Stratum junctures and counterfeeding: Against the current formulation of cyclicity in Stratal OT*

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1. Introduction

Kiparsky (1999, 2013) and Bermúdez-Otero (2003, 2011), among others, propose that opacity can be dealt with in Optimality Theory by distinguishing between three levels of derivation. This means that the morphology-phonology interface is structured in a way that explains non-transparent mappings without recourse to any other information. Transitions between the subsequent domains of phonological process application are where opaque processes are observed. Consequently, stratum-internal structures are free of over- and underapplication. This paper contributes to the discussion on the feasibility of such a multilevel approach by showing that, contrary to the expectations, two independent phrase-level processes can interact opaquely. In the following sections, I present previously unreported data from Gran Canarian Spanish, which illustrate two cases of morphologically unbound underapplication: a synchronic chain shift and a case of counterfeeding deletion. As such, they pose a challenge to OT accounts that do not assume opaque mappings stratum-internally. I argue that the very existence of processes involving non-transparent level-internal mappings calls for a revision, and possibly redesign, of stratal frameworks that do not assume explicit process precedence relations, and for their refocussing on within-stratum interactions.

1.1 Theoretical background

Synchronic chain shifts are a type of opaque mappings that challenge OT's property of strict domination (Prince & Smolensky 1993/2004). Strategies employed within parallel OT that seem to be able to deal with some of the resultant faithfulness cumulativity effects (Farris-Trimble 2008) include constraint conjunction (Kirchner 1996), ternary scales

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(Gnanadesikan 1997) and contrast preservation (Lubowicz 2003). Meanwhile, Stratal OT (Bermúdez-Otero 2003, Kiparsky 1999) is usually believed to specialise in dealing with opaque counterfeeding interactions. Yet, as noted by McCarthy (2007), to the detriment of the framework, one of the pillars of Lexical Phonology, which served as a basis for level definition, was not transposed to Stratal OT. The crucial component is extrinsic rule ordering inside strata. Obviously, this was ousted from post-1993 generative phonology as strict parallelism was embraced. Because rules were replaced with universal constraints whose interactions are hierarchical and driven by markedness, and evaluations are not procedural (at least not in standard OT and its extensions), phonological operations cannot be externally ordered. Instead, it is argued, internal mechanisms drive the order of events where relevant.[1] For Stratal OT, this means that all the processes observed within a given stratum must be transparent. Because each level requires a crucial reranking of the constraints, opacity can be observed when passing from one stratum to another. The internal domains of process application are devoid of such phenomena, and because the construction of these domains is based on the morphological structure of the inputs, it can be argued that the morphology-phonology interface is responsible for opaque interactions. Because Stratal OT assumes precisely three levels of grammar, or two tier junctures, two degrees of opacity are predicted (Kiparsky 2013). A problem arises, however, when level-internal transparency cannot be granted.

The data presented in this paper demonstrate that the above assumptions are not borne out, and stratum-internal opacity is attested. As will be demonstrated, Stratal OT, though particularly apt at dealing with morphosyntactically-conditioned opacity, fails to resolve counterfeeding cases that do not involve passing from one stratum to another. The cyclicity model assumed by the proponents of this framework is either inadequate or too restrictive.[2]

2. The data: postvocalic voicing

In Gáldar, in the north-west of Gran Canaria, Spain, an extended process of noncontinuant voicing can be observed (1). This has been reported as intervocalic voicing by Oftedal (1985). The process is accompanied by generalised Spanish spirantisation, (2), which turns voiced stops into approximants of differing strength (aperture). The contexts of occurrence of the two processes partially overlap, creating a chain effect.[3]

[1]This includes constraint ranking, constraint types/families, and domain modelling resultant from the framework's architecture. It must be noted that although the order of process application is irrelevant in the classic version of OT, later subtheories rely on various types of intermediate steps to account for non-transparent mappings. In Stratal OT, the three-tier distinction governs the timing of process application. In OT with constraint conjunction there is no explicit ordering, but violation count is used to the same effect. In sympathy (McCarthy 1999), an intermediate form was established (sympathetic candidate). In OT-CC (McCarthy 2007) and Harmonic Serialism (McCarthy 2008), step-by-step operation application is employed.

[2]See also Ettlinger (2009), Newell & Piggott (2014) for a discussion on the subject.

[3]The data are based on fieldwork conducted in 2014–2016 in Poland and on Gran Canaria. A total number of 55 native speakers aged 17-75 were interviewed in the course of spontaneous and semi-structured interviews. The digital material was recorded in mp3 and .wav formats, extracted and analysed in Praat (Boersma & Weenink 2015). A full description of the preliminary fieldwork conducted in 2014/15 can be found in Broś (forthcoming).

(1) /p/ de[b]artamento ‘apartment’
/t/ fone[d]ica ‘phonetics’
/k/ má[g]ina ‘machine’

/p/ yo [b]ienso ‘I think’
/t/ juntos y [d]al ‘together etc.’
/k/ de [g]olombia ‘of Colombia’

(2) /b/ lle[β]o ‘I take’
/d/ po[ð]er ‘be able to’
/g/ ma[ɣ]o ‘magician’

/b/ la [β]oca ‘the mouth’
/d/ una [ð]osis ‘one dose’
/g/ mi [ɣ]rupo ‘my group’

As observed above, voiceless stops are voiced after vowels, and voiced stops are spirantised both inside words and across word boundaries. I use approximant symbols [β ð ɣ] for expositional clarity. It must be remembered, however, that weak approximants with a greater aperture are predominant in this dalect, especially in intervocalic position.

Although the two processes seem to apply in the same environments, there is one distributional difference between them. Whereas spirantisation applies everywhere except after a pause or a homorganic nasal/lateral, i.e. after all continuant sounds, voicing is strictly post-vocalic and is blocked after any consonant. While *el triple* ‘three times’, *me desperté* ‘I woke up’ or *actualidad* ‘the present’ surface with no voicing, *el buque* ‘the ship’, *algunos* ‘some’ and *ardiente* ‘burning’ undergo spirantisation. The end result for the grammar is phonemic overlap (Bloch 1941): voiced stops can be allophones of both voiceless and voiced underlying stops.[4]

Given the above, it must be noted that the changes observed in the Gran Canarian variety of Spanish present a chain effect. Voiced stops become approximants and their voiceless counterparts are voiced in partially overlapping environments, yet underlying voiceless stops do not undergo further lenition. If they did, they would merge with the underlying voiced stops, yet this would give rise to lexical confusion, which is illustrated by a series of minimal pairs presented below.

(3) *Weak minimal pairs in Gran Canarian*

la cama	[lagáma]	‘the bed’	la gama	[laɣáma]	‘the range’
cuatro	[kwádro]	‘four’	cuadro	[kwáðro]	‘painting’
paca	[pága]	‘pack/alpaca’	paga	[páɣa]	‘pays’
grato	[grádo]	‘pleasant’	grado	[gráðo]	‘degree’
la poca	[labóka]	‘the little’	la boca	[laβóka]	‘the mouth’

Thus, the leniting changes observed in the dialect are gradual in the sense that only one feature is affected. In voicing, the laryngeal specification, or feature [voice], is involved, whereas in spirantisation, a [−continuant] sound becomes [+continuant]. The two features cannot be affected simultaneously in the same token. In a phonological analysis, an order of events best explains the facts: voicing must apply second to counterfeed spirantisation.

(4) a. *Feeding order results in merger (unattested)*
coto ‘property’ [kóto] → [kódo] → *[kóðo]
codo ‘elbow’ [kódo] → [kódo] → [kóðo]

[4] I assume underlying stops, but see e.g. Baković (1995).

b. *Counterfeeding order blocks merger (attested)*
coto ‘property’ [kóto] → [kóto] → [kódo]
codo ‘elbow’ [kódo] → [kóðo] → [kóðo]

As noted above, the processes involving non-continuant weakening in Gran Canarian apply both inside words and across word boundaries, which makes them phrase-level phenomena. They are triggered by the continuant (and voiced) context to the left in connected speech. Most importantly, at word edges, pauses and hesitations tend to block weakening. If the speech signal is uninterrupted, lenition ensues. Hence the allophonic, coarticulatory nature of the studied phenomena. At the same time, the changes produced as a result of voicing and spirantisation are contrastive (they produce minimal pairs) and show alternations. Therefore, they must be accommodated by phonology. In Stratal OT terms, both have to be assigned to the post-lexical component. Note that a phonological account of the two phenomena must incorporate a way of blocking an A → C mapping in the observed [p t k] → [b d g] → [β ð ɣ] chain shift. This cannot be achieved with a stratal account, however, as both processes are phrase level and therefore apply within the same domain. Consequently, there is no stratum juncture, and no constraint reranking is possible within a stratum. Since both voicing and spirantisation are allowed in the language, markedness constraints triggering them must be ranked higher than the corresponding faithfulness constraints and a ranking paradox will ensue whenever the contexts for the application of both processes are met. The relevant constraints are listed below. This is followed by a failed OT evaluation of the sequence *una prima* ‘a cousin’, which features voicing but not spirantisation.

(5) ***V [−cont, −voice]**: voiceless non-continuants are banned after vowels
***[+cont] [−cont, −nasal]**: non-continuants are banned after continuant sounds
IDENT(voice): input value of the feature voice must be preserved in the output
IDENT(cont): input value of the feature continuant must be preserved in the output

(6) *Evaluation of the sequence* una prima *‘a cousin’*

/una prima/	*V [−cont,−v]	*[+cont] [−cont,−nasal]	IDENT (cont)	IDENT (voice)
a. u.na.prí.ma	*!	*		
☹ b. u.na.brí.ma		*!		*
c. u.na.βrí.ma			*	*

As illustrated in (6), the desired candidate (6b) does not surface as optimal due to its violation of the high-ranked constraint banning nonadjacency in the feature [continuant]. Given the fact that the vowel context is a subset of the possible continuant sounds that constitute the contexts relevant for spirantisation, the more specific *V [−cont, −voice] constraint should be ranked higher than *[+cont] [−cont, −nasal, +voice]. At the same time, the ranking of IDENT[cont] with respect to IDENT[voice] cannot be determined based on the analysed data, hence the two might as well remain mutually unranked. I leave them randomly ranked, however, as this is not relevant for the subsequent discussion. Most im-

portantly, they must be ranked lower than the two markedness constraints. Given the fact that violating the two lowest-ranked constraints is less harmful than violating any of the higher-ranked ones, there is no way of preventing candidate (6c) from winning the evaluation. Nevertheless, such one fell swoop candidates are not attested.

Note that the problem does not lie in the overlap or juncture of any domains. Stratal OT allows for constraint reranking, but here both processes are phrase-level and hence neither of them can be applied at an earlier stratum than the other. If both are observed at the same stratum, no constraint reranking is possible and candidate (6c) will emerge as winner anyway. If we try to attribute the differences in voicing and spirantisation outputs to prosodic structure, we will see the same problem: prosodic structure is erected at the first stratum and then readjusted at later stages of the derivation. With phrase-level outputs, minimal pairs of the type presented in (3) can be produced, but no discrepancies at the level of prosody can be identified. What is more, although the left-hand environment is what distinguishes the domain of application of voicing versus spirantisation, the two phenomena overlap in intervocalic position both inside words and across word boundaries. Meanwhile, whereas phrasal voicing and aspiration can be analysed with recourse to prosodic structure and morphological word boundaries, there is no such possibility in the case of morpheme internal changes. In such cases, syllabic structure is erected at the stem level and does not undergo any changes nor does it misalign with any morphological constituent.[5]

One solution that is particularly viable in addressing the chain shift problem is constraint conjunction (Kirchner 1996, Moreton & Smolensky 2002, Lubowicz 2002), which makes it possible to distinguish between different mappings in quantitative terms. According to Kirchner, chain shifts illustrate a ban on multiple feature changes and a direct A to C mapping is not sanctioned in them as it involves a change in two features in order to satisfy one and the same markedness constraint. This cumulativity effect is achieved by combining the two crucial faithfulness constraints under a joint name and incorporating it in the ranking. In the case of Gran Canarian Spanish, voiceless stops are voiced and hence violate the IDENT[voice] constraint, while voiced stops are spirantised, violating the IDENT[continuant] constraint. Violating the two identity contraints at the same time is fatal. (7) shows a possible analysis, in which the high-ranked conjoined constraint prevents spirantisation of underlying voiceless stops by banning multiple faithfulness violations.

(7) *Evaluation of the sequence* una prima *'a cousin' with constraint conjunction*

/una prima/	*V [−cont,−v]	ID(cont)& ID(voice)	*[+cont] [−cont,−nas]	ID (cont)	ID (v)
a. u.na.prí.ma	*!		*		
☞ b. u.na.brí.ma			*		*
c. u.na.βrí.ma		*!		*	*

[5]The fact that both processes apply in overlapping domains and no stratum juncture or morphology-prosody mismatch is directly involved suggests that frameworks such as HS, which allow stepwise evaluation, are not suitable for solving the problem. This is because there is no way of mandating a single identity violation instead of two. The only option would be to introduce a constraint that explicitly requires faithfulness to the UR (see below).

As illustrated in (7), the correct output form is generated thanks to conjoining the two identity constraints. Nevertheless, while incorporating local conjunction works, it must be remembered that the solution is not internal to Stratal OT. Adding an additional constraint type might make the framework too powerful in terms of cross-linguistic predictions and typology.[6] A similar conclusion can be drawn if other external mechanisms, such as contrast preserving constraints, are adopted.

Another way of dealing with the chain shift in Stratal OT would be to enforce faithfulness to the UR rather than to the output of the previous stratum, as noted in footnote 5. Such a solution apparently deals satisfactorily with some data (Hauser et al. 2014, McCarthy 2007). Nevertheless, given the fact that the Canarian data involve two changes within one stratum, and that changes do not apply one at a time in this framework, there is no intermediate stage in the derivation in which the UR and the current input would differ in terms of voicing or continuancy. The only solution is to stipulate a constraint requiring that no change in continuancy may occur in underlying voiceless stops (e.g. IDENT$_{UR-O}$(cont)/[−voice]). This would ensure that /p t k/ do not go all the way to voiced continuants, solving the chain shift problem. Note, however, that Spanish does have continuants arising from stops in the coda (e.g. *actuar* 'to act' [ax.tu.ar] / [aɣ.tu.ar]) so a high-ranked constraint of the above type may not be the correct path to follow for the whole of the dialect.

Given the above, it may be concluded that in order to account for the chain shift effect observed in Gran Canarian (and a bunch if other languages and dialects presenting lenition for that matter),[7] the architecture of the adopted framework must be changed accordingly. In Stratal OT, an additional mechanism of UR-bound constraints or local conjunction must be incorporated as domain distinctions and reranking principles are insufficient to render the correct surface forms.[8]

3. Deletion as a blocker

Regardless of the solution adopted in the case of the chain shift, another counterfeeding interaction obscures the analysis of the Canarian data under a stratal approach. Interestingly, Canarian Spanish shows a blocking effect caused by elision. The widely extended process of coda deletion typically creates a context for voicing in phrase level phonology, yet no voicing applies. This is illustrated in (8).

(8) *Deletion in Gran Canarian*

la(s) caracterí(s)tica(s)	[la.ka.rak.te.rí.ti.ga]	'the features'
die(z) primo(s)	[dje.prí.mo]	'ten cousins'
por pensa(r) tontería(s)	[por.pen.sá.ton.te.rí.a]	'for thinking about silly things'
se puede acepta(r) que	[se.pwé.ðe.a.sep.tá.ke]	'it can be accepted that'

[6] Cf. Jesney (2005) on learnability.

[7] See Gurevich (2004) for a comprehensive account.

[8] Needless to say, other solutions, such as contrast preservation (Lubowicz 2003) or ternary scales (Gnanadesikan 1997), are also external to Stratal OT.

As can be observed in (8) above, coda consonants are deleted both inside words and across word boundaries. The process applies in rapid speech and is systematic. All consonants are affected, although /s/ is the most frequent one given the fact that it is of the widest distribution (verb endings and plurals). After deletion, the following stop becomes postvocalic, yet voicing does not apply. Thus, we are dealing with a counterfeeding effect: instead of feeding voicing in accordance with the general principle of its application (postvocalically), deletion blocks it. In an OT analysis, however, undominated *V[−cont, −voice] constraint makes it impossible to stop voicing. In this case, the relevant constraints have the following definitions.

(9) ***C]Coda**: consonants are banned in coda position

MAX(Seg): every segment of the input has a correspondent in the output (no phonological deletion; McCarthy & Prince 1995)

To ensure consonant deletion, MAX(Seg) must be ranked below *C]Coda. Nevertheless, since *V[−cont, −voice] is ranked at least equally high as the latter constraint to allow postvocalic voicing in the language, there is no way of generating the correct output forms in opaque cases of the type presented in (8). The process of voicing underapplies. This is presented in (10) below.

(10) *Failed evaluation of* pensar tonterías *'thinking about silly things'*

/pensar tonterias/	*V [−cont,−v]	*C]CODA	IDENT (voice)	MAX (Seg)
a. pen.sár.ton.te.rí.a		*!		
☹ b. pen.sá.ton.te.rí.a	*!			*
c. pen.sá.don.te.rí.a			*	*

In (10), the correct output form, (10b), cannot be generated as it disobeys the highest-ranked constraint. The relation between the surface form [pen.sá.ton.te.rí.a] and the effects of the constraint ranking is not transparent. Three major problems can be enumerated when dealing with these data. First, deletion is in a counterfeeding relationship with voicing, but both processes are phrase-level. Thus, there is no stratum juncture that might be considered responsible for the opacity effect. Second, the problem is non-local: local conjunction cannot be invoked because deletion applies to a different segment than voicing. If we wanted to conjoin the two faithfulness constraints involved, IDENT(voice) & MAX(Seg), the resultant constraint would be too strong. Note that in local conjunction literature, certain principles have been established that restrict this powerful mechanism. As argued by Baković (1999), Lubowicz (2002), Ito & Mester (2003), Fukazawa & Miglio (1998) and others, conjunction should be limited in terms of conjoinable elements to prevent implausible mappings and unattested structures. This restriction limits conjunction e.g. to certain constraint families in

order to prevent the proliferation of conjunction domains.[9] Another important restriction is that the violation of the conjoined constraint must be incurred by one and the same segment and not neighbouring sounds or any other output configuration. Otherwise the framework would become too powerful. Therefore, constraint conjunction must be strictly local and its domains clearly defined (Smolensky 1993, 1997, Moreton & Smolensky 2002, but confer McCarthy 2007, 34-36). The third problem consists in the fact that an ordering of events is necessary to make the blocking of voicing transparent, yet there is no harmonic mapping within OT that would predict waiting with deletion until the end of phonology.

In view of the above, it becomes apparent that stratum-internal opacity is possible and certainly requires a revision of the way phonological processes are modelled in OT. The question is what, if not morphosyntactic and morphophonological relations, is responsible for this kind of opaque mappings. In the case of counterfeeding deletion, it seems that the elided segment marks its presence on the surface, or at least during the derivation. Although it is no longer there and results unpronounced, it does affect phonological structure. Since it blocks an otherwise straightforward lenition process, it must leave a trace. Therefore, it is questionable whether the whole root node is eliminated from the input. It may be that oral pronunciation features are deleted or delinked, but the place occupied by the segment remains filled from the structural point of view. This implies an analysis in terms of covert structure or containment (Prince & Smolensky 1993/2004, van Oostendorp 2006, Trommer 2011). In articulatory terms, this may be motivated by gestural masking. According to Browman & Goldstein (1990), an overlap of articulatory gestures that belong to two different tiers may lead to apparent deletion. In other terms, if two gestures responsible for different articulatory areas or targets coincide, they may mask each other, the effect being perceptual blending. The resultant sound may thus be technically there (the corresponding gesture is effected) but perceptually absent (unpronounced). This is a typical phenomenon observed in fast, connected speech in which not only same-tier gestural overlap leading to e.g. assimilation, but also cross-tier overlap takes place.[10] Such an analysis of the facts requires further empirical study involving articulatory experiments. The acoustic analysis of the data does not allow me to identify articulatory gestures and check whether the corresponding muscles were involved in the articulation of the apparently deleted segments or totally absent. Nonetheless, the gestural masking hypothesis provides support for the observed blocking effect. There is no doubt that the deleted segment somehow 'affects' the pronunciation of such forms as *pensar tonterías*. Thus, if we assume that the missing consonant or its corresponding features are there although no sound can be perceived due to the masking effect of gestural (mis)coordination, an articulatory motivation for the functional and structural presence of the segment in question is added. Furthermore, given the fact that the elided segment has the power to influence phonology despite the lack of surface motivation (opacity), it is all the more logical that an articulatory gesture aimed at

[9] Note that the original formulation of conjunction by Smolensky (1995) allows for conjoining complex constraints, but see discussion in McCarthy (2007) and Moreton & Smolensky (2002).

[10] According to Browman & Goldstein, this is what happens e.g. in English fast speech: *must be*. Although the final /t/ of *must* is imperceptible, palatographic studies show that the alveolar gesture is present, hence the following bilabial closure masks the production of /t/ both in acoustic and in perceptual terms. See also Bradley (2007) for apparent /r/ deletion in Norwegian.

producing it be present during speech. The question is how the deleted segment should be represented in phonology.

4. Covert structure in Stratal OT

There have been various approaches to representing covert structure in phonology literature. Within OT, Prince & Smolensky's (1993/2004) original proposal involved Containment, according to which, whenever a segment or feature is absent from the output, it is represented as unparsed, i.e. not incorporated in the surface representation of the analysed sequence of sounds. Although this initial approach was later replaced by correspondence theory (McCarthy & Prince 1995), the end of the 1990s marked a return to theoretical discussions on input-output material discrepancies.[11] Goldrick (1998, 2000) assumes turbidity for certain phonological representations. According to this approach, input sound properties are projected, but not necessarily pronounced. Projection and pronunciation lines govern input-output relations. In OT terms, this can be represented by reformulating constraints when necessary to reflect these association lines, and by introducing a RECIPROCITY constraint that requires bidirectionality. The latter mandates that the abstract structural relationship between the segments and their featural representations must be pronounced (faithfully rendered in surface realisations, which are then subject to phonetic interpretation). This is typically illustrated in the form of arrows: a down arrow for projections and an up arrow for pronunciations.

The turbidity framework was created in response to the growing problem of opacity in phonology, as well as problems related to the representation of autosegmental material in output-based OT. It was later taken up by other phonologists interested in the influence of hidden structure on output representations within OT and beyond. Marc van Oostendorp's (2006) Coloured Containment framework builds on the projected vs. the pronounced hypothesis put forward by Goldrick and, crucially, on the notion of Consistency of Exponence, according to which 'no changes in the exponence of a phonologically-specified morpheme are permitted' (McCarthy & Prince 1993, 1995). This principle is interpreted as follows: GEN cannot affect the lexical specification of morphemes; epenthetic elements cannot be linked to underlying morphological structure, and deleted elements are interpreted as unparsed and unable to change a given morpheme's makeup. In Coloured Containment, the innovation lies in the fact that morphemes come with specific 'colours', which are present in all the segments and other structural elements accompanying them in the underlying representation. These colours cannot be removed or added to inserted phonological elements. Crucially, Containment is assumed for all input-output relations. Given the problems related to the use of classical Containment (Prince & Smolensky 1993/2004), however,[12] van Oostendorp (2005) proposes a revised version of the principle. This involves the use of two crucial constraint types.

[11] The need to retain underlying segments in the course of derivation was emphasised since the very advent of Stratal OT. See e.g. Rubach (1997) for remarks on containment versus correspondence in problematic syllable structure cases in Polish under his Derivational OT model – the precursor of Stratal OT.

[12] For instance, the recognition of inserted elements as epenthetic (empty by default) and the problem of vowel harmony to epenthetic elements.

(11) **PARSE-ϕ(α)**: The morphological element αmust be incorporated into the phonological structure. (No deletion.)
PARSE-μ(α): The phonological element αmust be incorporated into the morphological structure. (No insertion.)

Revithiadou (2007) follows Goldrick and van Oostendorp by assuming Coloured Containment and turbid structure. In her view, the colour-based model is superior to classical OT in that it gives phonology insight into the morphological affiliation of phonological elements. In transparent cases, phonology 'mirrors' morphology, while in more complicated ones, especially in opaque interactions, a representational (and realisational) mismatch can be observed. As a result, a more restrictive theory of morphophonological interactions is provided, and OT constraints can be formulated in a way that better 'controls the mapping between morphological structure and prosodic form' (Revithiadou 2007, 3).

Trommer (2011) assumes a theoretical model of Coloured Containment that involves strata, arguing that different affixes have different consequences for certain phonological processes. This should be reflected in different process application domains, and hence subsequent input and output structures generated in a feed-forward fashion along the lines of Kiparsky (1999) and Bermúdez-Otero (2011). Trommer assumes that four types of representations should be considered in the case of epenthetic and deleted segments, depending on whether they are phonetically and/or morphologically visible. The robust set of mechanisms proposed by this author will not be used here, however, given the need to introduce a wide range of additional theoretical assumptions and changes in the way constraints and evaluations are provided in the classic version of Stratal OT. It must be noted, however, that Trommer's arguments for adopting strata are particularly valid and should be considered groundwork for extending the framework by turbid representations.

In view of the above, it can be said that the turbidity model was introduced and later used above all to solve representational problems related to autosegmental material accompanying segmental phonology.[13] It can, however, be successfully used to account for segmental phenomena, such as derived environment effects (van Oostendorp 2006) or opaque counterfeeding effects presented herein. As shown by the Gran Canarian data, covert material can exert an effect on surface structures, which is in line with Goldrick's original claim that 'the output of the grammar [may] contain unpronounced material which 'can' influence the surface – the portion of the output which is pronounced' (2000, 2). As rightly argued by Revithiadou (2007, 14), the 'split between underlying and surface structure at the representational level' does away with referring to representational or structural elements such as association lines in constraint formulation, and at the same time allows for embracing containment in the sense of representing phonological deletion without the physical removal of any features from the input. Such a move is necessary to represent floating features and/or segments in the grammar, as well as underlying elements and 'intermediate forms' that influence surface realizations in a non-transparent manner.

[13]For instance, Lugandan compensatory lengthening discussed by Goldrick, stress shift in Greek in Revithiadou's analysis, or the spreading and reciprocity model adopted by Finley (2008) for vowel harmony.

To account for the special blocking-by-deletion case presented in the previous section, I propose a simplified version of the Coloured Containment model in which 'traditional' OT constraints have slightly different formulations. MAX(Seg), for instance, should reflect projection-pronunciation relations and obey the Consistency of Exponence principle. This means that whatever is 'deleted' is not removed from the representation, it is simply left unpronounced, i.e. lacks the pronunciation association line between the input and the output structure. In a simplified manner, this can be represented in the form of a representational marker [u] - unpronounced. Since nothing can be removed from the input, the deleted segment is projected but unpronounced, hence [pu]. MAX(Seg) is violated. An epenthetic segment, by constrast, would have a reverse structure: [up] - unprojected, pronounced.[14] At the same time, root node reciprocity is violated. The corresponding constraint can be interpreted as a phonological transparency guardian. Needless to say, identity constraints, whose formulations rely on correspondence theory, take a revised form. IDENT(voice), for instance, states that the feature [voice] must be incorporated in the underlying/surface structure (along the lines of PARSE-μ/ϕ(F) in (11) above). If this is not true, a violation mark is due.[15] To represent the evaluation of the problematic deletion examples from Spanish, the following constraint formulations are needed.

(12) ***V [-cont, -voice]**: voiceless non-continuants are not pronounced after vowels

IDENT(voice): the input value of the feature voice must be pronounced in the output

***C]CODA**: consonants are not pronounced in coda position

MAXSeg = RECIPROCITY(Rt): the input root node must be incorporated in the output structure (projected = pronounced)

Output-oriented markedness constraints govern pronunciation or particular segments and autosegments, hence they are similar to Goldrick's (2000) PRONOUNCE constraints. MAX(Seg) is reinterpreted as a RECIPROCITY(Rt) constraint: it makes sure that all projected material is pronounced. Since no literal deletion is permitted in this model, there is no need for two different constraints governing reciprocity relations. The evaluation goes as follows.

(13) *Successful evaluation of* pensar tonterías *'thinking about silly things'*

/pensar tonterias/	*V [−cont,−v]	*C]CODA	IDENT (voice)	MAX (Seg)
a. pen.sa[r_{pp}].ton.te.rí.a[s_{pu}]		*!		*
b. pen.sa[r_{pu}].don.te.ría[s_{pu}]			*!	**
☞ c. pen.sa[r_{pu}].ton.te.rí.a[s_{pu}]				**

[14] An unprojected, unpronounced output is not possible in this case. In a Stratal OT framework, however, it would be possible to have an epenthetic segment that affects grammar, but is left unpronounced later on.

[15] I omit the discussion on the nature of features here for reasons of space. Binary features might require constraint doublets as in van Oostendorp's model: PARSE-ϕ, PARSE-μ.

In (13), reciprocity in the projected vs. pronounced material is sacrificed to obey a higher-ranked constraint, *C]CODA. The presence of the underlyng structure (projection link/ marker) is crucial, however, to ensure that no gratuitous voicing takes place. In (13b) the violation of IDENT(voice) is unmotivated: it does not happen to satisfy any high-ranked markedness constraint. *V[−cont, −voice] is blind to the unpronounced status of the [r] in *pensar*. The ranking of IDENT(voice) above MAX(Seg) is crucial to obtain a counterfeeding effect.

The above analysis successfully solves the opacity problem identified in the Gran Canarian data thanks to the recognition of covert structure as a crucial element of grammar. As for the chain shift problem discussed in section 2, the same line of reasoning can be applied. In this case, featural reciprocity should be invoked in the form of a cumulative constraint defined as follows.

(14) **RECIPROCITY(F)**: input features must be incorporated in the output structure

In this case, all projected features should be pronounced accordingly. If not, the constraint is violated. This is illustrated below.

(15) *Evaluation of the sequence* una prima *'a cousin'*

/una prima/	*V [−cont,−v]	RECIP (F)	*[+cont] [−cont,−nasal]	ID (cont)	ID (voice)
a. u.na.prí.ma	*		*		
☞ b. u.na.brí.ma		*	*!		*
c. u.na.βrí.ma		**!		*	*

5. Conclusions

As argued in this paper, the current definition of cyclicity in Stratal OT is inadequate for dealing with stratum-internal counterfeeding effects. Both synchronic chain shifts and blocking in deletion environments require auxiliary mechanisms. A comprehensive analysis is possible only if covert structure is incorporated into the model.

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