ON THE NUMBER OF NUMERAL PROJECTIONS

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It has been proposed that grammatical number features are associated in some way with their own syntactic projection, usually called NumP; *cf*. Löbel (1990), Ritter (1991, 1993). This paper presents an analysis of some Modern Irish data which further supports the idea that number is syntactically active, and which provides evidence for two distinct types of number projection: a lower projection associated with grammatical number — often realized as plural inflectional morphology; and a higher projection associated with certain types of classifier expression, and with cardinality in a broader sense.

The focus of this paper is on the distribution and internal structure of *numeral* expressions, which — with the exception of Hurford (1975) — have not previously received much attention within generative grammar, to my knowledge. This neglect may be due to the fact that numeral expressions quite often display rather eccentric behaviors when compared with other nominal modifiers in a given language; since these behaviors are not easily handled even in language-particular terms, they may appear to have little to tell us about more universal aspects of noun-phrase syntax. For whatever reason, even relatively straightforward questions about numerals have received almost no discussion: for example, whether numeral phrases are endocentric and/or whether they have any hierarchical structure.[1]

In this paper, it is claimed that the constraints on word-order and agreement in Irish noun-phrases containing numerals — which a purely lexical treatment cannot account for — can be perspicuously handled by adopting a syntactic approach. It will also be claimed, somewhat tentatively at this stage, that this type of analysis may have a more general, crosslinguistic application, offering a possible account of the ordering restrictions on classifiers and numeral elements, observed in Greenberg (1972), and schematized in (1):

1.	a.	Numrl-Class-N	c.	Class-Numrl-N	e.	*Class-N-Numrl
	b.	N-Numrl-Class	d.	N-Class-Numrl	f.	*Numrl-N-Class

Before considering the Irish data, it is necessary to set out the theoretical assumptions which constrain the range of analyses. First, I assume that constituent order within noun-phrases is determined by core syntactic principles and mechanisms; that is, such orders are not the result of the type of 'post-syntactic' readjustment rules proposed in Chomsky (1995). At least with respect to Irish, I assume that noun-phrases have an articulated functional structure, with at least three functional projections {DP, AgrP, and NumP} above the thematic NP, and that Noun-Adjective (N-A) order is derived by a process of head-movement of the noun to a functional position above the adjective-phrase; see Cinque (1993), Longobardi (1994), amongst others. Thus, a phrase like *an fear cróga* ('the brave man') will have the representation in (2). Building on the work of

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[1] Naturally, it could be that there are no purely linguistic constraints on how numerals and noun-phrases can interact — though there may be cognitive constraints on their arithmetic structure, as Greenberg (1978) discusses. The assumption here that this is not the case, and that the behavior of numeral phrases is linguistically informative.

others, especially Guilfoyle (1990), Löbel (1990), Ritter (1991), I have argued for this type of structure in previous work; for a detailed analysis, see Duffield (in press, Chap. 5). Finally, following Kayne (1993), I assume that grammars universally 4exclude rightward movement and rightward adjunction.[2] With these theoretical constraints in mind, let us consider the data.

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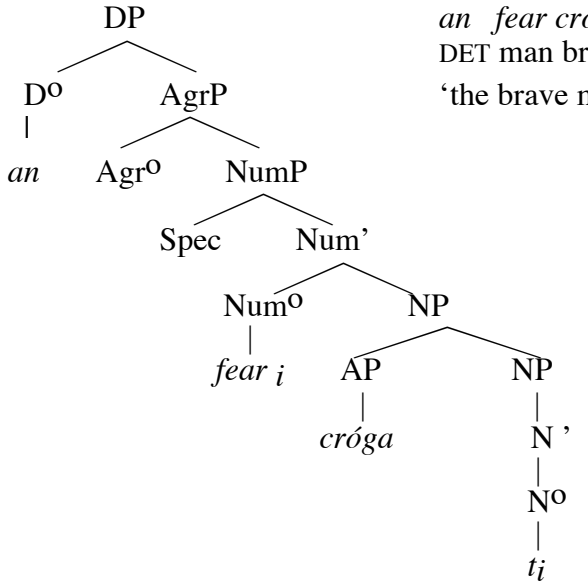

an fear cróga
DET man brave
'the brave man'

The Irish noun-phrases in (3-7) below illustrate part of a complex set of alternations in numeral placement, adjective agreement and initial consonant mutation (ICM) effects: numerals expressions, head-nouns, and modifying adjectives vary systematically in their surface realization and distribution according to whether the head-noun is singular or plural, and whether or not the noun-phrase contains a classifier element (CL). The point to note is that although several patterns are available, 'mixed patterns' are not permitted: the contexts where, for example, the modifying adjective must show singular or plural agreement, or when 'tens' must appear before or after the relational noun, are strictly defined.[3]

Complications arise through the interaction of two independent factors. The first of these is that certain numeral expressions are discontinuous. In the case of 'teens', for example, *units* appear pre-nominally while the *tens* follow the head-noun. This is shown by the examples in (3b-e). Notice that in these examples the postnominal numeral element *déag* ('ten') obligatorily *precedes* any modifying adjectives: — in (3b), for example, we find the order TEEN-LITTLE, not LITTLE-TEEN. Notice further that the head-noun is obligatorily realized as a singular, although the modifying adjective shows plural agreement. The adjective also obligatorily undergoes initial

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[2] This does not mean that I accept all parts of Kayne's system — the leftward adjunction of AP in (2) in fact violates Linearity — however, it seems reasonable to assume that if we can get by without rightward movement or adjunction, then we should: Irish being a strongly head-initial language, this is generally quite possible.

[3] Throughout this paper, I rely on the standard descriptions of the language — e.g. Christian Brothers (1960, 1990), Ó Huallacháin & Ó Murchú (1976). Native speakers and (otherwise highly proficient) second language learners show considerable variability and uncertainty in dealing with this aspect of noun-phrase syntax.

consonant mutation in this context, irrespective of the phonological characteristics of the preceding element: in (3b), for example, *beaga* is realized as [v'eg´]. Modern Irish orthography reflects these alternations quite directly: in these examples, the spirantization of /b/ is indicated by the immediately following <h>.[4]

3.	a.	dhá rud bheaga two thing-SG. little-PL 'two little things'	(base form: beag 'little') 2
	b.	dhá rud déag bheaga two thing-SG. ten little-PL 'twelve little things'	(*dhá rud bheaga déag) 12
	c.	na trí charr déag bheaga the three car-SG ten little-PL 'the thirteen small cars'	(*na trí charr bheaga déag) 13
	e.	na hocht gcarr déag bheaga the eight car-SG. ten little-PL 'the eighteen small cars'	(*na hocht gcarr bheaga déag) 18

Ó Huallacháin & Ó Murchú (1976:97n5) describe an alternative means of forming phrases involving the numerals 3-10. In this pattern, illustrated in (4), both the relational noun and any modifying adjectives are marked as plural; following the numerals 3-6, the head noun is now subject to a different mutation process known as anti-lenition, rather than lenition (whereby <h>-INSERTION is observed before vowel-initial nouns). In this usage too, modifying adjectives show a different pattern of consonant mutation effects — one which *is* sensitive to the phonological properties of the preceding element: adjectives are only spirantized following nouns that end in palatalized consonants. In (4a), for example, the plural adjective *móra* is lenited to *mhóra* following *báid* ('boats') but not following *caranna* ('cars'). Once again, the teen numeral *déag* obligatorily appears between the relational noun and any attributive adjectives, as in (4c) and (4d):

4.	a.	ceithre báid mhóra four boat-PL big-PL 'four big boats'	trí caranna móra three car-PL big-PL 'three big cars'

[4] The phenomenon of having teens straddle the noun in this fashion — in contrast to other numeral expressions — is not restricted to Irish: in the Aztec-Mayan language Nahuatl, both elements of the teen numeral generally appear to the left of the head noun, but they may also appear in the Irish pattern with only the unit numeral on the left, as shown below (from Launey (1981):

i.	niquitta màtlactli omeyi cuahuitl I-see ten three tree 'I see 13 trees'	*or*	niquitta màtlactli cuahuitl omeyi I-see ten tree x-three 'I see 13 trees'

b. naoi mbáid mhóra
nine boat-PL big-PL
'nine big boats'

naoi n-úlla beaga
nine apple-PL little-PL
'nine small apples'

c. trí paírceanna déag beaga
three field-PL. teen small-PL.
'thirteen small fields'

(*trí páirceanna beaga déag)

d. ceithre tithe déag aoldaite
four house-PL. teen whitewashed
'fourteen whitewashed houses'

(*ceithre tithe aoldaithe déag)

In (5), we observe that tens other than the teen numeral *déag* — i.e., '20-90' — appear to the right of the adjective-phrase, and are introduced by a reduced form of the conjunction *agus* ('and'), just in case a unit numeral precedes the head-noun. In contrast to the teen numeral, other decades may not intervene between the relational noun and the modifying adjective: in (5a), for example, we find the order LITTLE+AND TWENTY, not AND-TWENTY+LITTLE:

5. a. dhá rud bheaga is fiche
two thing-SG little-PL and twenty
'twenty-two little things'

(*dhá rud is fiche bheaga)

b. cúig theach mhóra is tríocha
five house-SG big-PL and thirty
'thirty-five big houses'

(*cúig theach is tríocha mhóra)

c. seacht gcapall bhána is seasca
seven horse-SG white-PL and sixty
'sixty-seven white-PL horses'

(*seacht gcapall is seasca bhána)

Where no unit numeral is involved, however, tens (10-90) *precede* the noun, as in (6). Just in this latter context, adjectives now obligatorily agree in number with the head-noun — that is, they show *singular* agreement; they are also spirantized according to the declension class of that noun:

6. a. fiche rud beag
twenty thing-SG small-SG
'twenty little things'

(*rud beag fiche)

b. caoga capall bán
fifty horse-SG white-SG
'fifty white horses'

(*capall bán caoga)

c. nócha fuinneog mhór
ninety window-SG large-SG
'ninety big windows'

(*fuinneog mhór nócha)

A final complication is that Irish makes frequent use of a restricted set of classifier elements (e.g. *ceann, cinn, cuid, cloigeann*) to express the number properties of the noun-phrase.

In this usage, the relational head-noun appears in a following, 'partitive', construction introduced by the proposition *de*, as in (7) below. In this construction, any modifying adjectives now agree in number and case with the (plural) noun. The teen numeral *déag* now appears to the right of the classifier but to the left of the partitive phrase:

7. a. trí cinn de charanna beaga (cf. 3a, 4a)
three CL DE car-PL little-PL
'three little cars'

b. aon cheann déag de charanna beaga
one CL ten DE car-PL little-PL
'eleven little cars'

c. seacht gcinn déag de lachain fhiáine
seven CL ten DE duck-PL wild-PL
'seventeen wild ducks'

d. ceithre cinn déag de thithe aoldaithe
four CL teen DE house-PL whitewashed-PL
'fourteen whitewashed houses'

These various alternations are summarized in (8), where the alignments to some extent anticipate the analysis. The challenge is to come up with a principled treatment of these distributions: one which accounts for the distributions themselves, for the alternations in number agreement, and for the initial consonant mutation facts. It should also be the case that this account does not violate any of the general assumptions that were appealed to earlier, in particular, the ban on rightward-movement and adjunction.

8. a. (DET)-UNIT-N_{SG}- $ADJP_{PL}$ (3a)
b. (DET)-UNIT-N_{SG}-TEEN-$ADJP_{PL}$ (3b)

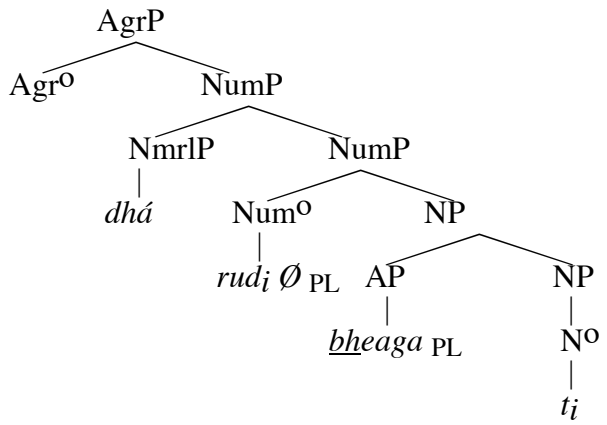
c. (DET)-UNIT-N_{PL}- -$ADJP_{PL}$ (4a)
d. (DET)-UNIT-N_{PL}-TEEN-$ADJP_{PL}$ (4c)

e. (DET)-UNIT-N_{SG}- -$ADJP_{PL}$-'*is*'-TEEN (5)
f. TEEN-N_{SG}- -$ADJP_{SG}$ (6)

g. (DET)-UNIT-CL-TEEN-de-N_{PL}-$ADJP_{PL}$ (7)

Consider, first, pattern (8a) as illustrated by example (3a) above. As mentioned earlier, I have argued in previous work that adjective-phrases are generated to the left of NP. It was also proposed — on the basis of 'simple' noun-phrases — that numerals and certain classifier expressions are base-generated in [Spec, Num']. If these two assumptions were correct — and no movement other than N^o-raising had taken place — then one could derive the pattern in (8a) by having the head-noun simply raise to Num^o, as in (9) below:

9.



Notice that in this representation the head-noun is adjoined to Num^{o}, rather than substituting for the Num^{o} head itself. This is an attempt to derive the (plural) number agreement exhibited by the modifying adjectives: in all of the examples in (3), the modifying adjective is obligatorily marked as plural, yet the noun is singular. Assuming this agreement to be grammatical, rather than semantic — as is strongly suggested by the contrastive and equally obligatory *singular* marking of the adjective-phrases in (6) — then the adjective must be agreeing with some element other than the head-noun. In the absence of any overt element bearing plural agreement, it appears justified to suppose that this is some abstract number morpheme (represented as *Ø* $_{PL}$ in (9)). Also in (9), the numeral phrase *dhá* is taken to occupy the [Spec, Num'], though it could also be that numerals are adjoined to this specifier position, rather than occupying it directly.

The choice between these two alternatives is probably irrelevant, however, since (9) is unlikely to be the correct analysis of the sentences in (3) overall. There are essentially two reasons for rejecting (9) as a possible analysis, the more obvious of these being that it cannot handle any of the other distributions diagrammed in (8). In particular, it is impossible to derive the minimally different examples involving 'teens' in (3b-e) from this representation without positing an illicit rightward-movement rule to place *déag* to the right of the head noun.[5]

A second reason for rejecting (9) as the analysis of pattern (8a) is that it fails to account for the mutation properties of unit numerals. In previous work, including Duffield (in press), I have claimed that the type of initial consonant mutation that is *in*sensitive to the phonetic properties of the preceding element — termed 'F-mutation' in that work — is triggered by

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[5] An implicit assumption is that all components of the numeral-phrase originate within the same projection. Of course, this is not necessarily correct, although it seems fairly intuitive, and is indirectly supported by the fact that whenever numerals appear in isolation — in 'counting contexts' — they appear as complex units, without conjoining elements like *agus*. This point is illustrated in (i):

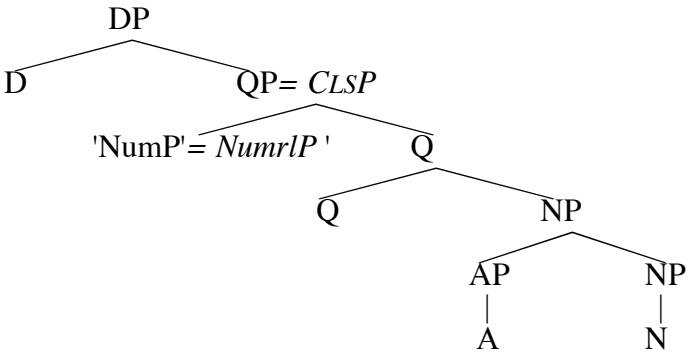
i.	a.	a haon déag	11	a.'	fiche a haon	21
	b.	a dó dhéag	12	b.'	fiche a dó	22
	c.	a trí déag	13	c.'	fiche a trí	23
	d.	a ceathair déag	14	d.'	fiche a ceathair	24

specific structural configurations; specifically that mutation triggers (the preceding elements) are invariably lexicalized functional heads. Every other F-mutation-trigger in Irish can be shown to be a syntactic head, rather than a specifier. In (9) however, the F-mutation trigger *dhá* occupies a specifier position, contrary to the F-mutation hypothesis.

Some recent work by Löbel (1990) suggests a way to make sense of at least a subset of these facts. In a comparative study of quantified noun-phrases, with particular focus on Japanese and German, Löbel shows that several cross-linguistically common patterns can be perspicuously represented by positing CLASSIFIER-PHRASES within the noun-phrase. A starting-point for Löbel's analysis is Greenberg's (1972) claim that certain logically possible orderings of numerals, classifier elements and head nouns — those given in (1e) and (1f) above — are unattested cross-linguistically.

Löbel proposes to generalize the type of structure required to provide a position for classifier elements and measure-nouns to *all* noun-phrases, even those involving no overt classifier morpheme: that is, she claims that all noun-phrases contain a classifier projection — which she labels QP — whose head may be phonologically empty if the relevant number features are realized on other elements, typically the head-noun.[6] The structure proposed by Löbel is reproduced in (12) below, together with some relevant examples from German and Vietnamese, respectively:

12.



a.	die	drei	Ø	großen	Blumen
	the	three		large	flowers
b.	die	drei	Liter	kalte(r)	Milch
	the	three	litre	cold	milk
c.		vier	Stück		Vieh
		four	head		cattle
d.		ba	con		trâu
		three	head (animate CL.)		buffalo

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[6] To account for the frequently observed complementarity between overt classifier elements and plural marking, Löbel appeals to Emonds' (1987) Invisible Category Principle, reproduced in (i):

(i) Invisible Category Principle
A closed category B with positively specified features C_i may remain empty throughout a syntactic derivation if the features C_i (save possibly B itself) are all alternatively realized in a phrasal sister of B.

The point to observe here is the proposed structural parallelism between a noun-phrase containing a classifier expression or measure noun in (12c) and (12d) and a regular quantified noun-phrase as in (12a).

Now, in the terminology adopted in this paper, Löbel's 'NumP' corresponds to what we have been calling 'NumrlP'; it should be thus be distinguished from our NumP, which represents grammatical number agreement, rather than hosting numeral expressions. Furthermore, there is some reason in Irish to distinguish positionally between classifier expressions and true quantifier phrases, such as *gach aon/achan* ('every'); see Duffield (in prep.). For this reason, we will re-label Löbel's QP as ClsP (Classifier Phrase), and NumP as NumrlP.

Upon first inspection, it might seem as if the (relabelled) structure in (12) would be no more successful in accounting for the Irish patterns than that given in (9): numerals would remain in an adjoined specifier position, the teen numeral *déag* in (3b-d) would still have to be moved rightward, and now the head-noun would appear on the wrong side of the adjective-phrase. However, rather than *substituting* the Classifier Phrase in (12) for the NumP in (9), the proposal is that we combine the two analyses: by positing *both* functional projections, together with a series of head-movement operations, it becomes possible to account for at least a subset of the distributional patterns summarized in (8), whilst retaining the restriction on rightward adjunction. Consider now the structure in (13) as a representation of (3b) — pattern (8b) — repeated here for convenience:

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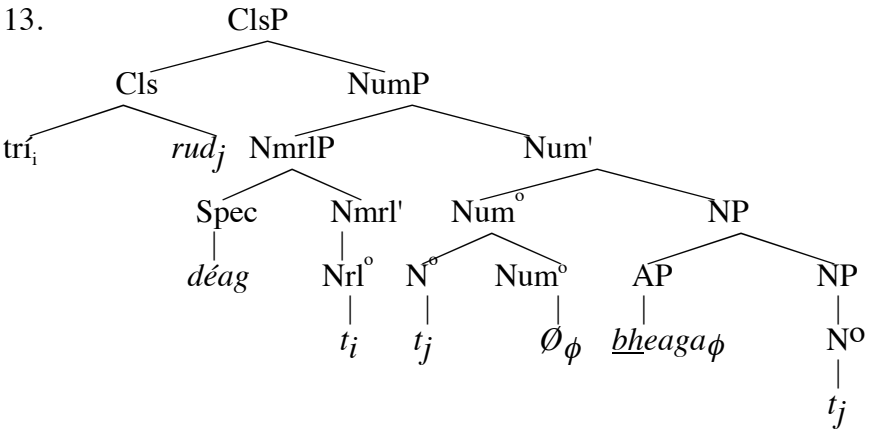

3. b. trí rud déag bheaga
three thing-SG. ten little-PL.
'thirteen little things'

In (13), the head-noun *rud* ('thing') has raised *via* head-to-head adjunction to Num^o, and thence *via* free substitution to the head of the Classifier Projection; the numeral head *dhá* has then raised independently, adjoining to *rud* in Cls^o. (Since Nmrl^o does not c-command Num^o, it seems reasonable to assume that it will not constitute a Minimality barrier for direct movement of the head-noun from Num^o to Cls).

Although this may seem an unnecessarily complex solution to the problem of deriving the post-nominal placement of *déag,* it turns out to have a number of theoretical and empirical advantages. First, as mentioned earlier, by positing an abstract morpheme in Num^o to which the head-noun adjoins, we can simultaneously account for the agreement properties of the adjective

and for the lack of any plural marking on the noun: it is the abstract morpheme which bears the number agreement and with which the adjective-phrase agrees.[7]

A second advantage of (13) is that by positing a separate null classifier-phrase in (3b) the same structure could be employed to derive those noun-phrases containing *overt* classifier-elements, such as those in (7) (pattern 8g). On such an analysis, the only difference between the two types of phrase would be the extent of overt N^o-raising: if the Cls^o were empty, the noun could raise past the numeral phrase — in [Spec, N'] — to that position, as in (14a, 3b); by contrast, if Cls^o were filled by an overt classifier, the noun would raise only as high as Num^o in the overt syntax, as in (14b, 7a). On this analysis, the partitive preposition *de* would be treated as some type of dummy case-marker: a similar conclusion is drawn in Ritter's (1991) analysis of the (typologically-related) free genitive constructions in Hebrew.

14. a. trí$_i$ <u>ch</u>arr$_j$ déag t$_i$ t$_j$ Ø$_\phi$ <u>bh</u>eaga$_\phi$ t$_j$ (3b)
three car-SG ten little-PL.
'thirteen small cars'

b. trí$_i$ cinn déag de <u>ch</u>aranna$_{\phi j}$ beaga$_\phi$ t$_j$ (7b)
three CL ten de car-PL little-PL
'thirteen small cars'

In fact, although this analysis would account neatly for the complementary distribution of head-noun *vs*. overt classifier, it is probably far too simplistic. A consideration of the structure of free genitive type constructions cross-linguistically suggests that *de* in (14b) is not merely a dummy case-marker, or that the structures are fully parallel; the fact that it blocks F-mutation on the adjective is only one indication of this. See Duffield (in press) for further discussion. However, even if the partitive phrase *de charanna beaga* in (14b) should be analyzed instead as an adjunct PP, Linearity considerations still require that it be *left*-adjoined to a noun-phrase projection, as in (15):

[7] By hypothesis, if the head-noun only adjoins to this category, then it need not pick up or check any inflectional features. Following Roberts (1993), I assume a principled distinction between three types of head-movement: free-substution, adjunction and morphologically-driven selection. By drawing these distinctions, it becomes possible to derive the difference between pattern (8b) and (8c): where the head-noun does get marked as plural as in (8c), this results from morphological-driven movement into the head of Num^o, rather than adjunction to an abstract head.

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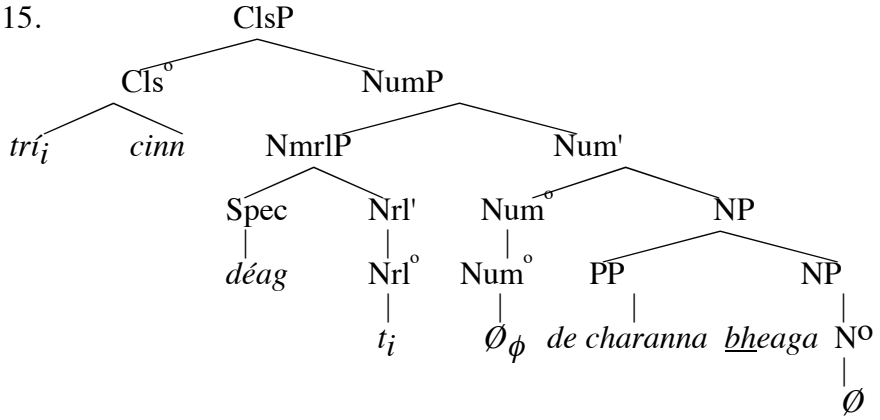

Whether noun-phrases containing partitive expressions such as those in (7) should be given a precisely identical analysis or not, there would appear to be no simpler solution to the problem presented by 'rightward teens' that does not violate the constraint on rightward movement. Suppose, for instance, that the head-noun raised *via* adjunction to the NumrlP head; if this were the case, then we would expect N°-Numrl°, rather than Nmrl°-N° order, given the ban on rightward adjunction. In fact, the only way to derive the discontinuity of the numeral-phrases, other than base-generating the Numeral-Phrase within NP — which would make exactly the wrong predictions with respect to adjective-placement — is just by positing some higher projection, here labeled ClsP, to which both the head-noun and the numeral head may independently raise.[8]

Finally, the analyses diagrammed in (12) and (15) would go some way toward explaining the different mutation effects induced by the unit numerals ('3-10'): unit numerals would trigger (phonetically conditioned) L-mutation on the head-noun that they adjoin in Cls°; in addition — by lexicalizing the functional head Cls° — F-mutation would be induced on any modifying adjectives. These two distinct mutation effects are diagrammed in (16a) and (16b) respectively:[9]

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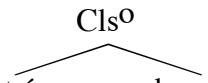
[8] Notice that on this analysis, it is necessary that in (13) the head of the classifier phrase should be radically empty when not filled by a classifier-element, so that N°-raising to Cls° counts as a substitution operation; if N°-raising to Cls° were a case of head-adjunction then the subsequent adjunction of the raised numeral would again violate Linearity, which admits of at most one adjunction to any head.

[9] These advantages notwithstanding, a number of serious and unresolved questions remain, even for the relatively limited set of data presented here. For example, there appears to be no way short of stipulation to derive the fact that (semantically) plural nouns must be marked as singular when they follow 'round tens' (i.e. '20, 30, *etc*. but not '21, 31') — as in (4), (pattern 6f.) — and that in these contexts attributive adjectives must bear singular, rather than plural agreement, but that in all other contexts, the same nouns may be marked either singular or plural and adjectives are invariably plural, when they follow unit numerals. Clearly, the problem is not that of coming up with two mechanisms of number agreement — this is achieved in (12) and (15) by positing a null morpheme in Num°; rather, the problem is with constraining the application of the two mechanisms to particular structural contexts.

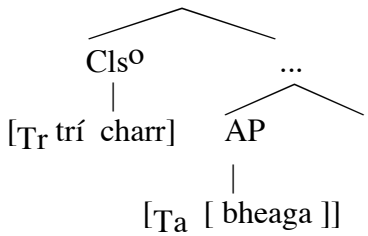
16. a.



L-mutation

trí ch<u>ch</u>arr (lenition) 'three cars'
seacht g<u>gc</u>arr (eclipsis) 'seven cars'

b.



F-mutation

Tr = F-Mutation Trigger
Ta = F-Mutation Target

In closing, it is worth speculating on whether and how this analysis of the syntax of Irish numerals might have a more general cross-linguistic application. Consider first how it might explain the ordering restrictions noted at the beginning of this article. If classifier and numeral expressions were both universally associated with projections *above* the thematic noun-phrase, and if rightward movement were disallowed in the syntax — as is proposed here — then Linearity considerations would correctly exclude the unattested orderings of numerals, classifiers and head-nouns schematized in (1e) and (1f) above: **Class-N-Numrl* order (1e) would be ruled out for want of an independent landing-site for N^{o}-raising between the head of ClsP and the (adjoined) Numeral Phrase, while the **Numrl-N-Cls* order in (1f) would be excluded by the impossibility of having a head-*final* Classifier Phrase. The fact that the constituent order in (1c) seems to be statistically considerably more common than the underlying order instantiated by Irish, namely (1a), suggests that the adjunction-site of numeral phrases may need to be parametrized if this analysis is extended, to allow numerals to adjoin either to ClsP (as in English, German, Vietnamese, etc.) or NumP (Irish, and conceivably Japanese). See Duffield (in prep.) for further discussion of Numrl-Class interactions in other languages.

To summarize, I have tried to make some sense of a fairly complex set of facts in Modern Irish that arise in noun-phrases containing numeral expressions. Although these data are intricate and in many respects highly idiosyncratic, their very systematicity calls for some type of explanation. The claim here is that a syntactic approach to the problem is a reasonably profitable one, and that the particular analysis presented here may well have some interesting cross-linguistic applications. At the very least, it is hoped that this paper will encourage further consideration of an underestimated area of noun-phrase syntax.

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