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# A formal scheme for prosodic disalignment

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**William Hart, 2017. A formal scheme for prosodic disalignment.** *Studies in Phonetics, Phonology and Morphology* 23.1. 145-169. This paper presents a formalized scheme for the representation of constraints that codify the force of prosodic repulsion, a concept first introduced in Hart (2015a) and expanded upon in Hart (2015b). Prosodic repulsion embodies a force of resistance between phonological entities which works together in concert with a force of attraction between entities to define and regulate prosodic structure. While the force of attraction has commonly been referred to as alignment, the force of repulsion can analogously be understood as disalignment. The proposed scheme for the formalization of such disalignment has here been dubbed *Generalized Repulsion* for the commonalities it shares with the constraint scheme proposed by McCarthy and Prince (1993), yet it differs from Generalized Alignment in several respects. First, the arguments of GR constraints indicating the relevant prosodic structures are both marked with the universal operator. Second, reference to only one edge is required. Third, an additional argument is included to represent the *buffer*, which is the minimal distance required between the two constituents that repel each other. With the introduction of this constraint scheme, the overall phonological grammar as a whole is simplified, and several previously unconnected phonological phenomena can be brought together under a single theoretical umbrella. **(University of Seoul)**

**Keywords**: alignment, disalignment, prosodic repulsion, buffer

## 1. Introduction

The term *prosodic repulsion* was introduced in Hart (2015a) to describe a kind of resistance that can be seen to be operating between phonological elements and structures in all human languages. The word *elements* is used here in reference to the basic building blocks of segmental and suprasegmental structure such as consonants, morae and tones. The word *structures*, on the other hand, refers to the constituents such as syllables, feet and prosodic words that form the larger units of sound serving as domains for the operation of phonological phenomena. While the alignment of phonological, morphological and syntactic constituents has served as a rich source of investigation in much past work (cf. Selkirk 1984, McCarthy and Prince 1993), prosodic repulsion covers the other side of the coin: disalignment.

If alignment is construed as a kind of attraction between the edges of two entities, then disalignment can be understood as a force of resistance or repulsion between them. Due to these two opposing forces, one pulling things together and the other pushing away one from the other, phonological elements and structures are attracted to each other yet resist each other at the same time, being drawn together while simultaneously being forced apart. Thus, in a manner somewhat akin to planetary systems or atoms, phonological constituents are held together and structurally defined by a balance of opposing forces working in concert.

One of the advantages of looking at phonological structure and phenomena through the lens of prosodic repulsion is that it provides a conceptual framework that can be used to elucidate and unify a vast range of long established observations. In turn, this allows us to simplify the phonological grammar as a whole by reducing the number of formal devices needed to account for this complexity. The major proposal of this paper represents such an effort towards unification and simplification of the grammatical apparatus by offering a formalized scheme for the representation of Generalized Repulsion constraints.

## 2. Theoretical Background

### 2.1 Alignment

In order to fully understand the balance of attractive and repellant forces that shape the prosodic structure of phonological constituents, it is necessary to comprehend how both of these forces work. In the "pull and push" that defines the balance of forces at work in prosodic structure, alignment is the force that pulls constituents toward each other, while repulsion is the force that pushes them apart. The main focus of the present project is on repulsion constraints, which ban the alignment of prosodic constituents. However, this section will look at the other side of the coin, examining the force of attraction which pulls prosodic constituents together in order to keep them aligned.

Although this section will deal mainly with McCarthy and Prince's (1993) scheme of Generalized Alignment (henceforth GA) in the theoretical context of OT, their work was influenced by earlier proposals and research on the edge-based theory of interface between morpho-syntax and phonology such as Clements (1978), Selkirk (1986), Chen (1987), Hale and Selkirk (1987), Selkirk and Tateishi (1988), Selkirk and Shen (1990), and most directly by Selkirk (1993), who first proposed an OT account of this interface.

After the basic idea of GA has been introduced, the form and function of GA constraints will be explained in some detail, and there are two reasons for this. The first is that alignment represents the “other side of the coin” with respect to repulsion, since it is the balance and counterbalance of the two forces working in concert that determines the prosodic structure of phonological constituents. In this sense, the precise functions of both alignment and repulsion constraints must first be grasped individually. Understanding the precise functions of these two constraint types will clarify the ways in which they simultaneously exert their influence in the evaluation of candidates.

The second reason why the specific mechanics of GA constraints need to be laid out carefully in this section is that at first glance their basic form might appear quite similar to that of the repulsion constraints to be introduced later in this chapter. However, this similarity is only a superficial one, and if the form and function of repulsion constraints are to be completely understood, it will help to differentiate them from those of GA constraints in terms of how each argument is defined and how violation marks are assigned. So these are the aspects of GA that will now be examined.

McCarthy and Prince (1993) present GA constraints in terms of a universal template whose arguments can be filled on a language-specific basis to account for various aspects of morphological and phonological phenomena. The basic constraint form is presented in (1) below.

(1) Generalized Alignment (McCarthy and Prince 1993)

Align(Cat1, Edge1, Cat2, Edge2) $=_{def}$

∀ Cat1 ∃ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.

Where

Cat1, Cat2 ∈ PCat ∩ GCat

Edge1, Edge2 ∈ {Right, Left}

Unpacking the definition in (1) step by step, we will start with the sets of possible identities for each argument, as indicated in the “Where” section. The first (Cat1) and third (Cat2) arguments can each be any one member of a set of separately defined prosodic (PCat) and grammatical (GCat) categories, while the second (Edge1) and fourth (Edge2) arguments specify either the left or the right edge of Cat1 and Cat2, respectively.

While the set of prosodic categories used in the particular analysis presented in McCarthy and Prince (1993) is limited to the prosodic word, the Foot and the Syllable, the authors recognize that this set could potentially be extended to include moraic, segmental, and even sub-segmental levels of representation. As for the grammatical categories, at first an inventory of four constituents is specified, consisting of the Morphological Word, the Stem, the Affix and the Root. This relatively small set is then expanded to include the possibility of language-specific morphemes, with showcase analyses featuring the *-um-* and *-ka-* affixes of Tagalog and Ulwa, respectively. This expansion is a bold move, as it not only negates the possibility that the set of constraints is universally held across all languages, but also allows for a veritable explosion in the number of typological predictions for GA constraints.

Moving on, the next key aspect of the constraint template in (1) that needs to be explained is the presence of the universal (∀) and existential (∃) operators. That the universal operator applies to the first argument means that the constraint must be applied to *all* constituents of the type specified by Cat1, whereas the use of the existential operator for the third argument indicates that the existence of only a *single* constituent of the set indicated by Cat2 is sufficient to satisfy the constraint, as long as the two constituents are aligned at the edges respectively specified by the constraint.

It is crucial to remember that the universal operator always applies to the first argument, and the existential operator to the third, since the reversal of these two arguments can result in different violation profiles. To illustrate this, consider the GA constraint in (2) below, which is responsible for the initial dactyls found in English words of sufficient length such as *Lòllapalóoza, Tàtamagóuchee* and *Wìnnepesáukee* that begin with a series of an initially stressed light syllable followed by two unstressed light syllables (i.e. ˈLLL…).

(2) GA constraint for initial dactyls (McCarthy and Prince 1993)
**ALIGN**(PrWd, L, Ft, L) ‘Each PrWd begins with a Foot.’

Since the universal operator applies to the prosodic word and the existential operator to the foot, the constraint **ALIGN**(PrWd, L, Ft, L) demands that the left edge of *every* prosodic word must be aligned with the left edge of a *single* foot. As such, a form such as [(LL)L(H)L] satisfies **ALIGN**(PrWd, L, Ft, L), while the form [L(LL)(H)L] violates it, since the former has a single foot aligned at the left edge of the prosodic word and the latter does not.

However, if the order of the arguments in this constraint is reversed to result in **ALIGN**(Ft, L, PrWd, L), then the violation profile will be quite different. In contrast to the original version, this new "reversed" constraint demands that the left edge of every foot be aligned with the left edge of a single prosodic word. This means that both [(LL)L(H)L] and [L(LL)(H)L] will violate the new constraint, since both of these forms have at least one foot that is not aligned with a prosodic word at the left edge. In the case of the former, only the second foot will incur a violation since the first foot is crisply aligned at the left edge of the prosodic word, while in the latter case neither foot is so aligned.

Another point to be mentioned about the form of GA constraints regards the two edges specified in the constraint template. Although the edges indicated by Edge1 and Edge2 are both Left or both Right in an overwhelming majority of analyses applying the GA scheme, the reason McCarthy and Prince (1993) leave the possibility of bifurcated edge specification open is that they attempt to encompass all morphological operations into their framework, which includes both prefixation and suffixation. For cases of apparent prefixation, this would entail specifying that the right edge of an affix be aligned with the left edge of a root or stem, while apparent cases of suffixation involve the alignment of the left edge of an affix with the right edge of a root or stem.

The advantage of this split-edge formalism is presumably that affixes do not need to be specified as prefixes or suffixes but just as affixes in general, with the GA constraint doing the rest of the work. Yet it also means that every prefix or affix must be given its own personal constraint specifically targeting that particular morpheme. This results in an inventory of GA constraints for every language that is at least as large as the total number of affixes it has, and this inventory will also be specific to that language rather than part of Universal Grammar.

This leads to another point which will conclude this subsection, which is that the number of typological predictions implicit in the GA scheme is rather large. Even disregarding the potential vastness of the constraint inventory in terms of morpheme-specific constraints, the total number of constraints predicted by GA to possibly exist across human languages typologically is quite large. This is because the constraint template consists of four arguments plus two different possible modes of violation assignment (Boolean and gradient), and the number of predicted constraints grows even more unwieldy with each expansion of the PCat and GCat sets. Whether these typological predictions are actually met is of course an empirical matter that lies outside of this investigation, yet the point to mentioned here is that the typological predictions of the constraint scheme proposed in this paper are much more manageable than those of GA.

### 2.2 Extrametricality and nonfinality

If one were to look for a theoretical analog from early metrical phonology whose functions corresponded in some way to those of prosodic repulsion, that precursor would be the device of *extrametricality.* This theoretical device was first proposed by Liberman and Prince (1977) to account for the observation that some final syllables appeared to be invisible to their rules for stress assignment in English, namely words ending in *-y* such as *promissory, dignitary,* and *sanctimony,* or words with final liquids such as *caterpillar, alligator* and *participle.*

This pattern of general immunity to the regular stress rules of a language was found to extend far beyond such cases by Hayes (1980), who formalized extrametricality as a diacritic and presented the rule below in (3), which covers both initial and final extrametrical rimes.

(3) Rule schema for rime extrametricality (Hayes 1980)

$$\text{R} \rightarrow [\text{+ex}] \; / \left\{ \begin{array}{l} \_\_\_ \, ] \\ [ \, \_\_\_ \end{array} \right\}$$

The schema was intentionally fashioned to include the possibility of application at both the left and right edges of words or phrases. For example, the rule R → [+ex] / $\_\_\_]_{word}$ is required to account for the apparent invisibility of final rimes to the stress algorithm of languages such as English and Latin. On the other hand, the mirror-image rule R → [+ex] / $[_{word}\ \_\_\_$ is used to account for languages like Macedonian, Parnkalla and Winnebago. In such languages, stress is edgemost in disyllabic words yet appears on the post-peninitial syllable in words of longer length.

Although the particular rules presented in the previous paragraph apply specifically to rimes, it is important to note that Hayes (1980) formulated rules for the placement of extrametrical diacritics not only on subsyllabic prosodic constituents, but also vocalic and consonantal segments. For example, he proposed a rule for Meadow Cheremis that marks lax mid vowels extrametrical in word-final position, and another rule that marks the final consonants of all words in English as extrametrical. This inclusion of segmental elements as targets of application is one thing that separates early metrical treatments of prosodic phenomena from theoretical analogues that emerged later with the development of OT, which deal solely with suprasegmental prosodic constituents or their projections in grid form. Incidentally, this recognition of segmental elements as potential arguments in formal devices is a characteristic shared by the present proposal of repulsion constraints, which allows not only prosodic constituents such as feet and syllables as arguments, but also the more basic elements of morae and segments.

The next major development in extrametricality came with Halle and Vergnaud (1987), who continued Hayes' (1980) tradition of allowing application at both the left and right edges of domains, and extended the targets of rule application to include morae. Another key aspect of Halle and Vergnaud's (1987) analytical framework is that their extrametricality rules apply not directly to constituents themselves, but rather to marks on the metrical grid, marks which represent formalized abstract projections of these constituents (Prince 1983). This handling of phonological entities indirectly through the use of marks on the metrical grid is a characteristic shared by later analogous proposals in the realm of OT by Hyde (2007, 2011).

Despite the impressive analytical advances in metrical theory allowed by the device of extrametricality, the emergence of Optimality Theory (Prince and Smolensky 1993/2004) to the forefront of phonological work in the last decade of the twentieth century left a sizable gap that this device had once filled. The problem with extrametricality was that it had always been employed as part of a system of rule derivations in the classic generative tradition. This often meant that metrical structure could be rebuilt over structures that had formerly been extrametrical, after the device had done its work.

However, with the "one shot" parallel evaluations of OT, output forms can either be parsed into particular prosodic structures or not, without wavering between the two at different steps of a derivation. The use of extrametricality was thus no longer considered viable, so the data that this device had once been used to account for then stood in need of fresh treatment in the form of structural markedness constraints.

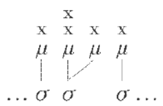
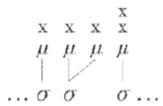
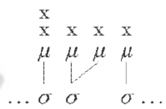
The answer provided by Prince and Smolensky (1993/2004) was the constraint **NONFINALITY**, which states that "no head of PrWd is final in PrWd" (56), effectually preventing the final syllable of a word from being parsed into the head foot in optimal forms. While accounting neatly for the extrametricality of final syllables in English and Latin, there are several points which set nonfinality constraints apart from the earlier proposals of Hayes (1980) and Halle and Vergnaud (1987).

First, as the name of the constraint implies, **NONFINALITY** and other constraints of its type can only apply at the right edges of phonological domains, not the left. Secondly, since Prince and Smolensky's (1993/2004) formulation of nonfinality is head-based, it cannot be used to account for any non-head phenomenon. This means not only that it fails to cover any phenomena involving prosodic constituents such as morae, syllables and feet which are not heads, but also that it leaves the consonantal segment inventory completely out of the picture, since consonants cannot ever serve as prosodic heads. These restrictions leave many phonological phenomena completely unaccounted for.

In contrast to the head-based nonfinality of Prince and Smolensky (1993/2004), an alternative proposal has been made by Hyde (2007, 2011) which is based on the metrical grid formalism (Prince 1983). The basic constraint schema is **NON-FIN**(GCat, Cat, PCat), which formally bans the occurrence of a GCat over the final Cat of PCat, with 'GCat' indicating an entry on a particular level of metrical grid, 'PCat' a prosodic category, and 'Cat' either a grid entry or a prosodic category (Hyde 2007).

One example of a constraint using this scheme is **NON-FIN($X_F$, μ, σ),** which Hyde (2007) uses to account for the common cross-linguistic tendency for stress to prefer heavy syllables to light ones. Violations and satisfactions of this constraint are demonstrated in (4) below.

(4) Violation profile for **NON-FIN($X_F$, μ, σ)** (Hyde 2007)

| | **NON-FIN($X_F$, μ, σ)** |
|---|---|
| a.  | |
| b.  | * |
| c.  | * |

Given its first three arguments, what **NON-FIN($X_F$, μ, σ)** bans is the occurrence of a foot-level gridmark over the final mora of a syllable. As indicated by the structure of the final syllable in (4b) and the initial syllable of (4c), this constraint is violated by any stressed light syllable. These violations occur because the grid mark for the foot (i.e. the topmost mark in each grid representation of (4)) is located above the single mora of that syllable. On the other hand, (4a) shows that a stressed syllable which is heavy satisfies this constraint, since it has an additional mora which is syllable-final yet is not dominated by any foot-level grid mark. The constraint **NON-FIN($X_F$, μ, σ)** thus evaluates a monomoraic stressed syllable as less harmonic then a bimoraic one, accounting for the common tendency of weight sensitivity in stress languages.

The flexibility that Hyde's (2007, 2011) grid-based formalization of nonfinality provides in terms of the prosodic categories that can be used as constraint arguments allows this scheme to account for a range of phenomena that includes not only weight sensitivity but also rhythmic lengthening and minimal word restrictions. However, the approach is not without its weaknesses. First, unlike the repulsion constraint scheme proposed in the present work, the NON-FIN constraint scheme leaves all left-edge prosodic phenomena completely unaccounted for. Second, the use of the grid formalism necessitates recognition of an entirely separate edifice for metrical structure in addition to prosodic representations. Hyde (2011) states this very clearly when he explains that in his system of nonfinality, metrical structure and prosodic structure are independent of each other. Despite the noted advantages of the grid-based analysis, it would be preferable to find a way to account for the same range of phonological phenomena without recourse to the use of a separate, formalized structural system of representation in addition to canonical prosodic structure.

Fortunately, the concept of prosodic repulsion provides such a solution, meeting the output-based parallel derivational requirements of OT while also overcoming the weaknesses of both the head-based and grid-based nonfinality constraints discussed above in this section. Repulsion constraints thus subsume not only all previous work in extrametricality, but also both of the contending versions of nonfinality proposed by Prince and Smolensky (1993/2004) and Hyde (2007, 2011).

In addition to this, repulsion constraints cover a much wider range of phonological phenomena than any of their theoretical predecessors both within and beyond the realm of metrical and prosodic phonology, and do so with a manageable set of typological predictions. What's more, repulsion provides an underlying theoretical motivation for what have heretofore been merely unexplained descriptive devices. The concept of repulsion thus owes a huge debt to the developments previously made with the devices of extrametricality and nonfinality, but also takes up where they left off, carrying the theoretical torch onward in new directions.

### 2.3 Theoretical desiderata

To supplement the theoretical background of prosodic repulsion, two key desiderata of phonological theory will be discussed in this subsection. These two points, which apply specifically to the constraints seen in OT and other related constraint-based theories, form two of the major aims which the program of research initiated by the proposal of this project strives to achieve. The first desideratum concerns the negative framing of markedness constraints, while the second is about simplification of the grammar.

It is generally desired theoretically that markedness constraints in OT and other constraint-based theories be framed negatively as bans on illicit structural configurations, rather than as positively stated structural requirements (de Lacy 2006). We can understand why by considering the basic nature of constraints in OT, according to which the most fundamental classification of constraints is the binary division between *faithfulness* and *markedness*. While the basic function of faithfulness constraints is to protect the marked forms encoded in the lexicon by enforcing correspondence between input and output forms, the basic function of markedness constraints is to militate against these marked structures and configurations, which is why it is preferred that they be framed negatively (Prince and Smolensky 1993/2004).

Furthermore, within the theoretical framework of OT, the positive and productive aspects of language are reserved for the component of the grammar known as the GENERATOR. According to the property of *freedom of analysis,* this component is granted an unlimited license to produce phonological form and structure. It is then the job of the constraint component to strain through the virtually infinite products of the GENERATOR, filtering out all of the marked forms and structures to leave only optimal ones remaining (Prince and Smolensky 1993/2004). As such, the job of markedness constraints is not to build well-formed structures, but rather to eliminate ill-formed ones. This basic filtering function is reflected in the very name of the theoretical device that fulfills this function, since the job of markedness *constraints* is to *constrain* the outputs of the GENERATOR[1].

Given these negatively framed properties and functions of markedness constraints, one of the general theoretical goals of phonological analysts is present any newly proposed constraints as negative structural bans, and to reformulate existing positively stated structural requirements in negative constraint form (de Lacy 2006). In examining the grammatical mechanism needed to assign violation marks for constraints, de Lacy (2011) discusses this general program of constraint reformulation. He points out that while some positively stated constraints such as **ONSET** can be negatively reformulated in a relatively straightforward fashion, others such as **FTBIN** are more difficult to reformulate in negative terms.

The scheme of repulsion constraints proposed in the present work represents an attempt to answer this challenge to formulate and reformulate constraints negatively. Several examples of this attempt have been provided above, starting with two negative reformulations of **ONSET**, Kager's (1999) $\boldsymbol{*[_{\sigma}V}$ and Downing's (1998) ***ALIGNL** $\boldsymbol{(\sigma, \mu_S)}$, both of which satisfy the desideratum on markedness constraints by militating against the alignment of two phonological entities.

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1 I am indebted to Professor Tae-Yeoub Jang of Hankuk University of Foreign Studies for pointing out the negatively framed nature of the term *constraint.*

The next case dealt with in Section 2 is the constraint **FtBin**, which de Lacy (2011) uses as an example of a positively stated constraint that appears to defy negative restructuring. Despite this stated difficulty, the concept of prosodic repulsion allows us to reformulate **FtBin** easily, simply by positing a constraint that bans the alignment of a strong element at the edge of a foot, with the strong element being a mora in monosyllabic feet and a syllable in disyllabic ones[2]. In fact, all of the cases discussed in this paper represent examples of grammatically instantiated pressure against marked structures as embodied in negatively framed constraints.

The constraints proposed in this paper will be presented in shorthand notational form with the name **Repel**. Yet it should be kept in mind that all repulsion constraints are actually anti-alignment constraints. Each proposed constraint consists essentially of an ***Align** component specifying which elements resist each other, and a buffer component that indicates the minimal distance that must be maintained to hold those entities apart. As such, the entire program of research initiated by the proposal of repulsion constraints is meant to represent an effort to achieve the key theoretical desideratum of framing markedness constraints as negative bans on illicit structures, rather than as positive structural requirements.

The second key theoretical desideratum that the current proposal strives to achieve concerns the general drive to simplify the phonological grammar by reducing the formal apparatus needed to represent it. Connected ultimately to the learnability of a grammar, this drive toward simplification was first discussed in SPE and has existed as a constraining factor throughout the history of research in generative phonology. Most recently, the goal of simplification has reappeared in quantitative approaches as a measure of model complexity. Goldsmith and Riggle (2012) describe complexity as the "price" paid by any theoretical model, which should whenever possible be kept to a minimum. This concern has become especially important to research in OT,

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2 To complete the work of **FtBin**, a maximality constraint that caps the number of elements in a foot is also necessary. Though some may object that the replacement of a single constraint by two separate ones represents an unnecessary complication of the grammar, such a move actually satisfies another general desideratum of phonological theory, that complex constraints doing a lot of "work" be broken down into primitive constraints that have one simple task each. In addition, the vast simplification of the grammatical apparatus offered by repulsion constraints overwhelms any complication of the grammar brought on by the addition of a foot maximality constraint.

which has unfortunately come to be characterized by a veritable plague of unassociated and unmotivated *ad hoc* constraints.

Several significant attempts have been made in recent years to simplify the grammar by placing restrictions on possible constraint forms, or by collapsing and unifying the treatment of various phonological phenomena under a single constraint scheme. McCarthy and Prince's (1993) proposal of GA represents one such attempt, as does McCarthy's (2003) later attempt to tidy up GA by removing the possibility of gradient constraint violation. Other major works dedicated to the desideratum of simplifying the grammar include Eisner's (1999) work on constraint forms, de Lacy's (2002) dissertation on the formalization of markedness, and Potts and Pullum's (2002) model of constraint content in OT. Gouskova (2003, 2004) adds two more contributions to this list, the first of which deals with the economy of syncope, and the second of which proposes a relational hierarchy alignment model for various syllable contact restrictions across many languages.

Several excellent reasons for simplifying the grammar are laid out by Eisner (1999). First of all, restricting the formal apparatus of OT rather than allowing the rampant proliferation of *ad hoc* constraints results in an explicit and falsifiable theory of Universal Grammar, allowing an objective way for phonological theories to be tested and disproven. Second, it provides a way to simplify the overall theory by revealing formal similarities across apparently disparate constraints. Third, it supplies tools for linguists to be able to perform computational work on their theories regarding algorithms for acquisition, generation and parsing. Finally, it constrains phonological descriptions and helps phonologists frame descriptive generalizations more straightforwardly by providing representations and constraints that are both well-motivated and well-formalized.

The concept of prosodic repulsion has the potential to exemplify all of these possibilities. Like its predecessors mentioned above, the proposal of a general scheme for repulsion constraints put forth in this paper thus represents another attempt to simplify the grammar. It does so by bringing together several previously proposed constraints under a single umbrella, unifying them with a common form and function. The proposal thus allows us to sweep a plethora of unmotivated and apparently unrelated *ad hoc* constraints off the table. At the same time, this proposed constraint scheme can be utilized in order to provide new analyses for thorny old problems in phonology and to recast well known prosodic structures and phenomena in a new light.

## 3. Generalized Repulsion Constraint Scheme

A formal definition of the constraint template proposed in this paper is provided in (5) below, presented along the lines of McCarthy and Prince's (1993) GA constraint scheme.

(5) Generalized Repulsion

**REPEL(Cat1, Cat2, Edge, Buffer)** $=_{def}$

∀ Cat1 ∀ Cat2 such that Edge of Cat1 and Cat2 do not coincide.

Where

Buffer indicates the minimal distance between Cat1 and Cat2.

Cat1, Cat2, Buffer ∈ {PrWd, Foot, Syllable, Mora, Segment}

Edge ∈ {Right, Left}

In plain language, the **REPEL**[3] constraint form shown in (5) above states that no member of Cat1 may be aligned with any member of Cat2 at the specified Edge, with Buffer being the minimal distance required to keep them apart. Minimality specifically entails that, while additional elements may freely intervene between the two constituents being repelled from each other, there must minimally exist at least one token of the type of constituent specified as the buffer situated in between the two repulsed entities in order for the particular constraint to be satisfied.

The types of constituents that can appear as the Cat1, Cat2 and Buffer arguments make up a single unified set. While the members of this set may be subscripted in actual constraints to indicate their status as heads, or as strong or weak elements, their types are tentatively restricted to the entities laid out in the definition.

In order to provide examples of the types of forms which violate and satisfy this **REPEL** constraint form, we will use the sample constraint **REPEL(PrWd, Foot, R, σ),** which is the generalized form of the instantiation of this template that accounts for the apparent extrametricality of final syllables in English nouns and suffixed

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[3] The name *repel* has been chosen for this constraint scheme since it is the verbal form of the noun *repulsion*, with which it shares a root. Note incidentally that the adjectival form of this root chosen for use throughout this dissertation is *repellant* rather than *repulsive*, due to the negative connotation of the latter form.

adjectives. Forms which violate and satisfy this constraint, respectively, are provided in (6) below.

(6) A sample constraint: **REPEL(PrWd, Foot, R, σ)**
  (a) Violated by
    i. [(σ σ)]
    ii. [(σ σ) (σ σ σ)]
    iii. [(σ σ) C]
  (b) Satisfied by
    i. [(σ σ) σ]
    ii. [(σ σ) σ σ]
    iii. [σ σ σ σ]

All of the forms shown in (6a) violate the constraint **REPEL(PrWd, Foot, R, σ)**, and violations are categorical. In the case of (6ai) and (6aii), the constraint is violated because the right edge of the rightmost foot is directly aligned with the right edge of the prosodic word, without any buffer at all standing in between the two. The fact that (6aii) has an illicit foot makes no difference to the violation marks for the **REPEL** constraint, since the illformedness of that structure will be punished by a separate constraint that limits the size of feet to a maximum of two syllables.

In form (6aiii), the rightmost foot is not strictly aligned with the right edge of the prosodic word, but the distance between them does not suffice to fulfill the demands of the repulsion constraint, which requires a minimal distance between the two of at least a syllable. Since a consonantal buffer is not substantial enough to hold the foot away from the edge of the prosodic word, a violation mark is incurred. Incidentally, the illformedness of the consonant parsed within the PrWd but outside of the foot plays no role in determining violations of the repulsion constraint, since the wellformedness of that parsing will be regulated by structural markedness constraints on syllabic parsing.

In contrast to the forms shown in (6a), all of the forms appearing in (6b) satisfy the constraint **REPEL(PrWd, Foot, R, σ).** In (6bi) and (6bii) the foot and the prosodic word are misaligned at their right edges, and the distance between these edges is at least a syllable, satisfying all of the requirements of the repulsion constraint. On the other hand, form (6biii) satisfies the **REPEL** constraint vacuously, since there simply exists no Foot at all to be aligned with the prosodic word. This type of vacuous satisfaction of repulsion constraints is ubiquitous throughout the phonology of a language. This is because any two particular constituents that satisfy a repulsion constraint will stand misaligned not only with each other, but also with all other constituents of the relevant type, which are just too far away to incur any violations. Finally, it should be noted that whether the two unparsed syllables at the end of form (6bii) or the four unparsed syllables of form (6biii) incur violations of a separate Foot parsing constraint is irrelevant to the satisfaction of **REPEL(PrWd, Foot, R, σ),** which regulates only the alignment of the specified arguments.

Based on the formal definition of **REPEL(Cat1, Cat2, Edge, Buffer)** presented above in (5) and the examples of constraint violation and satisfaction shown in (6), it should be clear that the resemblance between repulsion constraints and GA constraints is only superficial, since there are a number of differences that set them apart from each other. These differences truly make a difference, not only in terms of how the two constraint types function in the grammar, but also in terms of the scope of their typological predictions.

First of all, repulsion constraints differ from those of GA because their first two arguments both require use of the universal operator, rather than one universal operator and one existential operator, as is the case with GA. This is because the nature of repulsion demands that *every* member of a specified constituent type necessarily be repelled from *every* instance of the other specified type. Let us consider how violation marks would be assigned if this were not the case, using a hypothetical repulsion constraint that uses the existential operator as its second argument.

(7) A hypothetical constraint: **REPEL**(∀ PrWd, ∃ Foot, R, σ)
(a) Violated by [ $(\sigma\ \sigma)_i$ ]
(b) Satisfied by [ $(\sigma\ \sigma)_i\ (\sigma\ \sigma)_j$ ]

What the hypothetical constraint in (7) technically demands is that for every prosodic word there exists at least one foot that is misaligned with it at the right edge. In the case of (7a), in which only a single foot is represented, a violation mark will be incurred since there does not exist even a single instance of a foot that is separated from the PrWd at the right edge, with the minimal distance between them of a syllable.

However, the real problem with the existential operator is illustrated by the form in (7b). Just as in the previous case, the rightmost foot is strictly aligned with the PrWd at the right edge, a structural configuration that would incur a violation of the hypothetical constraint if it happened to be the only Foot that appeared in the representation. Yet it is not. Recall that what the hypothetical constraint technically requires is that for every PrWd there exists at least one single foot that is misaligned with it at the right edge. This requirement is not met by the right-aligned $(\sigma\ \sigma)_j$, but it is indeed met by the left-aligned $(\sigma\ \sigma)_i$, which is separated from the right edge of the PrWd by more than the minimally required distance of a single syllable.

Since the particular structural configuration of the form in (7b) satisfies the hypothetical constraint **REPEL**(∀ PrWd, ∃ Foot, R, σ), this constraint does not do the job we need it do. This means that the existential operator will not suffice to define the function of repulsion constraints. What is needed instead is the universal operator, which demands that *every* member of the specified set resists alignment with *every* member of the other specified set, just as stated in the original definition provided in (5) above. Thus, both $[(\sigma\sigma)_i]$ and $[(\sigma\sigma)_i(\sigma\sigma)_j]$ from (7) above violate the repulsion constraint **REPEL (PrWd, Ft, R, σ)** since the universal operator applies to both of the first two arguments.

The fact that repulsion constraints must be defined with universal operators on both of the first two arguments carries interesting implications in addition to setting them apart functionally from GA constraints. First of all, it means that in the statement of repulsion constraints, the order in which the first two arguments are listed is completely irrelevant. If every member of the first specified set resists every member of the second specified set, then the constraints will assign the same violations regardless of which argument is listed first and which second. This is important to the enterprise represented by this proposal, since it represents a significant reduction in the number of typological predictions. For example, instead of needing to find both **REPEL(PrWd, Foot, R, σ)** and **REPEL(Foot, PrWd, R, σ)** working as active constraints in rankings of known languages, only "one of the two" needs to be found in order to provide empirical verification of the typological predictions, since they both function in precisely the same way. In fact, these two constraint representations are just alternative forms of precisely the same constraint.

The non-uniqueness of the initial two arguments of repulsion constraints also means that previously proposed constraints of the ***ALIGN** type such as Downing's (1998) version of **ONSET** need to be re-examined, since these constraints do not actually perform the functions desired by their proponents. The problem with these constraints is that the scope of negation is not specified, and the precise function of the constraint will change depending on how that scope is defined. At face value, using the universal and existential operators on the first two arguments of an ***ALIGN** constraint would mean that any form containing at least one single instance of the existentially specified constituent that is misaligned with the universally specified constituent would satisfy it. As shown by the forms in (26) and the ensuing discussion, we have already found such a formulation to be problematic. What this tells us is that using an "asterisked version" of GA does not suffice for capturing the patterns of misalignment in language, and that another scheme is necessary. Generalized Repulsion represents such a scheme.

One more difference in the formalism between GA and the newly proposed scheme of constraints is that the former requires specification of two edges, while the latter requires only one. There are two reasons for this. The first is that in the vast majority of the cases of repulsion that the author has found so far, both internal and external to the English language, only a single edge needs to be referenced. In most cases, it is either the left edge of both constituents that repel each other, or the right edge of both constituents.

Another reason for the single edge specification of Generalized Repulsion is that it leaves entirely untouched the realm of linguistics that the GA scheme was meant to encompass in referencing the edges of arguments individually. GA allows for separate reference of left and right edges because McCarthy and Prince (1993) originally intended to account for the morphological operation of affixation with GA constraints. For prefixation this would require alignment of the right edge of an affix with the left edge of a root or stem, and vice versa for suffixation. However, as no claims are made here for the relevance of repulsion to morphological operations such as affixation, there exists no need for individual edge reference.

The fact that the formal expression of repulsion constraints requires only a single edge reference comes with an additional economical advantage for the proposal: a further reduction of typological predictions. While the proposal of a new GA constraint of the form **ALIGN**(Cat1, L, Cat2, R) also predicts typologically the existence of other constraints such as A**LIGN**(Cat1, R, Cat2, R), **ALIGN**(Cat1, R, Cat2, L) and **ALIGN**(Cat1, L, Cat2, L), analogous repulsion constraints are all collapsed into one form with a single edge reference, making typological predictions much more manageable.

Before bringing this section to a close, one final question needs to be addressed. In the section above on the general theoretical desiderata of constraint-based theories, it was asserted that markedness constraints should preferably be framed negatively, as bans on particular structural configurations, rather than as positively stated requirements. Since one of the goals of the present project is to fulfill this theoretical desideratum, the question of whether or not GR constraints are negatively framed demands serious consideration.

The simple answer to this question is yes – repulsion constraints are negatively framed. It must first be reiterated that although the notational convention **REPEL** does not explicitly contain an asterisk or any other marker of negation (e.g. **NO**/**NON**), repulsion constraints inherently function in a negative manner. This is because their fundamental function is to ban particular structural configurations by militating against the alignment of phonological constituents. As discussed above, one of the reasons repulsion constraints cannot be stated in the ***ALIGN** form is because this notational convention is already used for the GA scheme, which differs from GR with respect to the arguments included and the logical operators which define those arguments.

Yet despite the notational convention chosen for GR constraints, the work that they do is essentially the same as the work done by "classic" negatively framed markedness constraints. For example, Pater's (1999) ***NC̥** bans the alignment of a nasal segment and a voiceless obstruent, Prince and Smolensky's (1993/2004) **NONFINALITY** bans the alignment of a prosodic word and its head, Bradshaw's (1995) **NO-VELCONT-LAB** bans the alignment of a velar continuant with a labial segment, and Kager's (1994) ***FTFT** bans the alignment of two feet. The function of all of these negatively stated markedness constraints is to militate against the alignment of two elements or structures, which is precisely the role fulfilled by repulsion constraints.

Of course, what distinguishes GR constraints from the markedness constraints in the previous paragraph is that they not only ban the alignment of constituents, but also indicate the distance by which these two constituents must be kept apart, as specified by the buffer. For this reason it may be supposed that GR constraints are in fact positively stated, since they appear to specify not only an illicit structural configuration, but also the manner in which that illformedness may be resolved. One of the strengths of OT is that the *trigger* and *repair* of phenomena are handled independently, which means that markedness constraints can be satisfied in several different ways, with the optimal form in any particular situation being determined by the interaction of other constraints. As such, the postulation of a buffer argument may at first appear disadvantageous to the claim that GR constraints are negatively framed.

However, two points will be raised in response to this objection. The first is that repulsion constraints do not in fact specify precisely how illicit configurations should be resolved, but rather merely specify the *minimal distance* by which particular constituents must be separated. This minimality condition is not the same as a positive structural requirement, since there literally exist infinite ways in which any repulsion constraint can be satisfied. As long as one token of the specified minimal buffer intervenes between the two offending constituents, then any number of additional entities may also intervene along with it. Regardless of the type or number of additionally intervening entities, all of the infinite possible configurations this implies will satisfy the given repulsion constraint.

Furthermore, just as Pater (1999) demonstrated for the constraint ***NÇ̥**, repulsion constraints can be satisfied in several different ways, with the particular manner of satisfaction in any case being determined by the interaction of other constraints in that particular language. In order to avoid the alignment of two constituents as specified by a repulsion constraint, one of these constituents could be deleted, or another constituent could be epenthesized between them, or a constituent edge could be shifted, or the constituent type could be altered through the building or stripping down of prosodic structure, and so on. For any particular evaluation, the GENERATOR produces several candidates which represent various alternative means of satisfying the relevant repulsion constraint, and the most harmonic of these candidates is determined as the optimal form according to the ranking of other constraints in the language.

If repulsion constraints were positively stated structural demands, then this would not happen, and each constraint would always be satisfied in the same way, with the same structural configuration as required by that positively stated constraint. What we find in actual prosodic phenomena however, is that GR constraints are satisfied in many different ways for different types of structures in different languages, which is one of the hallmark characteristics of negatively framed markedness constraints.

One final point can made in response to the aforementioned objection that specification of a minimal buffer disqualifies repulsion constraints from being considered negatively. This point is that many other well-established markedness constraints which are commonly acknowledged as being negatively framed actually require the same type of information as repulsion constraints in their description. Sometimes this information is implicitly assumed, or added parenthetically as part of the constraint's explanation. For example, Prince and Smolensky's (1993/2004) **NONFINALITY** bans the alignment of a head foot at the right edge of the prosodic word. Yet implicit in this restriction is the fact that in order for this constraint to be satisfied, that foot must lie a minimum distance of at least a syllable from the edge of the word. Although this condition on satisfaction is not stated directly in the presentation of the constraint, it nonetheless exists implicitly as a crucial part of how violations are evaluated.

With other types of negatively framed markedness constraints, information analogous to the buffer of repulsion constraints is actually stated explicitly as part of the constraint's representation. For example, Alderete (1997) uses **$*\text{PLACELAB}^{2}_{\text{STEM}}$** to ban the occurrence of two place specifications in a single stem, and proposes several other constraints which frame various OCP restrictions as local conjunctions of negatively stated markedness constraints. In setting the domain of application as part of their formal representation, these constraints are basically setting the minimal distance which must occur between the specified elements, which is precisely the function achieved by the minimal buffer in repulsion constraints.

Given the functional similarity of buffers to the information included implicitly in constraints such as **NONFINALITY** and stated explicitly in constraints like **$*\text{PLACELAB}^{2}_{\text{STEM}}$**, it would simply be inconsistent to say that these types of constraints are negatively framed bans while claiming at the same time that repulsion constraints are not. When this observation is compounded with the arguments presented above regarding the minimality condition on buffers and the multiple means of satisfaction available for GR constraints, it is clear that repulsion constraints can safely be considered negatively framed bans on marked structures, thus satisfying one of the core theoretical desideratum of constraint-based frameworks such as OT.

One final remark to be emphasized regarding the proposal of a Generalized Repulsion constraint scheme is that essentially, the concept of repulsion is nothing new. As pointed out already, the roots of this concept lie in previous theoretical work on disalignment (cf. Downing 1998, Kager 1999) extrametricality (cf. Liberman and Prince 1977, Hayes 1980), and nonfinality (cf. Prince and Smolensky 1993/2004, Hyde 2007, 2011). The innovations of this proposal rest instead on two points. The first lies in the device of the buffer. Despite much previous work in disaligment, the minimal distance by which two constituents must be disaligned has never been formally specified in this way.

The second innovation of the GR proposal is that this project attempts to raise the phenomenon of disalignment from a marginalized status to a more central position in the grammar.[4] Previously, devices such as extrametricality have been largely used to account for exceptions to the general phonological rules of a language. Yet one of the major objectives of the current research plan is to demonstrate the vast extent to which disalignment plays a role across languages and various areas of phonology.

## 4. Summary and Conclusion

This paper has presented a formalized scheme for the representation of constraints that codify the force of prosodic repulsion, a concept first introduced by Hart (2015a) and expanded upon by Hart (2015b). Prosodic repulsion embodies a force of resistance between phonological entities which works together in concert with a force of attraction between entities to define and regulate prosodic structure. While this force of attraction has commonly been referred to as alignment, the force of repulsion can analogously be understood as disalignment. The proposed scheme for the formalization of such disalignment has here been dubbed *Generalized Repulsion* for the commonalities it shares with the constraint scheme proposed by McCarthy and Prince (1993), yet it differs from Generalized Alignment in several respects. First, the arguments of GR constraints indicating the relevant prosodic structures are both marked with the universal operator. Second, reference to only one edge is required. Third, an additional argument is included to represent the *buffer*, which is the minimal distance required between the two constituents that repel each other. With the introduction of this constraint scheme, the overall phonological grammar as a whole is simplified, and several previously unconnected phonological phenomena can be brought together under a single theoretical roof.

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