar in this way, a cooperative interaction analysis makes predictions and captures generalizations that an alternative analysis with an *ad hoc* constraint against sufficiently identical adjacent consonants in principle cannot. The proposal is thus further corroborated by the extent to which cooperating constraint(s) are active in the grammar of the language in question.

There is also a simple Occam's Razor argument against accounting for sufficient identity avoidance directly with constraints penalizing adjacent consonants that are identical enough. NO-GEM is independently motivated to account not only for the observed crosslinguistic markedness of geminate consonants, but also for more strict examples of antigemination involving the avoidance of completely identical adjacent consonants alone. Additional constraints specifically penalizing sufficiently identical adjacent consonants are rendered unnecessary to the extent that the cooperative interaction between NO-GEM and other active constraints is itself sufficient to account for sufficient identity avoidance.

2. English

The past tense and plural suffixes in English are standard introductory textbook examples of morphophonemic alternation (Hockett 1958, Langacker 1968, Fromkin 2000, among others). The research literature is also riddled with references to these alternations, with particular attention paid to them in such works as Bloch (1947), Luelsdorff (1969), Hoard & Sloat (1971), Basbøll (1972), Anderson (1973), Harms (1978), Kiparsky (1985), Borowsky (1986, 1987), Pinker & Prince (1988), and Benus et al. (2004).

The avoidance of sufficiently identical adjacent consonants apparent in these alternations is a model case for the present proposal: NO-GEM crucially interacts with other constraints independently motivated by the very same set of alternations. The resulting analysis illustrates in particularly clear terms the most important result of the proposal: in order to accomplish the work of a putative constraint that simply stipulates what it means for adjacent consonants to be sufficiently identical, NO-GEM must interact cooperatively with other constraints the activity of which is independently demonstrable.

2.1. Past tense suffix alternations

The past tense form of a verb in English is regularly formed by suffixation of one of three phonologically-conditioned alternants: a voiceless alternant [t], suffixed to stems ending in [–voi] obstruents other than /t/; a voiced alternant [d], suffixed to stems ending in [+voi] segments other than /d/, and a syllabic-and-voiced alternant [əd], suffixed to stems ending in /t/ or /d/.[1]

Straightforward and uncontroversial arguments demonstrating that the underlying representation of the past tense suffix must be /d/ as opposed to /t/ or /əd/ are presented in Fromkin (2000:609ff), Pinker & Prince (1988:101ff), and Benus et al. (2004). I accept these arguments and proceed under this assumption, but the basic point of the analysis is not substantively affected by this choice.

The voiceless alternant [t] is found after voiceless consonants, but the assimilation responsible for this fact does not apply following /t/. It would be possible to exclude /t/ from the set of voiceless consonants relevant to assimilation, but this would fail to explain why exactly this consonant is excluded — the one consonant that differs from the past tense morpheme only in terms of the feature [±voi]. Similarly, it would be possible to exclude [±voi] from the set of features relevant to the epenthesis process responsible for the distribution of the syllabic alternant [əd]; again, this would fail to explain why exactly this feature is excluded — the one feature that, if allowed to assimilate as otherwise expected in /t+d/, would yield a sequence of completely identical adjacent consonants.

Another way to look at the situation is as follows. Voicing assimilation unexpectedly fails to apply in the context /t+d/, and epenthesis unexpectedly goes out of its way to apply in exactly this context. Precisely where one process loses ground, the other process gains it; these processes are clearly interacting with each other in some crucial way. Previous accounts appeal to extrinsic rule ordering: epenthesis precedes and bleeds voicing assimilation, accounting for the exceptionality of /t/ to the latter.[2] The problem, of course, is that this approach still fails to explain the exceptionality of [±voi] to epenthesis.

Output candidate comparison and constraint interaction as defined in OT are perfectly suited to this kind of problem. Epenthesis applies to /t+d/ because the alternatives to the optimal epenthetic candidate [təd] — voice-assimilated *[tt] and faithful *[td] — are independently penalized by active constraints in the grammar. One of these constraints is NO-GEM, ruling out the assimilated candidate *[tt]. The other is the independently active markedness constraint responsible for voicing assimilation — here called SEQ(voi) — ruling out the faithful candidate *[td]. These two constraints thus cooperate to ensure the optimality of epenthetic [təd], which violates the lower-ranked faithfulness constraint DEP-V.

SEQ(voi) penalizes tautosyllabic obstruents that disagree in [±voi]. Note that both the 'tautosyllabic obstruents restriction is necessary in the structural description of this constraint; sequences of obstruents that disagree in [±voi] across syllables are common in English (*subcase* [bk], *backbone* [kb], *baseball* [sb]), as are tautosyllabic sequences of [+voi] sonorants and [–voi] obstruents (*apron* [pr], *apply* [pl], *snow* [sn], *part* [rt], *pint* [nt], *fault* [lt]).[3] In order to enforce voicing assimilation, SEQ(voi) must dominate the faithfulness constraint

IDENT(voi) penalizing changes in [±voi] from input to output. But SEQ(voi) can in principle be satisfied by changes other than assimilation; for instance, it can be satisfied by epenthesis. DEP-V must thus also dominate IDENT(voi).

The following tableaux demonstrate how the ranking just established works with relevant examples. (The comparative tableau format (Prince 2002) is used to clarify necessary rankings.) The first tableau below shows how the ranking works with a stem ending in a [–voi] consonant other than /t/. The optimal assimilated candidate is compared with the suboptimal faithful candidate in (i). The assimilated candidate is preferred by SEQ(voi), while the faithful candidate is preferred by lower-ranked IDENT(voi). This justifies the ranking SEQ(voi) ≫ IDENT(voi). In (ii), the optimal assimilated candidate is compared with the epenthetic candidate, which manages to satisfy SEQ(voi) as well as the optimal assimilated candidate does while performing better on IDENT(voi). The fact that the assimilated candidate is optimal justifies the ranking DEP-V ≫ IDENT(voi).

(1) English past tense after e.g. voiceless bilabial stop: *tapped* [pt]

/p+d/ → [pt]	NO-GEM	SEQ(voi)	DEP-V	IDENT(voi)
i. [pt] ~ [pd]		W		L
ii. [pt] ~ [pəd]			W	L

Note that no ranking of the constraints is necessary with a stem ending in a [+voi] segment other than /d/, as shown in the next tableau. Both relevant alternatives to the optimal faithful candidate — the suboptimal epenthetic candidate in (i) and the suboptimal devoiced candidate in (ii) — fare worse on one or more of the constraints. The optimal faithful candidate satisfies them all.

(2) English past tense after e.g. voiced bilabial stop: *tabbed* [bd]

/b+d/ → [bd]	NO-GEM	SEQ(voi)	DEP-V	IDENT(voi)
i. [bd] ~ [bəd]			W	
ii. [bd] ~ [bt]		W		W

The next tableau demonstrates how the ranking works with a stem ending in /d/. Comparing the optimal epenthetic candidate with the faithful candidate in (i), the epenthetic candidate is preferred by undominated NO-GEM, while the faithful candidate is preferred by lower-ranked DEP-V. This justifies NO-GEM ≫ DEP-V. In (ii), the optimal candidate is compared with a supoptimal devoiced candidate which manages to satisfy NO-GEM as well as the optimal candidate does while performing better on DEP-V. The fact that the epenthetic candidate is optimal justifies the ranking SEQ(voi) ≫ DEP-V. (It can't be IDENT(voi) ≫ DEP-V, because the opposite ranking was already established in (1).)

(3) English past tense after voiced coronal stop: *ceded* [dəd]

/d+d/ → [dəd]	NO-GEM	SEQ(voi)	DEP-V	IDENT(voi)
i. [dəd] ~ [dd]	W		L	
ii. [dəd] ~ [dt]		W	L	W

This final ranking of SEQ(voi) above DEP-V is also necessary to account for the fate of the input /t+d/. The optimal epenthetic candidate [təd] fares worse than its competitors on DEP-V, but the faithful candidate *[td] and the assimilated candidate *[tt] violate higher-ranked SEQ(voi) and NO-GEM, respectively.

(4) Epenthesis, not voicing assimilation: *seated* [təd]

/t+d/ → [təd]	NO-GEM	SEQ(voi)	DEP-V	IDENT(voi)
i. [təd] ~ [td]		W	L	
ii. [təd] ~ [tt]	W		L	W

The key here is the way in which the dominant markedness constraints NO-GEM and SEQ(voi) work together — how they interact cooperatively — to enforce epenthesis. The ranking of SEQ(voi) and DEP-V above IDENT(voi) prefers devoicing after stems ending in voiceless segments, but in the case of /t+d/ the result of devoicing would be *[tt], which is blocked by NO-GEM. The ranking of NO-GEM and DEP-V above IDENT(voi) also establishes a preference for devoicing in the case of /d+d/; however, the result in this case would be *[dt], which is blocked by SEQ(voi). Epenthesis is the next best option in both cases, violating the higher-ranked of the two faithfulness constraints DEP-V but satisfying both of the even higher-ranked markedness constraints NO-GEM and SEQ(voi).

2.2. Plural suffix alternations

The plural suffix in English exhibits a pattern of alternations that is very similar to that of the past tense suffix.[4] The similarities between the alternants of this suffix and those of the past tense are fairly obvious: there is a voiceless alternant [s], suffixed after stems ending in [–voi] obstruents other than /s, ʃ, t͡ʃ/; a voiced alternant [z], suffixed after stems ending in [+voi] segments other than /z, ʒ, d͡ʒ/; and a syllabic-and-voiced alternant [əz], suffixed after stems ending in /s, ʃ, t͡ʃ, z, ʒ, d͡ʒ/.[5] For the sake of concreteness — and as with the past tense suffix, not crucially or controversially — I assume that the alternants of this morpheme arise from the underlying representation /z/.

The key difference between the plural and past tense suffixes lies in the distribution of their syllabic alternants. If the syllabic alternant of the plural suffix only followed consonants that differ at most in [±voi] from the consonant of the suffix, it would only be suffixed to stems ending in /s/ and /z/. However, we find the syllabic alternant of this suffix also following /ʃ/, /ʒ/, /t͡ʃ/, and /d͡ʒ/ — that is, following all of the sibilants of English. It seems that at least one other feature must be ignored in the determination of adjacent consonant identity.

Traditionally, the feature [±anterior] distinguishes [+ant] /s, z/ from [–ant] /ʃ, ʒ, t͡ʃ, d͡ʒ/, following the typical phonetic classification of the former as alveolar and the latter as postalveolar. As noted in Gafos (1997) and references therein, however, the exact point of the articulator to make contact (tongue tip or blade) and the exact point of contact of the articulator on the palate (dental, alveolar, or postalveolar) varies more widely from speaker to speaker than is suggested by these classifications. Gafos shows that the phonetic distinction holding constant

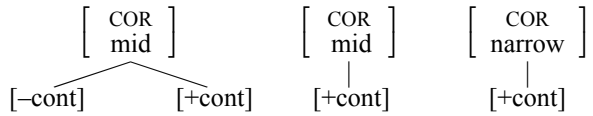
across this variation is a measurable relative difference in "the cross-sectional area of the channel between the tongue and the palate" (Gafos 1997:130).

Based on this and other evidence, Gafos proposes "a distinctive feature, called Cross-Sectional Channel (CSC), defined on the phonetic scale of the area of the fricative channel which is created by the approximation of the tip-blade to the palate" (Gafos 1997:128). The CSC value for /s, z/ is [narrow] and the CSC value for /ʃ, ʒ, t͡ʃ, d͡ʒ/ is [mid].[6] Different speakers are free to implement this contrast in different ways, as is observed; some speakers (such as myself) may have a lamino-dental articulation for /s, z/ and an alveolar articulation for /ʃ, ʒ, t͡ʃ, d͡ʒ/, while other speakers may have an apico-alveolar articulation for /s, z/ and a postalveolar articulation for /ʃ, ʒ, t͡ʃ, d͡ʒ/ — the articulatory difference that is often assumed, explicitly or implicitly, in typical descriptions of this contrast.

I follow Sagey(1986) in assuming that the affricates /t͡ʃ, d͡ʒ/ are internally complex segments, with a [–cont] gesture followed by a [+cont] gesture on the same tier (*cf.* Lombardi (1990)). The necessary specifications of the four [–voi]~[+voi] pairs of coronal affricates and fricatives are thus as shown in (5) below. The CSC value is assumed here to be part of the specification of the coronal articulator, and [±cont] is assumed to be a dependent of this articulator (Padgett 1994, 1995). Variations in featural dependency that are consistent with the specifications in (5) should be compatible with what follows.

(5) Coronal fricative distinctions

a. /t͡ʃ, d͡ʒ/ b. /ʃ, ʒ/ c. /s, z/



The representation of the affricates /t͡ʃ, d͡ʒ/ in (5)a clarifies what is meant to be conveyed by the underlining in their transcription: both halves of these segments are specified with the CSC value [mid] and thus involve the same subcoronal articulation. Although /t, d/ do not contrast with other stops in terms of their CSC value in English, their precise subcoronal articulation typically differs from the subcoronal articulation of the initial [–cont] portion of /t͡ʃ, d͡ʒ/. For example, my own articulation of the stops /t, d/ is more apico-laminal compared to my strictly apical articulation of (both halves of) the affricates /t͡ʃ, d͡ʒ/. Following Borowsky (1987:675), I assume that the order between the [±cont] specifications of an affricate means that NO-GEM is violated by a stop to the left of, or a fricative to the right of, an otherwise identically-specified affricate. Thus, an affricate /d͡ʒ/ differs from a following fricative /z/ only in its CSC value but from a following stop /d/ in [±cont] as well, which is why epenthesis is required when the plural, but not the past tense, is suffixed to an affricate-final stem.

The CSC contrasts in(5) remain to be factored into the analysis developed so far. Standard accounts of the plural suffix alternation, having already fallen into the trap that ignorance of [±voi] in the calculation of adjacent segment identity is a coincidence, cope with the further ignorance of CSC values (however these are

assumed to be featurally represented) as if this were just another coincidence. For example, Fromkin (2000:625) suggests "a modified definition of the notion *similar consonants*" (emphasis in the original): a stipulation that neither [±voi] nor CSC differences matter to the applicability of epenthesis. I have shown that this stipulation is unnecessary in the case of [±voi], and I now show that it is also unnecessary in the case of the CSC value contrasts among English coronals.

The key to the analysis is the constraint SEQ(COR) in (6), penalizing adjacent segments differing in their subcoronal articulatory specifications: tip vs. blade, which I refer to as the *point of articulation*, and alveolar vs. postalveolar, which I refer to as the *place of articulation*. Because the contrast between CSC [mid] /ʃ, ʒ, t͡ʃ, d͡ʒ/ and CSC [narrow] /s, z/ is implemented as some distinction in subcoronal articulation, adjacent [mid] and [narrow] violates this constraint.

(6) SEQ(COR) = *[υ] [ϖ], where $\upsilon \neq \varpi$ and $\upsilon, \varpi \in$ {point-place specifications}

The following tableau details how SEQ(COR) interacts cooperatively with NO-GEM and SEQ(voi) to produce the correct result with an input of the form /ʃ+z/; that is, a form with a stem-final sibilant that differs in terms of both [±voi] and CSC value from the plural suffix. So long as all three of the markedness constraints are ranked above DEP-V, epenthesis is correctly predicted to be optimal: not assimilating at all (i) fares worse than epenthesis on both SEQ(COR) and SEQ(voi), voicing assimilation alone (ii) fares worse than epenthesis on SEQ(COR), CSC assimilation alone (iii) fares worse than epenthesis on SEQ(voi), and complete assimilation (iv) fares worse than epenthesis on NO-GEM.

(7) Epenthesis: *bu<u>shes</u>* [ʃəz]

/ʃ+z/ → [ʃəz]	NO-GEM	SEQ(voi)	SEQ(COR)	DEP-V
i. [ʃəz] ~ [ʃz]		W	W	L
ii. [ʃəz] ~ [ʃs]			W	L
iii. [ʃəz] ~ [ʃʒ]		W		L
iv. [ʃəz] ~ [ʃʃ]	W			L

Bringing SEQ(COR) into the analysis has further consequences. Because SEQ(COR) must dominate DEP-V in order to obtain the correct result in (7), the prediction made is that — all things being equal — violation of SEQ(COR) can always be avoided because violation of DEP-V is at least better, if not best.

It can be easily verified that DEP-V violation is not the best way to avoid SEQ(COR) violation; in minimally different contexts, SEQ(COR) does not enforce epenthesis. Consider, for example, the regular past tense forms such as *ca<u>shed</u>* /ʃ+d/, *ma<u>tch</u>ed* /t͡ʃ+d/, and *ju<u>dg</u>ed* /d͡ʒ+d/. None of these forms undergoes epenthesis, yet violation of DEP-V should be more harmonic than violation of SEQ(COR).[7] But do these consonant sequences in fact violate SEQ(COR)? Results from a static palatography study discussed by Bakovic & Kilpatrick (2005) show that the past tense suffix indeed shares the subcoronal articulation determined by the CSC value of the preceding sibilant. SEQ(COR) is correctly predicted to be independently active in English, but it is satisfied by CSC assimila-

tion rather than by epenthesis in contexts where NO-GEM is not at stake. This is because DEP-V dominates IDENT(CSC), defined in (8).

(8) IDENT(CSC) = *[υ]$_i$ → [ϖ]$_o$, where υ ≠ ϖ and υ, ϖ ∈ {[narrow], [mid]}

The following comparative tableau adds this constraint and ranking to the analysis developed so far. The input considered here is /ʃ+d/; that is, a stem-final sibilant that differs in terms of both [±voi] and CSC from the past tense suffix. Since the two consonants also differ in terms of [±cont], NO-GEM is not at stake and so the candidate with both CSC and voicing assimilation is optimal. As with the initial [–cont] half of the affricates /t͡ʃ, d͡ʒ/, I henceforth use underlining to transcribe the result of assimilation of the stop of the past tense suffix with a preceding CSC [mid] sibilant; e.g., the optimal form [ʃt̲] in (9).

(9) CSC and voicing assimilation of the past tense suffix

/ʃ+d/ → [ʃt̲]	SEQ(voi)	SEQ(COR)	DEP-V	ID(voi)	ID(CSC)
i. [ʃt̲] ~ [ʃd]	W	W		L	L
ii. [ʃt̲] ~ [ʃt]		W			L
iii. [ʃt̲] ~ [ʃd̲]	W			L	
iv. [ʃt̲] ~ [ʃəd]			W	L	L

SEQ(voi) and SEQ(COR) again do their part in ruling out the completely unassimilated candidate (i), the CSC-unassimilated candidate (ii), and the [±voi]-unassimilated candidate (iii). The competition boils down to (iv), between the optimal candidate with both CSC and voicing assimilation and the suboptimal epenthetic candidate. The assimilated candidate fares worse on both IDENT(voi) and IDENT(CSC), but of course it fares better than the epenthetic candidate on the higher-ranked constraint DEP-V.

Differences in CSC values (and their implementations as different subcoronal articulations) thus play a perfectly parallel role to differences in voicing values in the proposed analysis. The calculation of adjacent segment identity appears to ignore both voicing and CSC value differences because such differences are independently prohibited, whether or not the segments are otherwise identical. Both of these prohibitions are regularly resolved via assimilation when the adjacent segments are not otherwise identical; NO-GEM is irrelevant in such cases, making violation of DEP-V unnecessary.

CSC assimilation in English is also apparent in a set of examples originally discussed by Clements (1985), Sagey (1986), Borowsky (1986), and Yip (1988). Sequences of coronal consonants in English assimilate in terms of their subcoronal articulation in several other contexts; in particular, /t, d, n/ surface with the same subcoronal articulation as a following CSC [mid] segment.

(10) *whi*t̲*e sh*o̲*es* [tʃ], *re*d̲ *sh*o̲*es* [dʃ], *i*n̲*ch* [ntʃ], *hi*n̲*ge* [ndʒ], *in*s̲*ure* [nʃ]

Other examples include /t, d, n/-final stems with the suffix *-ship*: *court*s̲*h*o̲*p* [tʃ], *assista*n̲t̲*sh*o̲*p* [ntʃ], *hea*d̲*sh*o̲*p* [dʃ], *frie*n̲d̲*sh*o̲*p* [ndʃ], *relatio*n̲*sh*o̲*p* [nʃ]. In these

examples and those in (10), CSC assimilation is regressive, unlike the progressive assimilation found with the past tense suffix. There are also other examples of progressive CSC assimilation; note the contrast word-initially between *stoop* [st] and *schtup* [ʃt], and word-medially between *Austin* [st] and *Ashton* [ʃt], *answer* [ns] and *mansion* [nʃ]. The generalization appears to be that a stop assimilates bidirectionally to an adjacent fricative, which can be seen most clearly between members of a compound (*office tower* [st], *dish towel* [ʃt], *rebate center* [ts], *heat shield* [tʃ]) and between words within phrases (*kiss today* [st], *fish today* [ʃt], *hit someone* [ts], *hit Shiela* [tʃ]). Assimilation between otherwise contrastive sibilants is blocked when the first has the CSC value [mid], both in compounds (*fish soup* [ʃs]) and between words (*fish someday* [ʃs]); when the order of sibilants is reversed, assimilation is partial and gradiently affected by speech rate (*police sheriff*, *miss Sheila* (Zue & Shattuck-Hufnagel 1979).[8] The lack of complete assimilation is plausibly due to the intervention of NO-GEM, but the question remains why the SEQ(COR) violation is tolerated when DEP-V violation (epenthesis) is preferable, given the ranking established in (7).

Note that it won't work to limit the applicability ofSEQ(COR) to, e.g., tautosyllabic or word-final consonants. This will incorrectly exclude the cases cited above in which CSC assimilation does in fact apply in other contexts between sibilants and nonsibilants, for which there is no question of NO-GEM violation. Another approach would be to split DEP-V into two constraints, one penalizing epenthesis generally and a positionally-restricted variant penalizing epenthesis at word boundaries (DEP-V/#). The restriction to word boundaries is meant to allow epenthesis between stems and the past tense and plural suffixes but to exclude it between members of compounds and phrases and also between stems and prefixes or word-like suffixes like *-ship* (see footnote 8), a division which is consistent with the evidence for boundary distinctions in the lexical phonology and morphology of English (Siegel 1974, Kiparsky 1982, Borowsky 1986, 1993). The correct result is achieved if DEP-V/# and NO-GEM ≫ SEQ(COR).

(11) Blocking of CSC assimilation and epenthesis: *fish soup* [ʃs]

/ʃ#s/ → [ʃs]	DEP-V/#	NO-GEM	SEQ(COR)	DEP-V
i. [ʃs] ~ [ʃʃ]		W	L	
ii. [ʃs] ~ [ʃəs]	W		L	W

Note that sequences violatingNO-GEM do occur "across certain morpheme boundaries" (*superrich, dissatisfied, unnecessary, vowellike, subbranch*; Fromkin (2000:625)). These violations all occur between stems and prefixes or word-like suffixes; epenthesis is blocked here if DEP-V/# ≫ NO-GEM.

(12) Blocking of epenthesis: *dissatisfied* [ss]

/s#s/ → [ss]	DEP-V/#	NO-GEM
[ss] ~ [səs]	W	L

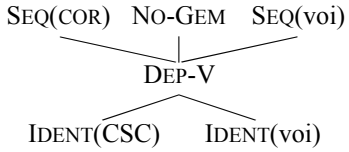
BecauseNO-GEM dominates both SEQ(COR) and IDENT(CSC), however, violation of the latter two constraints should be preferable to violation of NO-GEM. In

other words, we expect dissimilation: *dissatisfied* should surface with an [ʃs] sequence just like *fish soup*. There are two ways to resolve this issue, neither of which is problem-free. One is to limit the applicability of NO-GEM to word/syllable edges.[9] However, a restricted NO-GEM cannot account for the lack of intramorphemic (and intervocalic) geminates in English, and cannot be recruited to account for the lack of assimilation and epenthesis in examples like *fish soup* (11). The other avenue is to focus on the problem of dissimilation with respect to NO-GEM satisfaction. Dissimilation is a common way to avoid sequences of individual features on otherwise distinct consonants, but it is less well attested as a way to avoid sequences of adjacent identical consonants.

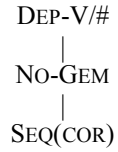
The final rankings proposed to account for the English facts are as follows. To emphasize the main theme of the paper, I keep the core cooperative interaction ranking (13)a separate from the (completely compatible) ranking responsible for blocking of CSC assimilation and epenthesis (13)b.

(13) Final ranking for English

a. Cooperative interaction ranking



b. Blocking of CSC assim. & epenthesis



3. Summary and Conclusion

Avoidance of 'sufficiently identical' adjacent consonants is the result of a cooperative effort to satisfy more than one constraint. One of these is a constraint against completely identical adjacent consonants, NO-GEM, and the others are active constraints in the grammar that independently penalize the relevant candidates in which the adjacent consonants are not completely identical. These constraints interact cooperatively in order to be satisfied insofar as they do not crucially conflict with each other, the end result being that 'sufficiently identical' adjacent consonants are avoided. This proposal was applied in this paper to an analysis of the well-known past tense and plural suffix alternations in English. This analysis yielded two noteworthy results.

First, an important connection was established between the epenthesis and assimilation processes involved in these suffix alternations, explaining why each of them has different contexts of potential applicability and actual application. Epenthesis is potentially applicable between consonants that have identical values for all features but it actually also applies between consonants that disagree only in [±voi] or subcoronal point-place specifications. Crucially, these features are otherwise expected to assimilate in this context and to thereby create adjacent identical consonants. NO-GEM, SEQ(voi) and SEQ(COR) can all be satisfied only by epenthesis when the stem-final consonant is 'sufficiently identical' to

the suffix consonant; more faithful candidates violate SEQ(voi) or SEQ(COR), and complete assimilation violates NO-GEM.

Second, a previously unnoticed assimilation was predicted and demonstrated to play a key role in these suffix alternations. The prediction arises because the plural suffix alternations indicate that both CSC [narrow] and CSC [mid] sibilants are 'sufficiently identical' to the CSC [narrow] plural suffix consonant to warrant epenthesis rather than voicing assimilation with sibilant-final stems. This requires an active constraint penalizing adjacent consonants that disagree in their subcoronal point-place specifications, SEQ(COR). Incorporating SEQ(COR) into the ranking requires that it dominate DEP-V, meaning that candidates with epenthesis will always be better than candidates violating SEQ(COR), all else being equal. Since there is no epenthesis with sibilant-final stems in the case of the past tense suffix, it must be that there is another SEQ(COR)-satisfying alternative, namely CSC assimilation.

At the outset of his paper on the morphology and morphophonemics of English verb inflection, Bloch (1947:399) cites a number of prominent earlier descriptions of the relevant facts and cautiously writes: "In view of the number and fullness of these descriptions, no new treatment can hope to add any facts hitherto overlooked: at most, a new treatment may be able to arrange the known facts more systematically than has been done before, or in a way that will be more useful to other linguists." The novel prediction that the past tense suffix adopts the point-place specifications of a stem-final coronal, made necessary by the proposed analysis of the English plural suffix alternations, has shown that it is even more worthwhile than Bloch had thought to revisit "fully described" facts with new theoretical hypotheses.

Notes

[1] Schwa [ə] is used as a cover symbol for whatever the exact quality of the vocalic element of these suffixes is. I also gloss over flapping of /t/ and /d/ in some varieties of English. An identical suffix forms denominal adjectives (*hooked* [kt], *horned* [nd], *talented* [təd]; Pinker & Prince (1988:102)).

[2] Harms (1978:46) and Pinker & Prince (1988:106) go so far as to suggest that this ordering follows from phonology (epenthesis) preceding phonetics (voicing assimilation). Whether or not there is independent evidence for this modular division of labor in this case or otherwise, the constraints responsible for these processes are crucially intertwined in the analysis proposed below.

[3] *Cf.* Harms (1978), Mester and Itô (1989), and Lombardi (1991, 1996), who assume that the relevant rule/constraint only targets final [–voi]-[+voi] sequences (and also initial [+voi]-[–voi] sequences, in the case of Harms' "universal phonetic constraint" (1978:46)). In the present context, this narrower interpretation of the constraint (as it applies finally) would predict that /d+d/ should be dealt with not by epenthesis but by devoicing, incorrectly resulting in *[dt].

[4] Other suffixes that are identical to the plural include the 3rd person singular present tense, the possessive, reduced *has*, *is*, and *does*, and a few others; see Pinker & Prince (1988:102).

[5] Note that the affricates /t͡ʃ/ and /d͡ʒ/ are transcribed with an underline diacritic to explicitly indicate that the initial [–cont] portions of these segments involve the same subcoronal articulation as the final [+cont] portions (see Ladefoged's (2001:145) transcriptions of these affricates in Quechua).

[6] A third value, [wide], is for the remaining coronal fricatives /θ, ð/. The sibilants /s, z, ʃ, ʒ, t͡ʃ, d͡ʒ/ must differ from /θ, ð/ in some other feature (e.g., [±strident]) under any analysis in order to account for the lack of epenthesis upon plural suffixation to a /θ, ð/-final stem: *myths* [θs], *lathes* [ðz].

[7] Thanks to Bob Kennedy and Colin Wilson for noting the relevance of these examples. Note that the same point being made here can be made for *ceased* /s+d/ and *seized* /z+d/, for speakers (like me) whose subcoronal articulation of /t, d/ also differs from that of /s, z/. I focus on the contrast between the subcoronal articulations of /t, d/ and /ʃ, ʒ, tʃ, dʒ/, if only because this is the contrast more often reinforced by standard classifications in terms of features like [±ant].

[8] This latter fact was originally pointed out to me by Bruce Hayes (p.c.).

[9] For Benus et al.'s (2004), what is crucially different about these cases is that the relevant sequence is intervocalic; independent constraints on gestural coordination conspire to block attempts to satisfy NO-GEM (in Benus et al. (2004), the gestural OCP) via open consonant-consonant transition.

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