Overtly Headed XPs and Irish Syntax–Prosody Mapping

Nick Kalivoda & Jennifer Bellik
University of California, Santa Cruz

1 Introduction

Phonological phrasing reflects syntactic phrasing, but imperfectly. Match Theory (Selkirk, 2011) explains this imperfect mapping within the framework of Optimality Theory (Prince & Smolensky, 1993/2004): mapping constraints demanding isomorphism interact with prosodic well-formedness constraints that motivate mismatches. A number of recent analyses of Irish phonological phrasing (Elfner, 2012, 2015; Bennett et al., 2016, 2019) have been influential in shaping Match Theory. In particular, Elfner (2012) refined the definition of matching to refer not to edges only, but to terminal strings. Elfner (2012) also notices a ranking paradox in the Irish phrasing of V-S-OO compared to V-SS-O, and offers an analysis using Harmonic Grammar (Legendre et al., 1990). We also discover a second ranking paradox involving the effects of STRONGSTART in sentence-initial versus sentence-medial contexts.

In the present paper, we provide a solution to this ranking paradox using OT with strict domination by introducing an additional MATCH constraint that targets XPs with phonologically overt heads: MATCH(OhP,φ). All ranking arguments presented in this paper are derived from fully defined OT systems with complete candidate sets, since within OT, a candidate is optimal if it is better on a constraint ranking than *all* competitors admitted by GEN. For syntax–prosody mapping, candidates are ⟨syntactic tree, prosodic tree⟩ pairs, and as a result, the candidate space grows exponentially as the number of terminals in the trees grows. We surmount this problem using the Syntax Prosody in OT app (SPOT; Bellik et al., 2020) to automate candidate generation and evaluation, and OTWorkplace (Prince et al., 2020) to compute and analyze typologies.

The paper is organized as follows. Section 2 presents background information about Irish syntax and our assumptions about the visibility of the syntax to phonology, as well as the prosodic data. In §3.1, we explain the first ranking paradox, and show that it can be resolved by introducing a MATCH constraint that targets overtly headed syntactic phrases. However, the resulting system with MATCH(XP,φ) and MATCH(OhP,φ) does not solve the second paradox, which we address in §3.2 by refining the definition of STRONGSTART. The complete OT system that combines these solutions is presented in §4. Section 5 discusses and concludes.

2 Background

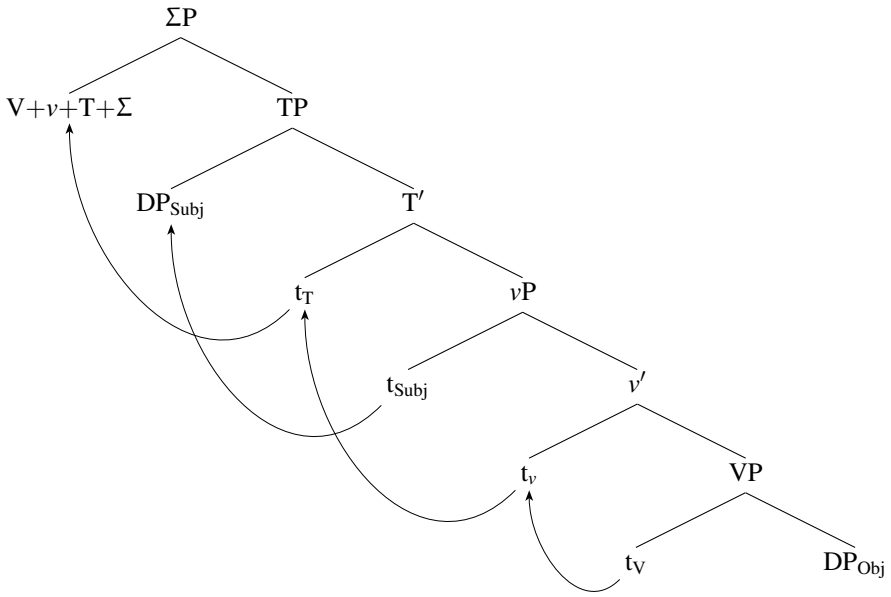
2.1 *Irish syntax* We follow Elfner (2012, 2015) in adopting the syntactic analysis of Irish clause structure developed by Chung & McCloskey (1987) and McCloskey (1991, 1996, 2001, 2011). According to this analysis, in a finite main clause, the verb undergoes successive head-movement through *v* and T to a polarity head Σ. The subject moves to Spec,TP, and if there is an object, it remains *in situ*.[1]

*We are grateful to Junko Ito and Armin Mester for comments and suggestions, and to everyone who has contributed to the SPOT project, especially SPOT co-creator Ozan Bellik. This work was supported by NSF Grant #1749368 to Junko Ito and Armin Mester. All mistakes are our own.

[1]We use '+' to indicate head-adjunction. V+*v*+T+Σ is an abbreviation for a complex head $[_{\Sigma}\ [_{T}\ [_{v}\ V\ v]\ T]\ \Sigma]$, and N+F abbreviates $[_{F}\ N\ F]$.

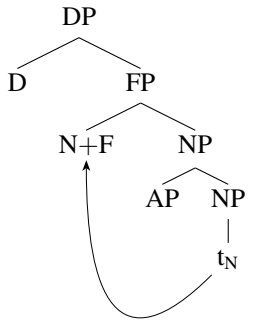
Proceedings of *AMP 2020*

(1) *Irish clause structure (VSO)*

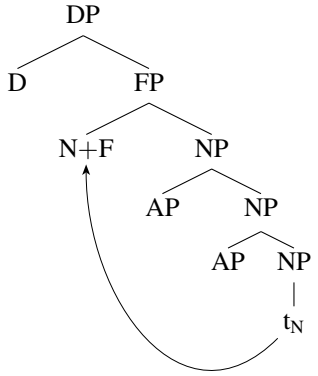


Within the DP, we follow Elfner (2012, 2015) and McCloskey (p.c.) in positing a functional head F between D and N, to which N obligatorily moves, deriving the correct noun-adjective word order.[2]

(2) *Irish DP with one adjective*



(3) *Irish DP with two adjectives*



2.2 *Prosodic hierarchy and the visibility of syntax to phonology* We assume that the phonology's view of the syntax is simplified in three major ways, following previous work. Firstly, syntactic projections that are [+minimal, +maximal] (non-branching XPs) are treated as X^0s by the MATCH constraints (4a).

Secondly, two XPs with the same overt terminal string are counted as a single XP by the MATCH constraints, and an XP that dominates no overt terminals is ignored by the MATCH constraints (Elfner, 2012) (4b). We also abbreviate complex heads by representing only their leftmost (most deeply embedded) adjunct, and omit traces.

Finally, XP labels such as TP, NP, and VP play no role in the phonology, and are replaced by the labels OhP (= overtly headed phrase) and ShP (silently headed phrase) (see Nespor & Vogel 1986 on the category-insensitivity of prosodic phonology) (4c). Of the branching XPs in the input trees in this study, every ΣP and FP is overtly headed: ΣP is headed by the moved verb, and FP is headed by the moved noun. All other branching XPs (TPs, DPs, NPs, *v*Ps, VPs) are covertly headed. They either have inherently silent heads, or lexical heads that have moved.[3]

[2]As will become apparent in §2.2, it does not matter for our purposes whether APs are adjoined to N or hosted within specifiers of dedicated functional projections above NP, as in cartographic syntax (Cinque, 2010).

[3]The head of AP does not move, but every AP in an input admitted by GEN is unary-branching, hence invisible anyway.

(4) a. Removing unary XPs: $[_{\Sigma P}$ V+v+T+Σ $[_{TP}$ N_i $[_{T'}$ t_T $[_{vP}$ t_i $[_{v'}$ t_v $[_{VP}$ t_V $(N_j)]]]]]]]$

b. After pruning and conflation: $[_{\Sigma P}$ V $[_{TP}$ N N]]

c. Eliminating category labels: $[_{OhP}$ V $[_{ShP}$ N N]]

We assume, following Elfner (2012, 2015), that the inventory of prosodic categories is limited to the set posited by Ito & Mester (2007, 2009a,b, 2010, 2013), with prosodic recursion being permitted and sometimes giving rise to different phonological phenomena at different levels of embedding (see also Ladd, 1986; Gussenhoven, 1991, 2005).

(5) *Prosodic hierarchy*

ι (the intonational phrase)
$>$ φ (the phonological phrase)
$>$ ω (the prosodic word)

In addition to its category label ι, φ, or ω, a prosodic constituent bears two features determined by its hierarchical relation to other constituents of the same category: [±minimal] and [±maximal]. A node of category κ is [+minimal] if and only if it does not contain any descendant of category κ, and [+maximal] if and only if it is not contained in any node of category κ. Phonological constraints can refer to combinations of these features.

2.3 *Prosodic data from Irish* Elfner (2012, 2015) presents a theory of phonological phrasing in Irish within Match Theory, in which phrasing can be inferred from the tonal diagnostics in (6).

(6) *Elfner's phrasing diagnostics for Irish*

a. LH leftmost ω of [−minimal] φ
b. HL rightmost ω of φ

These diagnostics allow us to interpret the tones in (7) to mean that *díofaidh*^{LH} and *rúnaí*^{LH} are at the left edges of non-minimal φs, while *dathúil*^{HL} and *blathanna*^{HL} are at right edges of φs. This suggests that the prosody of this sentence has the structure (*díofaidh*^{LH} ((*rúnaí*^{LH} *dathúil*^{HL}) *blathanna*^{HL})), which comes close to matching its syntactic structure. Likewise, in (8), the rise on *cheannaigh*^{LH} indicates that it is at the beginning of a non-minimal φ, while the falls on *múinteoirí*^{HL} and *bána*^{HL} mean that these words are at the right edges of φs.

(7) *V-SS-O* (Elfner, 2012:62)

díofaidh^{LH} *rúnaí*^{LH} *dathúil*^{HL} *blathanna*^{HL}
sell.FUT secretary handsome flowers

'A handsome secretary will sell flowers.'

(8) *V-S-OO* (Elfner, 2015:1198)

cheannaigh^{LH} *múinteoirí*^{HL} *málaí bána*^{HL}
bought teachers bags white

'Teachers bought white bags.'

Applying these diagnostics to transitive and intransitive sentences with default word order and one, two, or three words in each DP yields the phrasings in (9), reported by Elfner (2012). These phrasings reveal that Irish φs are usually isomorphic to XPs. However, they sometimes deviate from perfect syntax–prosody matching (9a, b, d) to satisfy prosodic markedness constraints, primarily STRONGSTART and BINARITY.

(9) *Phrasings proposed by Elfner (2012, 2015)*

a.	V-SS	→	$((V^{LH}\ S^{HL})\ S^{HL})$	(mismatch)
b.	V-S-O	→	$(V^{LH}\ (S\ O^{HL}))$, $((V^{LH}\ S^{HL})\ O^{HL})$	(match, mismatch)
c.	V-SS-O	→	$(V^{LH}\ ((S^{LH}\ S^{HL})\ O^{HL}))$	(match)
d.	V-S-OO	→	$((V^{LH}\ S^{HL})\ (O\ O^{HL}))$	(mismatch)
e.	V-SS-OO	→	$(V^{LH}\ ((S^{LH}\ S^{HL})\ (O\ O^{HL})))$	(match)
f.	V-SSS-OO	→	$(V^{LH}\ ((S^{LH}\ (S\ S^{HL}))\ (O\ O^{HL})))$	(match)
g.	V-SS-OOO	→	$(V^{LH}\ ((S^{LH}\ S^{HL})\ (O^{LH}\ (O\ O^{HL}))))$	(match)

These are the mappings that we aim to capture in our analysis below.

3 Analytical Puzzles

3.1 *Puzzle 1: Overt Headedness* The puzzle noticed by Elfner (2012) concerns the rankings needed to account for the complete pattern of matching and mismatching in Irish. Rebracketing occurs in V-SS (9a) and V-S-OO (9d), which are phrased as ((V S) S) and ((V S)(O O)). These mismatches occur in order to avoid having an initial phonological word be sister to a φ, which would violate STRONGSTART, defined in (10).

(10) Elfner's STRONGSTART(ω) (paraphrased): Assign one violation for every node whose leftmost daughter is an ω, and is lower in the prosodic hierarchy than its sister constituent immediately to its right.

The rebracketing in ((V S) S) and ((V S) (O O)) demands the ranking STRONGSTART ≫ MATCH(XP,φ). But rebracketing is blocked in (9e, f, g) by binarity; *((V S S)(O O)) and similar alternatives contain ternary φs, indicating that BINMAX(φ,branches) ≫ STRONGSTART (see (18) in Elfner, 2012:161). BINMAX(φ, branches) is defined in (11).

(11) BINMAX(φ, branches): Assign a violation for every φ that has more than two immediate daughters.

However, rebracketing is also blocked in V-SS-O (9c), which receives a faithful parse that violates STRONGSTART. Why do we not see *((V S)(S O))? The unattested rebracketed phrasing satisfies binarity and STRONGSTART, but violates MATCH. To avoid the unattested rebracketing of V-SS-O, we need the ranking MATCH(XP,φ) ≫ STRONGSTART. But this is a ranking paradox; the Elementary Ranking Conditions (ERCs; Prince, 2002) for these two winners are contradictory, as shown in (12).

(12) *Contradictory ERCs*

Input	Winner	Loser	ST ST	MATCH (XP,φ)	BIN MAX
[V [[N A] N]]	$(V^{LH}\ ((N^{LH}\ A^{HL})\ N^{HL}))$	$(((V^{LH}\ N^{HL})\ A^{HL})\ N^{HL})$ $((V^{LH}\ N^{HL})\ (A\ N^{HL}))$	$L_{1>0}$	$W_{0<2}$	$e_{0=0}$
[V [N [N A]]]	$((V^{LH}\ N^{HL})\ (N\ A^{HL}))$	$(V^{LH}\ (N^{LH}\ (N\ A^{HL})))$	$W_{0<2}$	$L_{1>0}$	$e_{0=0}$

To resolve this paradox, we need a constraint that penalizes mismatching the subject in V-SS-O more than it penalizes mismatching the TP containing both subject and object. One difference between these XPs is that the matched subject FP is overtly headed, while the mismatched TP is not. We therefore define the additional MATCH constraint in (13).

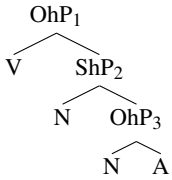
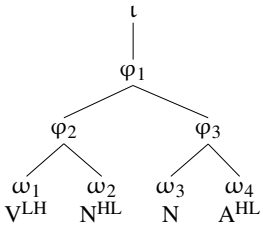
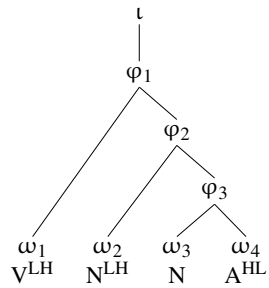
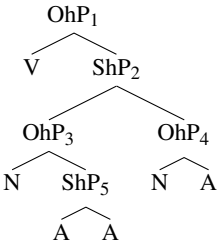
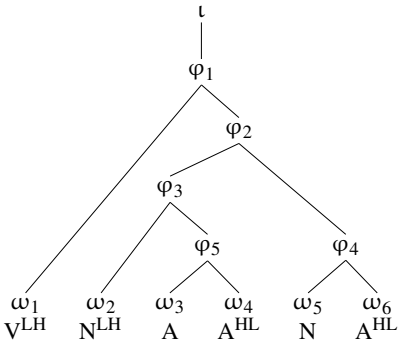
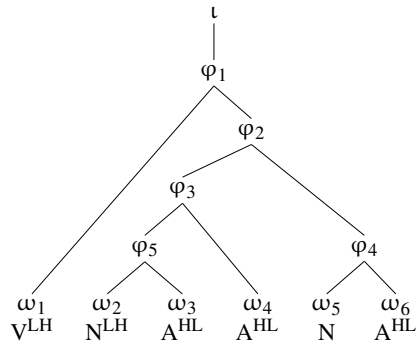
(13) $\text{MATCH}(\text{XP}_{\text{OvertlyHeaded}},\varphi)$ (abbreviated as MATCH(OhP,φ))
Assign a violation for every OhP (overtly headed XP) that does not have a matching φ in the output.

This constraint is also proposed by Van Handel. We will show in detail in §4 that the introduction of MATCH(OhP,φ),[4] does indeed resolve the paradox.

3.2 *Puzzle 2: Toleration of medial "weak starts"* With the inclusion of the full candidate set, we discovered a second puzzle, depicted in (14). Tableaux for V-S-O, V-SS-O, V-S-OO, and V-SS-OO show that MATCH(OhP,φ) must outrank STRONGSTART, which in turn outranks MATCH(XP,φ), as established above. But for the perfectly isomorphic phrasings of V-SSS-OO and V-SS-OOO, MATCH(XP,φ) must dominate STRONGSTART.

[4]The distinction between OhPs and ShPs is reminiscent of a part of Truckenbrodt's (1995, 1999) Lexical Category Condition. However, we do not adopt the LCC, since our definition of XP-visibility differs in three crucial ways. (i) We follow Elfner (2012, 2015) in treating functional XPs like TP and ΣP as visible for mapping. (ii) ShPs are not invisible to all of the constraints we propose in §4, but are ignored by only one particular constraint. (iii) The distinction OhP/ShP is different from the distinction LexP/FuncP; a LexP might be silently headed, and a FuncP might be overtly headed.

(14) *Contradictory ERCs with plain* STRONGSTART

Inputs	Winner-Loser Pairs	MATCH (OhP,φ)	ST ST	MATCH (XP,φ)	BIN MAX
V-S-OO: 	Wins:  Loses: 	e	W	L	e
V-SSS-OO 	Wins:  Loses: 	e	L	W	e

Considering the ω–φ sister sequences that are and are not tolerated, we can observe that the tolerable pair occurs ι-medially. In the first loser, ω_1–φ_2 is not tolerated. In the second winner, ω_2–φ_5 is tolerated. MATCH(OhP,φ) does not distinguish the winners and losers here. Both winners match all OhPs. This suggests a solution to the second puzzle through a refinement to STRONGSTART as in (15) to only penalize a rise in prosodic category when it occurs at the left edge of an intonational phrase.

(15) $\text{STRONGSTART}_{\text{Init}}$
Assign a violation for every ι-initial ω that is sister to a φ.

This indexation of STRONGSTART to the ι differs from Elfner's indexation of STRONGSTART to a

particular category in three respects. First, it is indexed to the category of the parent (ι), whereas Elfner's STRONGSTART is indexed to the category of the child that is prosodically weaker than its sister. Second, it penalizes a rise in prosodic category between the first child and *any* sister, rather than being restricted to a rise in category between the first and second sister as in Elfner (2012, 2015) and Selkirk (2011). This innovation was also independently suggested by Chen (2020), under the name STRONGSTRONGSTART. Finally, $\text{STRONGSTART}_{\text{Init}}$ treats an ω as ι-initial even if it is not an immediate daughter to the ι, exactly like STRONGSTART(κ,π) in Hsu (2016). These three modifications enable $\text{STRONGSTART}_{\text{Init}}$ to penalize the ι-initial rise in category ω_1–φ_2 in the first loser in (14), without penalizing ω_2–φ_5 in the second winner. If $\text{STRONGSTART}_{\text{Init}}$ replaces STRONGSTART in the above (14), it resolves the ranking paradox between STRONGSTART and MATCH. This is demonstrated in the following section, which lays out our full analysis.

4 Analysis

By combining MATCH(OhP,φ) and $\text{STRONGSTART}_{\text{Init}}$, we can capture the phrasing of all the transitive sentences in (9). We define an explicit OT system in the sense of Alber et al. (2016). GEN for our system consists of pairs of syntactic and prosodic trees. The syntactic inputs, defined in (16), are transitive and intransitive sentences, where each DP can have up to two adjectives. This GEN defines a number of trees for which we lack data, which were included in our calculation of the typologies and ranking arguments, but which will not be discussed in this paper for reasons of space. The input trees for which we do have data from Elfner (2012) are listed in (17).

(16) GEN *Inputs*
An input is a tree $[_{\text{OhP}}$ V $[_{\text{ShP}}$ DP (DP)], where each DP is of the form (a), (b), or (c):
a. N
b. $[_{\text{OhP}}$ N A]
c. $[_{\text{OhP}}$ N $[_{\text{ShP}}$ A A]]

(17) *Input trees*
a. *V-SS* = $[_{\text{OhP}}$ V $[_{\text{OhP}}$ N A]]
b. *V-S-O* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ N N]]
c. *V-SS-O* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ $[_{\text{OhP}}$ N A] N]]
d. *V-S-OO* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ N $[_{\text{OhP}}$ N A]]]
e. *V-SS-OO* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ $[_{\text{OhP}}$ N A] $[_{\text{OhP}}$ N A]]]
f. *V-SSS-OO* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ $[_{\text{OhP}}$ N $[_{\text{ShP}}$ A A]] $[_{\text{OhP}}$ N A]]]
g. *V-SS-OOO* = $[_{\text{OhP}}$ V $[_{\text{ShP}}$ $[_{\text{OhP}}$ N A] $[_{\text{OhP}}$ N $[_{\text{ShP}}$ A A]]]]

The prosodic trees in our system, defined in (18), are trees rooted in ι in which all intermediate nodes are branching φs, and terminal nodes are prosodic words. These were calculated with SPOT (Bellik et al. (2020)). Note that for an input tree with 6 terminals (V-SS-OOO), this GEN function yields 229 prosodic output trees, and an input with 7 terminals (V-SSS-OOO) yields 1,068 outputs, so automation is crucial.

(18) GEN *Outputs*
For an input *sTree*, an output *pTree* is a prosodic tree such that
a. Every maximal syntactic word X^0 in the input is mapped to an output phonological word ω.
b. The linear order of words is preserved.
c. The root node is of category ι.[5]
d. All non-terminal non-root nodes are of category φ.
e. Every node of category φ immediately dominates at least two other nodes.

[5] In bracketed string representations of trees, we sometimes omit the outer brackets $\{_{\iota}$ $\}$ for convenience, though the ι is always assumed to be present.

Having defined GEN for the system, we turn to the constraint set CON (19), which consists of two MATCH constraints enforcing syntax-prosody mapping, and two markedness constraints enforcing prosodic well-formedness. As discussed above, MATCH(OhP,φ) and $\text{STRONGSTART}_{\text{Init}}$ are our innovations in the analysis of Irish prosody (for an application of MATCH(OhP,φ) in Italian, see Van Handel, 2019).

(19) CON

a. *Syntax–prosody mapping constraints*

i. MATCH(XP,φ) (Selkirk, 2011; Elfner, 2012, 2015)
Assign a violation for every input XP that does not have a matching φ in the output, where matching is defined as in (20).

ii. $\text{MATCH}(\text{XP}_{\text{OvertlyHeaded}},\varphi)$ (Van Handel, 2019)
Assign a violation for every input OhP (overtly headed XP) that does not have a matching φ in the output, where matching is defined as in (20).

b. *Markedness constraints*

i. BINMAX(φ,branches) (Elfner, 2012, 2015)
Assign a violation for every φ that immediately dominates more than two nodes.

ii. $\text{STRONGSTART}_{\text{Init}}$ (new proposal)
Assign a violation for every ι-initial ω that is sister to a φ.

(20) *Definition of matching* (Elfner, 2012:, our wording)

Two constituents α and β are matching iff the terminal string of α is identical to the terminal string of β.

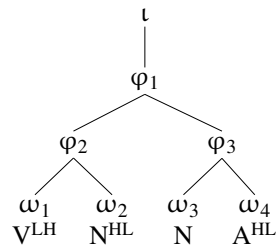
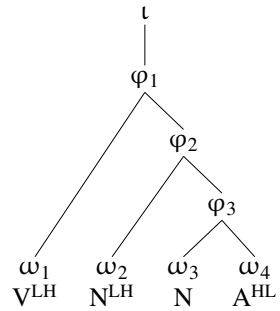
We created violation tableaux for this system using SPOT (Bellik et al., 2020), and calculated rankings and a typology using OTWorkplace (Prince et al., 2020). The typology, shown in (25) below, contains three languages, one of which (L2) is compatible with all the transitive inputs for Irish. However, none of the three captures the prosody of the single intransitive sentence for which we have data.

4.1 *The prosodic grammar of Irish* We will examine the ERCs in L2 ("Irish" in this system) for the three sentences (V-S-OO, V-SS-O, and V-SS-OO), in order to understand how the system derives the correct parses for each of these.

In the tableau for V-S-OO in (21), there are two possible optima.[6] The winner is a rebracketed, mismatching candidate (a). It violates MATCH(XP,φ), because ShP (the silently-headed TP) has no matching φ, but satisfies $\text{STRONGSTART}_{\text{Init}}$. The isomorphic loser (b) satisfies MATCH(XP,φ), since OhP is mapped to φ_1 and ShP is mapped to φ_2. However, it fatally violates $\text{STRONGSTART}_{\text{Init}}$ because ω_1 is sister to φ_2. The success of mismatching candidate (a) here shows that STRONGSTART outranks MATCH(XP,φ) in this language.

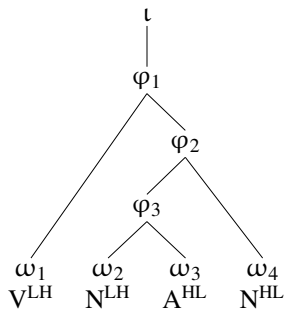
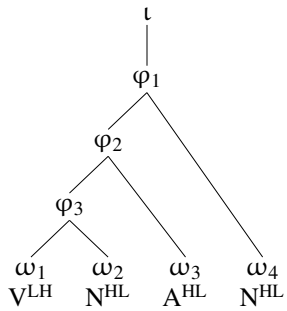
[6]Our tableaux here contain only non-harmonically-bounded candidates. Candidates found to be harmonically bounded using OTWorkplace were considered, but are not informative about ranking information.

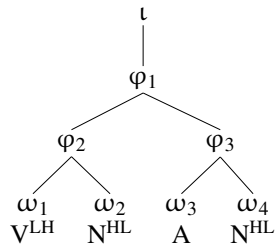
(21) *Tableau for Irish V-S-OO (2/2 optima; 10 HBs omitted)*

$[_{OhP}$ V $[_{ShP}$ N $[_{OhP}$ N A]]]	MATCH (OhP,φ)	ST ST_{Init}	MATCH (XP,φ)	BIN MAX
a. → 	0	0	1	0
b. 	e_0	W_1	L_0	e_0

To establish the ranking of MATCH(OhP,φ), we can examine the ERC in (22) for V-SS-O. This sentence receives a matching parse in Irish. The isomorphic winning candidate (a) fully satisfies MATCH(XP,φ), and by entailment MATCH(OhP,φ), but violates $STRONGSTART_{Init}$ since ω_1 is sister to φ_2. The losing candidates (b) and (c) tie on all constraints. Each violates MATCH(XP,φ) twice: neither the ShP (the TP) nor the smaller OhP (the subject) is matched. Each violates MATCH(OhP,φ) once, for the OhP subject. Neither violates $STRONGSTART_{Init}$. Combined with the ERC in (21), that in (22) for V-SS-O shows: MATCH(OhP,φ) ≫ $STRONGSTART_{Init}$.

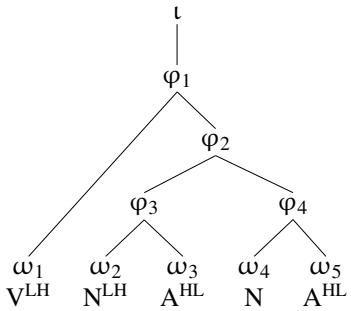
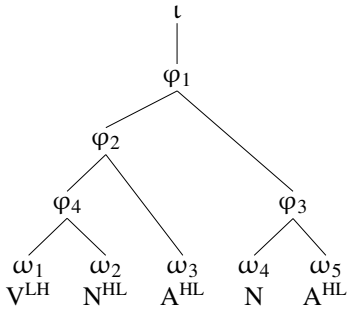
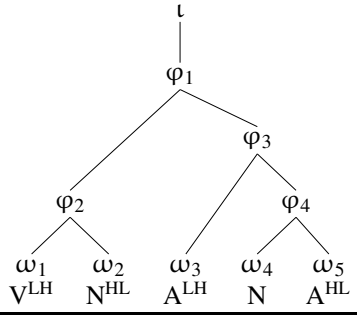
(22) *Tableau for Irish V-SS-O (3/3 optima; 9 HBs omitted)*

$[_{OhP}$ V $[_{ShP}$ $[_{OhP}$ N A] N]]	MATCH (OhP,φ)	ST ST_{Init}	MATCH (XP,φ)	BIN MAX
a. → 	0	1	0	0
b. 	W_1	L_0	W_2	e_0

c. 	W_1	L_0	W_2	e_0

The V-SS-OO case in (23) is similar to the V-SS-O case in (22), providing the same ERC. What these have in common is that it is impossible to phrase the verb with the word to its left, avoiding a $\textsc{StrongStart}_{\text{Init}}$ violation, without violating $\textsc{Match}(\text{OhP},\varphi)$. This is because a multi-word subject is an OhP. This is also the case for V-SSS-OO and V-SS-OOO, which also have fully matching phonological phrasings (tableaux not shown).

(23) *Tableau for Irish V-SS-OO (3/3 optima; 48 HBs omitted)*

$[_{\text{OhP}}$ V $[_{\text{ShP}}$ $[_{\text{OhP}}$ N A] $[_{\text{OhP}}$ N A]]]	$\textsc{Match}$ (OhP,φ)	$\textsc{St}$ $\textsc{St}_{\text{Init}}$	$\textsc{Match}$ (XP,φ)	$\textsc{Bin}$ $\textsc{Max}$
a. → 	0	1	0	0
b. 	W_1	L_0	W_2	e_0
c. 	W_1	L_0	W_2	e_0

4.2 *Factorial Typology* By looking at the rest of the factorial typology, we can better understand how the Irish pattern fits into the range of possible mapping patterns predicted by this system.

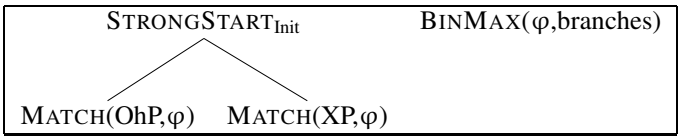
The grammars for the three languages here can be seen in the Hasse diagrams in (24), and the optima

for each language appear in the typology table in (25). Bold text in cells indicates a phrasing reported by Elfner.[7] The interaction of the three constraints follows a general pattern seen wherever two constraints are in a special-general relationship, and are both opposed by a third, call it the antagonist. MATCH(OhP,φ) is a special case of MATCH(XP,φ), since whenever MATCH(XP,φ) is satisfied, MATCH(OhP,φ) necessarily is, too. STRONGSTART$_{\text{Init}}$ is antagonized to both MATCH constraints: Since all syntactic inputs begin with a word (the verb) that is sister to an XP, all isomorphic prosodic structures would violate STRONGSTART$_{\text{Init}}$. Satisfying MATCH(XP,φ) entails violating STRONGSTART$_{\text{Init}}$, and vice versa. We can expect, therefore, that of the three languages, one will perfectly satisfy the antagonist (STRONGSTART$_{\text{Init}}$), one will perfectly satisfy the general constraint (MATCH(XP,φ)), and one will satisfy the special constraint (MATCH(OhP,φ)) but violate the general constraint.

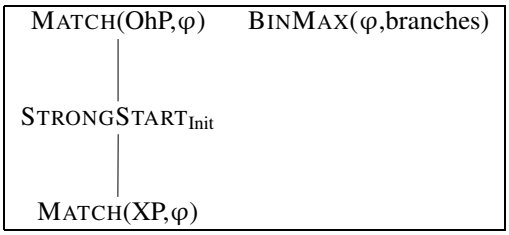
These predictions are borne out. In L1, the antagonist STRONGSTART$_{\text{Init}}$ is top-ranked (24a). Ranking STRONGSTART$_{\text{Init}}$ over both MATCH constraints results in rampant rebracketing; no prosodic output is isomorphic to the syntactic input.

The opposite pattern occurs in L3 (24c), where the general MATCH(XP,φ) is ranked over the antagonist STRONGSTART$_{\text{Init}}$. There is no crucial ranking between STRONGSTART$_{\text{Init}}$ and the more specific MATCH(OhP,φ). In L3, all prosody is isomorphic to syntax. This language always respects MATCH(XP,φ), even at the expense of STRONGSTART$_{\text{Init}}$; no rebracketing occurs. Between these two extremes, we find L2, in which the antagonist STRONGSTART$_{\text{Init}}$ is ranked between the special MATCH(OhP,φ) and the general MATCH(XP,φ) (24b). L2 always respects MATCH(OhP,φ), but will violate the general constraint MATCH(XP,φ) to satisfy STRONGSTART$_{\text{Init}}$. This ranking produces the intermediate matching/mismatching pattern seen in Irish, because it allows rebracketing of silently headed XPs, while blocking rebracketing of overtly headed XPs.

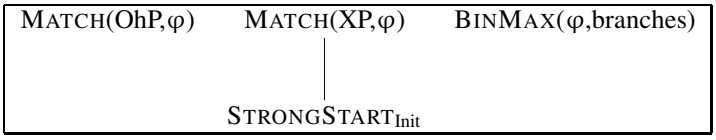
(24) a. *Grammar of L1*



b. *Grammar of L2 (Irish)*



c. *Grammar of L3*



[7] There is optionality in the phrasing of [V [N N]].

(25) *Factorial Typology*

	Input	L1	L2	L3
a.	$[_{O}$ V $[_{O}$ N A]]	**((V N) A)**	(V (N A))	(V (N A))
b.	$[_{O}$ V [N N]]	((V N) N)	**((V N) N)**	**(V (N N))**
c.	$[_{O}$ V $[[_{O}$ N A] N]]	(((V N) A) N) ((V N) (A N))	**(V ((N A) N))**	**(V ((N A) N))**
d.	$[_{O}$ V [N $[_{O}$ N A]]]	**((V N) (N A))**	**((V N) (N A))**	(V (N (N A)))
e.	$[_{O}$ V $[[_{O}$ N A] $[_{O}$ N A]]]	(((V N) A) (N A)) ((V N) (A (N A)))	**(V ((N A) (N A)))**	**(V ((N A) (N A)))**
f.	$[_{O}$ V $[[_{O}$ N [A A]] $[_{O}$ N A]]]	(((V N) (A A)) (N A)) ((V N) ((A A) (N A)))	**(V ((N (A A)) (N A)))**	**(V ((N (A A)) (N A)))**
g.	$[_{O}$ V $[[_{O}$ N A] $[_{O}$ N [A A]]]]	(((V N) A) (N (A A))) ((V N) (A (N (A A))))	**(V ((N A) (N (A A))))**	**(V ((N A) (N (A A))))**

5 Conclusion

To sum up, we have presented a solution in classic OT with strict domination to a known ranking paradox in Irish phrasing, in which a specialized version of MATCH outranks STRONGSTART, which in turn outranks the general MATCH. Rather than being indexed to maximal XPs (Ishihara 2014) or lexical XPs, this specialized MATCH is indexed to overtly headed XPs. This addition to Match Theory is also proposed by Van Handel (2019). A topic for further investigation is whether MATCH(OhP,φ) might be able to handle some data previously explained using the Lexical Category Condition (Truckenbrodt, 1999) or MATCH(LexP,φ).

We also found that the MT analysis of these Irish sentences benefits from a version of STRONGSTART that only applies sentence-initially. Although Bennett et al. (2016) and Elfner (2012) apply STRONGSTART sentence-medially in Irish, for the simple transitive sentences investigated here, STRONGSTART violations at the beginning of the sentence are less tolerable than those that occur mid-way through an intonational phrase. Hsu (2016) also employs a version of STRONGSTART indexed to the category of both the prohibited weak child and the ancestor that must start strongly (ι vs. φ), providing further evidence that this distinction is useful cross-linguistically.

The system explored here, although successful at describing all transitive sentences, was unable to account for the phrasing of the intransitive sentence $[_{OhP}$ V $[_{OhP}$ N A]] → ((V N) A), where rebracketing apparently applies to an overtly-headed XP. More work is needed to discover what factors might account for this exception, and to integrate the account here with other work on Irish phrasing (Elfner, 2012, 2015; Bennett et al., 2016, 2019).

Finally, this project contributes a methodological point: If the full set of candidates is not taken into account in syntax-prosody mapping (and indeed in OT more generally), errors will creep in (Karttunen, 2006; Bane & Riggle, 2012; Bellik et al., 2021). Using SPOT and OTWorkplace to define and study OT systems (Alber et al., 2016) brought our attention to candidates that pose problems for previous formulations of STRONGSTART (Puzzle 2), enabling the refined definition presented here.

References

Alber, Birgit, Natalie DelBusso & Alan Prince (2016). From intensional properties to universal support. *Language* 92:2, e88–e116.

Bane, Max & Jason Riggle (2012). Consequences of candidate omission. *Linguistic Inquiry* 43:4.

Bellik, Jennifer, Ozan Bellik & Nick Kalivoda (2020). Syntax–Prosody in Optimality Theory (SPOT). URL `https://spot.sites.ucsc.edu/`.

Bellik, Jennifer, Junko Ito, Nick Kalivoda & Armin Mester (2021). Matching and alignment. *Prosody and Prosodic Interfaces*, Oxford Studies in Phonology and Phonetics, Oxford University Press.

Bennett, Ryan, Emily Elfner & James McCloskey (2016). Lightest to the right: An apparently anomalous displacement in Irish. *Linguistic Inquiry* 47:2, 169–234.

Bennett, Ryan, Emily Elfner & James McCloskey (2019). Prosody, focus, and ellipsis in Irish. *Language* 95:1, 66–106.

Chen, Fulang (2020). On the left-/right-branching asymmetry in mandarin tone 3 sandhi. Presentation at AMP 2020.

Chung, Sandra & James McCloskey (1987). Government, barriers and small clauses in Modern Irish. *Linguistic Inquiry* :18, 173–237.

Cinque, Guglielmo (2010). *The Syntax of Adjectives: A Comparative Study*. MIT Press.

Elfner, Emily (2012). *Syntax-Prosody Interactions in Irish*. Ph.D. thesis, University of Massachusetts Amherst.

Elfner, Emily (2015). Recursion in prosodic phrasing: evidence from Connemara Irish. *Natural Language & Linguistic Theory* 33, 1169–1208.

Gussenhoven, Carlos (1991). The English rhythm rule as an accent deletion rule. *Phonology* 8, 1–35.

Gussenhoven, Carlos (2005). Procliticized phonological phrases in English: evidence from rhythm. *Studia Linguistica* 59, 174–193.

Hsu, Brian (2016). *Syntax-Prosody Interactions in the Clausal Domain: Head Movement and Coalescence*. Ph.D. thesis, University of Southern California.

Ito, Junko & Armin Mester (2007). Prosodic adjunction in Japanese compounds. Miyamoto, Y. & M. Ochi (eds.), *Formal Approaches to Japanese Linguistics: Proceedings of FAJL 4*, MIT Department of Linguistics and Philosophy, vol. 55 of *MIT Workping Papers in Linguistics*.

Ito, Junko & Armin Mester (2009a). The extended prosodic word. Grijzenhout, J. & B. Kabak (eds.), *Phonological Domains: Universals and Deviations*, Mouton de Gruyter.

Ito, Junko & Armin Mester (2009b). The onset of the prosodic word. Parker, S. (ed.), *Phonological Argumentation: Essays on Evidence and Motivation*, Equinox.

Ito, Junko & Armin Mester (2010). Recursive prosodic phrasing in Japanese. *Proceedings of the 18th Japanese/Korean Conference*, CSLI, Stanford, vol. 55 of *MIT Workping Papers in Linguistics*.

Ito, Junko & Armin Mester (2013). Prosodic subcategories in Japanese. *Lingua* 124, 20–40.

Karttunen, Lauri (2006). The insufficiency of paper-and-pencil linguistics: The case of Finnish prosody. Miriam Butt, Mary Dalrymple & Tracy Holloway King (eds.), *Intelligent linguistic architectures: Variations on themes by Ronald M. Kaplan*, Stanford, CA: CSLI Publications, 287–300.

Ladd, D. Robert (1986). Intonational phrasing: the case for recursive prosodic structure. *Phonology Yearbook* 3, 311–340.

Legendre, Geraldine, Yoshiro Miyata & Paul Smolensky (1990). Can connectionism contribute to syntax? Harmonic Grammar, with an application. Ziolkowski, M., M. Noske & K. Deaton (eds.), *Proceedings of the 26th Regional Meeting of the Chicago Linguistic Society*, 237–252.

McCloskey, James (1991). Clause structure, ellipsis and proper government in Irish. *Lingua* :85, 259–302.

McCloskey, James (1996). Subjects and subject positions in Irish. Borsley, Robert & Ian Roberts (eds.), *The syntax of the Celtic languages: a comparative perspective*, Cambridge University Press.

McCloskey, James (2001). On the distribution of subject properties in Irish. Davies, William D. & Stanley Dubinsky (eds.), *Objects and other subjects*, Kluwer.

McCloskey, James (2011). The shape of Irish clauses. Carnie, Andrew (ed.), *Formal approaches to Celtic linguistics*, Cambridge Scholars Publishing.

Nespor, Marina & Irene Vogel (1986). *Prosodic Phonology*. Foris Publications.

Prince, Alan (2002). Entailed ranking arguments, URL `http://roa.rutgers.edu/article/view/510`. ROA-500.

Prince, Alan & Paul Smolensky (1993/2004). *Optimality Theory: Constraint interaction in Generative Grammar*. Wiley-Blackwell.

Prince, Alan, Nazarré Merchant & Bruce Tesar (2020). OTWorkplace.

Selkirk, Elisabeth (2011). The syntax-phonology interface. Goldsmith, John A., Jason Riggle & Alan C. L. Yu (eds.), *The Handbook of Phonological Theory*, Blackwell Publishing, 435–484.

Truckenbrodt, Hubert (1999). On the relation between syntactic phrases and phonological phrases. *Linguistic Inquiry* 30:2, 219–255.

Van Handel, Nicholas (2019). Case study: Matching XPs with overt heads in Italian. Presentation at 6th International Conference on Phonetics and Phonology.