Detecting Contiguity-Prominence

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Richards (2010, 2016) proposes an account of why languages differ in the types of overt movement they exhibit:

(1) a. **Who** did Minswu see? [*English*]

b. Minswu-nun **nwukwu**-lul po-ass-ni? [*Korean*]

Minswu-TOP who-ACC see-PAST-Q

c. Jean **voit** souvent Marie. [*French*]

John sees often Mary

d. John often **sees** Mary. [*English*]

Languages may vary, for example, in whether they have overt wh-movement, as in (1a-b), and in whether they have overt movement of the verb to some higher functional head, as in (1c-d). Minimalist approaches to syntax have mechanisms to enforce overt or covert movement (strong and weak features, and their theoretical descendants), and we have discovered a great deal over the years about the nature of these kinds of movement. But the differences in (1) are generally described as parameters; a language must be specified for which kinds of overt movement it has, and these specifications are typically not taken to interact with any other properties of the languages. We know, in other words, that wh-movement (for example) may be overt or covert in a given language, but we do not know why.

It could be, of course, that 'why' is the wrong question. This is the bet that standard Minimalist approaches are making; the fact that English has a strong wh-feature on C is a fact

that the learner must learn, not connected to any other facts about English. Here I will explore the consequences of a different bet.

In Contiguity Theory, overt movement is driven by principles governing the relation between syntax and phonology. There are, for example, universal conditions on the prosody of wh-questions, and these conditions are met in different ways in different languages because of phonological differences between the languages in question (for instance, differences in how prosody is organized). On this account, there may be no purely syntactic parameters, or at least no parameters governing the distribution of overt and covert movement.

Richards (2016) posited a binary parameter distinguishing languages by what he called the position of *prosodic activity*. The idea was that languages would realize important prosodic phenomena (boundary tones, lengthening, and so forth) at one or the other edge of phonological phrases. Material which is on the prosodically active side of a phonological phrase was said to be *Contiguity-prominent*, and overt movement operations were driven by a need to achieve Contiguity-prominence. Richards (2016) claimed that the distribution of overt movement could be linked to claims in the existing literature about the prosodic systems of various languages, understood as reflecting the setting of the prosodic activity parameter.

The discussion of prosodic activity in Richards (2016) had several drawbacks, however. One can be exemplified by Richards' discussion of Irish, which crucially relied on Irish realizing prosodic prominence on the Left edge of prosodic phrases. But Irish is one of a number of languages that have been argued to in fact have prosodic phenomena associated with both edges of phonological phrases (see de Lacy (2003) on Maori, Selkirk (2011) on Xitsonga, Yasin (2012) on Jordanian Arabic, and Elfner (2012) on Connemara Irish). The status of such languages in Contiguity Theory was left unclear in Richards (2016).

Another problem was that the tests for prosodic activity differed from language to language; one language might realize prosodic activity via a boundary tone, for example, while another might realize it via lengthening. Of course, this could simply be accurate; it could be that there is no single marker of prosodic activity. But in sections 1 and 2, I will demonstrate two tests for the position of prosodic activity, in the sense relevant for our concerns, and I will try to show that these can be uniformly applied in different languages.

Sections 1 and 2 will primarily be concerned with the phonetic signals of prosodic activity, but I should be clear that the claim is not that syntactic movement operations are triggered by phonetic details. What will be important for our purposes is that the grammar computes relations of relative prosodic prominence, and that it begins to do so during the syntactic derivation[1], in a way that syntactic operations can be sensitive to. The phonetic details to be discussed in the following two sections are simply meant to be indicators of the phonetic implementation of a phonological representation, which in turn has effects on syntax.

I will offer a particular rule for assigning prosodic prominence at the beginning of section 4. We will see in the following two sections that this abstract syntactic notion of prominence has effects on pitch and on the length of certain vowels. We will also see, as we might expect, that pitch and vowel length are affected by numerous factors, some of them powerful enough to obscure the effects of syntactically determined prominence altogether. The goal will be to show that the effects of syntactically based prominence are robust enough to be useful in the classification of languages, even with these obscuring factors.

The claim that prosodic phenomena have some kind of connection to syntactic structure is certainly not new to Contiguity Theory. A long literature on the placement of nuclear stress,

[1] See Bresnan (1971, 1972) for another argument for this claim.

for example, tries to find algorithms to correctly link sentence-level stress with syntactic structure (see Chomsky, Halle, and Lukoff 1956, Liberman and Prince 1977, Selkirk 1984, Halle and Vergnaud 1987, Cinque 1993, Hayes 1995, Zubizarreta 1998, Arregi 2002, Kahnemuyipour 2009, and much other work). Similarly, a long literature has documented the fact that various types of prosodic phenomena are associated with the edges of prosodic constituents of various kinds, which correspond to some degree with the constituents of the syntactic tree; some of this literature played a role in the development of the original proposals about prosodic activity, in Richards (2016).

The tests to be developed in this paper are entirely compatible with some of this literature. Section 1, for example, will discuss a downstep phenomenon found in English, among other languages, and English downstep is already discussed in the literature (see, for example, Pierrehumbert 1980). Similarly, Nespor and Vogel (1986) and Ghini (1993) discuss a phenomenon in Italian called Final Lengthening, which lengthens the stressed vowel in the word before a prosodic boundary. In section 2, I will discuss a test for prosodic activity which seems to detect the results of Final Lengthening in Italian, as well as in Russian and Brazilian Portuguese, and its absence in English, German, and Norwegian.

Another literature refers to a phenomenon, also called Final Lengthening, which is a candidate for a cross-linguistic universal (see Klatt 1975, Wightman et al 1992, Cambier-Langeveld 1997, Byrd and Saltzman 2003, Myers and Hansen 2007, Turk and Shattuck-Hufnagel 2007, 2020, Fletcher 2010, Cho 2015, 2016, Katsika 2016, Paschen et al 2022, and much other work). This version of Final Lengthening typically lengthens the rime of the last syllable of the word immediately before certain kinds of prosodic boundaries. The examples in section 2 will involve lengthening of stressed vowels, and none of the words involved will have

final stress, so this version of Final Lengthening appears to be orthogonal to the concerns of this paper.

Turk and Shattuck-Hufnagel (2007) argue that Final Lengthening in American English applies, not only to the rime of the final syllable of the word before a certain kind of prosodic boundary, but also to the vowel of the stressed syllable of that word (which, interestingly, need not be in penultimate position; that is, Final Lengthening can apply to discontinuous parts of this final word). Turk and Shattuck-Hufnagel's examples are of the form in (2):

(2) a. Please say [Michigan or Madison] and Vatican will play.

b. Please say Michigan or [Madison and Vatican] will play.

Turk and Shattuck-Hufnagel compare the lengths of phrase-final words (like *Madison* in (2a) and *Michigan* in (2b)) and phrase-medial words (like *Michigan* in (2a) and *Madison* in (2b)), and arrive at the conclusion that in this kind of example, Final Lengthening applies to stressed vowels, as well as to final rimes.

I think it is possible that Turk and Shattuck-Hufnagel have discovered an effect which is specific to the coordination structures in (2), or rather to the prosodic representations associated with such structures. Wightman et al (1992), working with a corpus that did not involve coordination, concluded that English Final Lengthening was confined to the final rime of the final syllable, and similar results have been found in other languages, using similar corpora (Cambier-Langeveld (1997), Paschen et al (2022)). The extent to which Final Lengthening can apply to a larger domain than the final syllable of the word is apparently still an open one, subject to variation both across languages and across types of grammatical structures. None of the data I consider in section 2 below will involve the kind of coordination in (2), and none of the English data will show the effects of the kind of Final Lengthening Turk and Shattuck-Hufnagel

discovered. It would be an interesting project, which I will leave for future work, to look for the kinds of results I report below in the type of coordination structure that Turk and Shattuck-Hufnagel concentrated on.

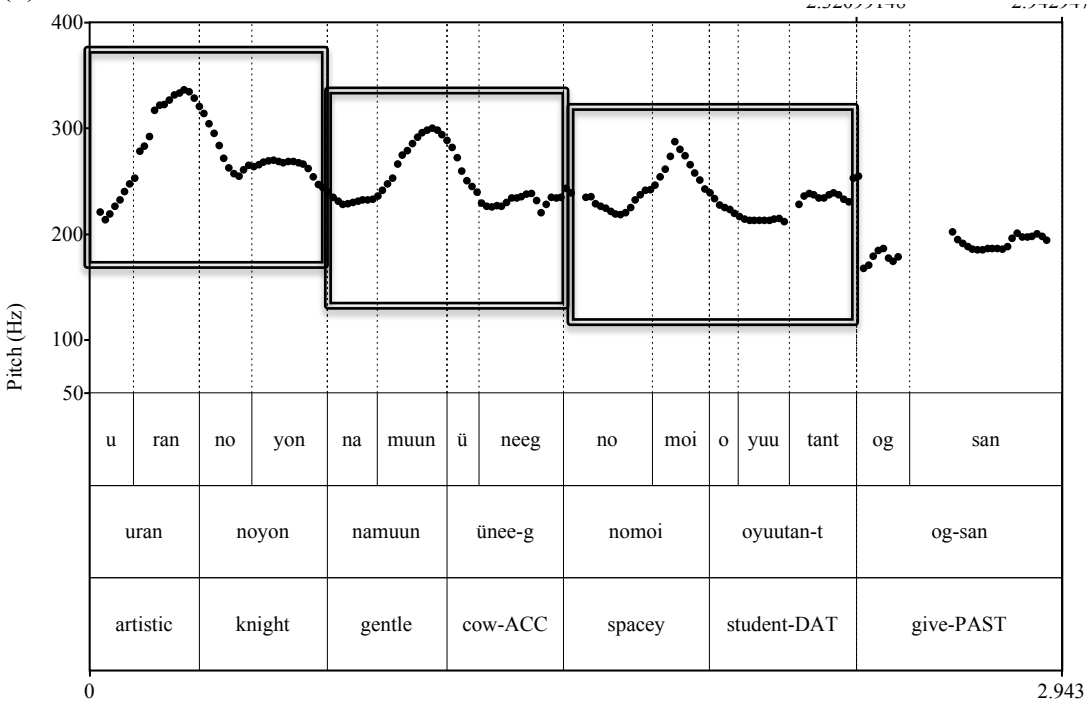
Similarly, I will leave for future work the question of how to reconcile the data described below with the literature on Nuclear Stress referred to be above. We will see evidence that an English noun phrase like *a foolish student* has greater prominence, in the relevant sense, on *foolish* than on *student*; the relevant data will have to do with the pitch and length of the stressed vowels of the adjective and the noun. This is not where the literature on Nuclear Stress would lead us to expect to find prosodic prominence; that literature typically places Nuclear Stress on the most deeply syntactically embedded element in a phrase (or, sometimes equivalently, the rightmost). As far as I am aware, the literature on Nuclear Stress is mostly not specific about the particular acoustic properties associated with prosodic prominence. One possibility is that Nuclear Stress is characterized by acoustic properties other than the ones of vowel length and vowel pitch that I will be discussing.

Sections 1 and 2 will be concerned with tests for prosodic activity, in the sense relevant to our concerns: section 1 will concentrate on a test involving pitch, and section 2 will be about a test involving vowel length. After discussing the tests and their results in the languages to which they have been applied so far, I will show how the results of the tests interact with the basic conditions of Contiguity Theory to yield desirable results.

1. One test for prosodic activity: the Pitch experiment

The first test for the position of prosodic activity has to do with downstep. In order to discuss this test, it will be useful to start by considering a distinction that is typically made in the literature on downstep. Consider the Mongolian pitch track in (3): (Urandari Byambadalai, p.c.):

(3)



'The artistic knight gave a gentle cow to the spacey student'

This sentence contains three DPs, the pitch tracks for which are in boxes. The first thing to note about the pitch track is that every word (with the possible exception of the verb) features a low-high sequence on its last two syllables; in other words, each word has its own pitch peak. There are two kinds of relations between these pitch peaks that are worth considering.

If we consider, for example, the highest pitch peak in each box, we can see that these peaks decrease in height as the sentence goes along. This is the phenomenon sometimes called *declination* (Cohen and 't Hart 1967, Ladd 1984, Poser 1984, and see Gussenhoven 2004: chapter 6 for discussion and further references); there is a general tendency for pitch to decline in the course of the sentence, and this tendency may be universal.

Next, we can pay attention to the two pitch peaks in each box. Here we can see that the first pitch peak (the peak on the adjective) is much higher than the second pitch peak (on the following noun). This is the relation I will refer to as *downstep*. We can see that downstep leads

to a more dramatic decline in pitch than declination; although declination guarantees that an adjective will have a lower pitch peak than the adjective in a preceding DP, the noun between those two adjectives is lower than either. As we will see, although declination is a candidate for a universal property of human speech, downstep is not.

For this test, we will be considering the relationship of relative pitch between an adjective and a noun within an NP. The experiment involves asking speakers to utter 10 sentences like the following, with branching, indefinite subjects and objects:

(4) In this novel, a **foolish student** awakens an **evil demon** while camping in the woods.

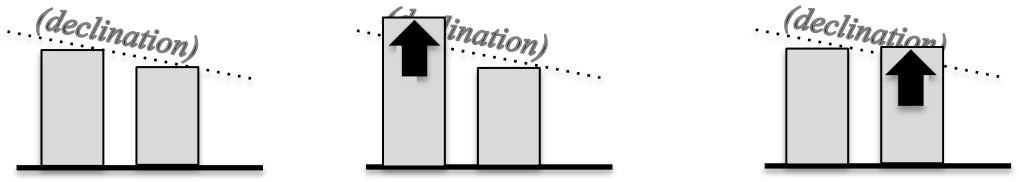
The sentences were all like (4) in being constructed so that the NPs of interest would be neither initial nor final in the clause, to avoid possible prosodic effects of being at the clause edge. Speakers were allowed to familiarize themselves with the sentences before reading them, and were encouraged to read them in an ordinary conversational style, imagining a context in which a fellow native speaker of their language had just begun a conversation with them. They were also told to feel free to repeat sentences if they felt they had not read them naturally, or if they made speech errors. They were recorded in a quiet room, using a Blue Yeti USB microphone.

In this test, we are attempting to discover the placement of prosodic prominence within the phonological phrase corresponding to the NP. The idea is that Richards' (2016) 'prosodic activity' corresponds to the relevant notion of prosodic prominence. Moreover, I will follow Richards (2016) in hoping that a given language reliably realizes prosodic prominence on the same side of every phonological phrase; that is, the hope is that once the setting of the prosodic activity parameter has been determined for the phonological phrase corresponding to NP, this will be the setting for phonological phrases in the language more generally. Future research

could teach us that this hope is misguided, of course, but it seems like a good simplifying assumption to make, unless we are forced to give it up.

What we will discover is that every language exhibits a boost of relative pitch, either for the word on the left or for the word on the right side of the NP. *Prosodic activity* will be the name for the location of this pitch boost. In interpreting the data, it will be useful to bear in mind the distinction introduced at the beginning of this section between declination and downstep. Because of declination, we expect the first pitch peak in an NP to be higher than the second. Languages with a pitch boost on the left will then exaggerate this general tendency; the first pitch peak will be *much* higher than the second. Languages with a pitch boost on the right will tend to eliminate or even somewhat reverse the general trend induced by declination; the two pitch peaks will be more or less equal in height.

(5) a. (expected) b. (Left-active) c. (Right-active)



In other words, languages may have prosodic activity on the left or on the right, but because of declination, the phonetic consequences of this parameter will look less symmetrical than that description might lead us to expect[2].

[2] A reviewer worries that I may be taking too much for granted the cross-linguistic uniformity of declination. Suppose, the reviewer suggests, the "left-active" languages are simply languages in which declination in general proceeds faster than in the "right-active" languages. Or alternatively, suppose that declination is uniform across languages, but that the "left-active" languages are the ones in which the two pitch peaks to be measured are comparatively far apart, compared to the corresponding peaks in the "right-active" languages (the idea being, as I understand it, that if the relevant pitch peaks are further apart, declination will create more of a difference in their height). I can only say that I can find no evidence for either of these theories. With regard to the second: in English, one of the Left-active languages, the relevant pitch peaks are typically separated in the data by only a syllable, so there is certainly no obvious sense in which these pitch peaks are further apart in English than they would be in the Right-active languages. And if it were possible to prove that declination proceeds faster in Left-active than in Right-active languages (something for which I can find no evidence in the data I have), I think I would just take this as

Speakers of eleven languages participated in the experiment:

(6)

Basque	4 speakers (1 female, 3 male)
Brazilian Portuguese	6 speakers (3 female, 3 male)
Bulgarian	7 speakers (6 female, 1 male)
English	5 speakers (3 female, 2 male)
French	8 speakers (5 female, 3 male)
Icelandic	3 speakers (1 female, 2 male)
Italian	3 speakers (all male)
Korean	2 speakers (both female)
Norwegian	3 speakers (1 female, 2 male)
Russian	3 speakers (1 female, 2 male)
Zulu	2 speakers (both male)

These languages turn out to fall into two major groups.

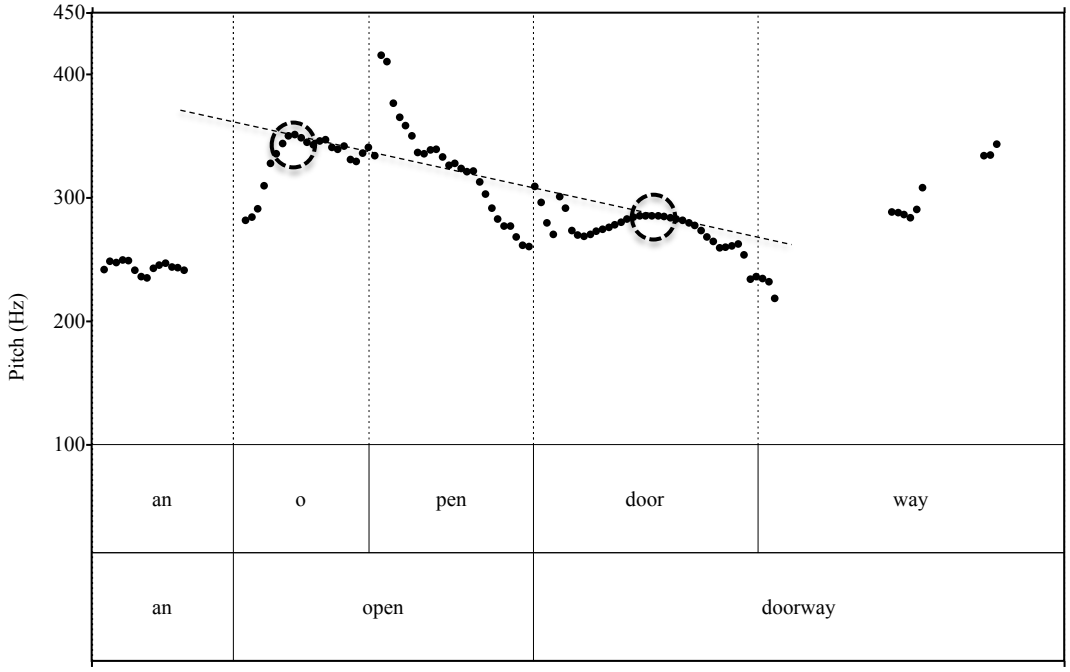
1.1 Left-active languages: English, Norwegian, Korean

In English, Norwegian, and Korean, the highest pitch in the first word in the branching noun phrase (the adjective, in these languages) is typically higher than the highest pitch in the second word[3]:

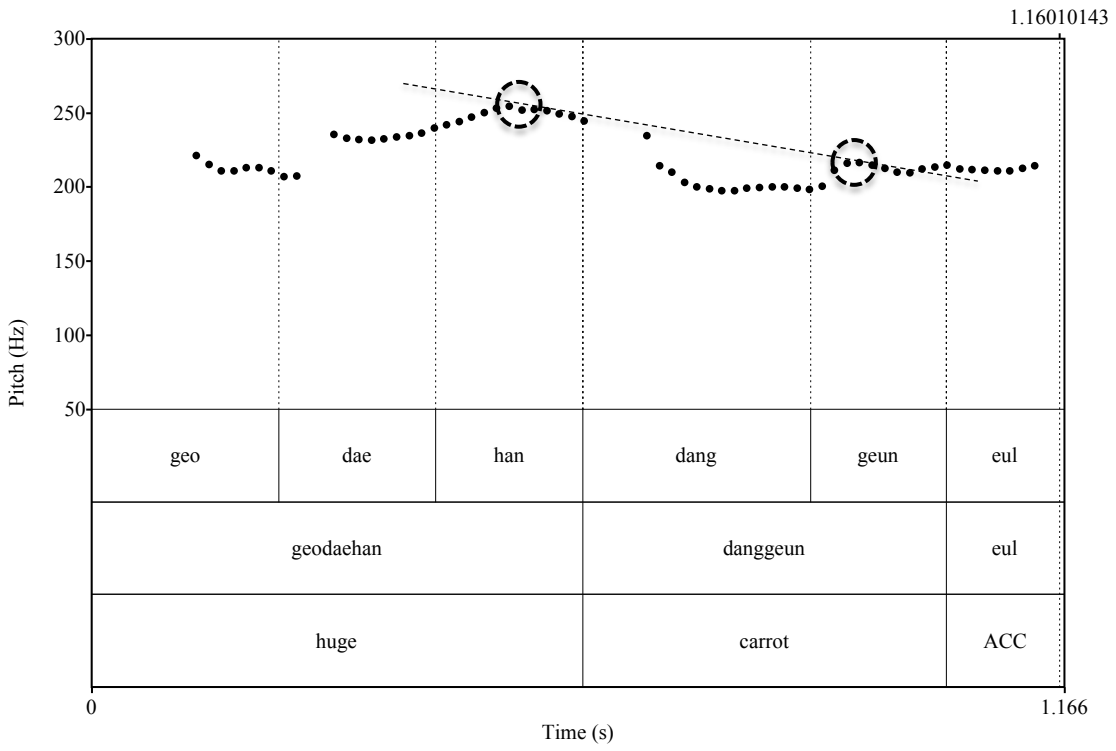
evidence for the parameter under discussion. In other words, if the reviewer were right about declination proceeding faster in Left-prominent languages than in Right-prominent ones, I would see this as evidence that languages do indeed differ with respect to where they realize prosodic prominence, although in this scenario, I would have misidentified the domain in which the effects of the parameter could be detected.

[3] Interestingly, Beckmann and Pierrehumbert (1986), in their discussion of an English phrase with this syntactic structure (their example is *an orange ball-gown*), declare that the default pronunciation of the phrase involves a lower pitch peak on the adjective than on the noun; they say that the pronunciation discussed here is associated with "a real or sarcastically feigned judiciousness". As we will see, the pictured pitch contour was the most common one given by the subjects in this experiment. The context that Beckmann and Pierrehumbert discuss for the utterance is different from the one in the experiment, perhaps in ways that could be used to account for the difference between their results and mine; they are imagining a response to the question "What's that?". The important point for my purposes is that in the discourse context used in the experiment, which I am trying to hold constant across languages, different languages behave differently.

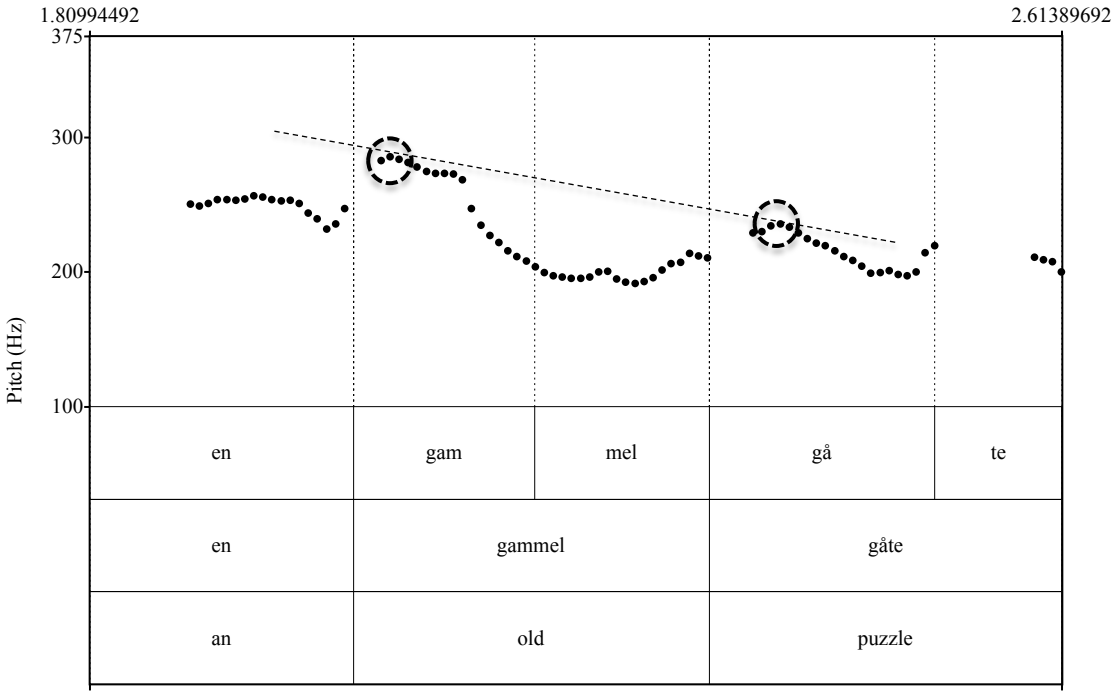
(7) (*English*)



(8) (*Korean*)

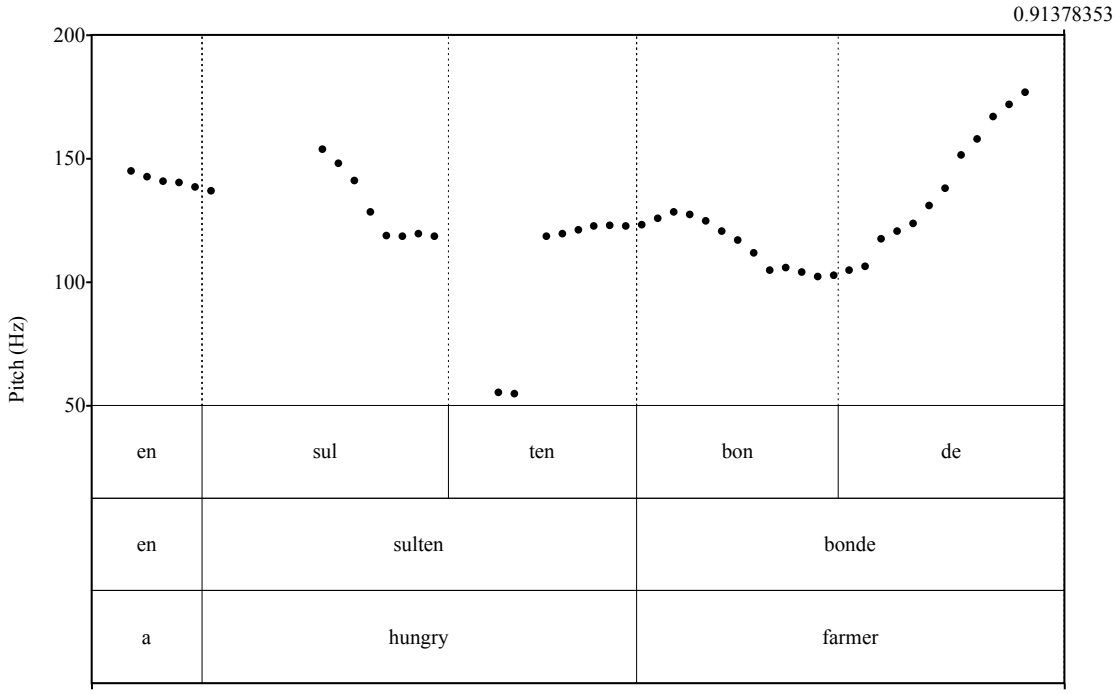


(9) (*Norwegian*)



The Norwegian results offer a complication not found in the other two languages. Slightly more than half of the Norwegian noun phrases in the sample (34/60) show pitch tracks like the one in (9), with pitch peaks on the (stressed) first syllables of the two words of the noun phrase. But a substantial minority (26/60) show a different pattern, adding a high pitch rise at the end of the noun phrase:

(10) (*Norwegian*)



Pitch tracks like (10) were not evenly distributed; one speaker (a man from Bogen) used them for 13 of the 20 noun phrases he recorded, while another (a man from Tromsø) used them for 8 of the 20 noun phrases, and the third (a woman from the Oslo area) used them for only 5 of the 20 noun phrases.

In examples of this form, the pitch peaks on the noun are reliably higher than they are in examples in which the noun only bears a single high pitch peak. For the time being, I have opted to discard the data from this kind of noun phrase, electing to build the theory on the simplest examples, in which single words do not have multiple high pitch targets. Ultimately, one would want to develop an understanding of these kinds of interactions between pitch targets that would

allow us to analyze all of the data, but I will leave the investigation of this kind of complexity for future work[4].

If we now find the ratio between the pitch peak (measured in Hertz) of the first word of the noun phrase and the pitch peak of the second, we get the data in (11) for these three languages:

(11)

language	average	standard deviation	number of examples
Korean	1.24	0.18	31
English	1.19	0.22	111
Norwegian	1.19	0.19	27

In these three languages, in other words, the first pitch peak of these noun phrases is typically higher than the second.

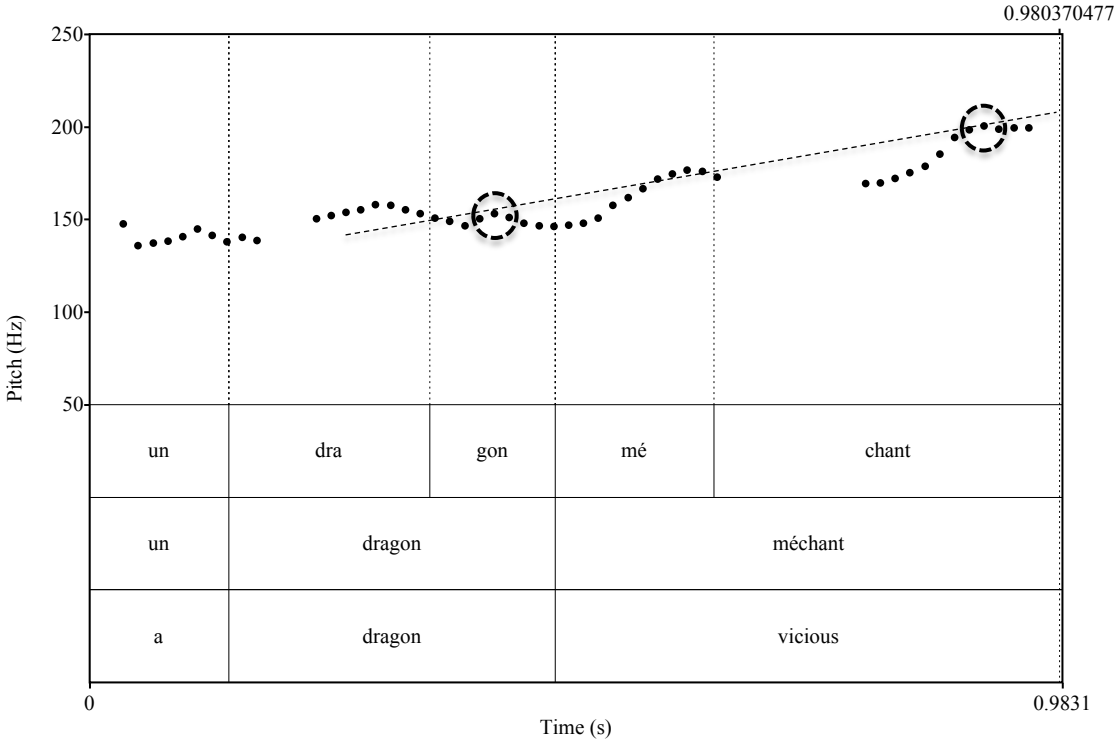
1.2 Right-active languages:

French, Portuguese, Italian, Icelandic, Bulgarian, Russian, Basque, Zulu

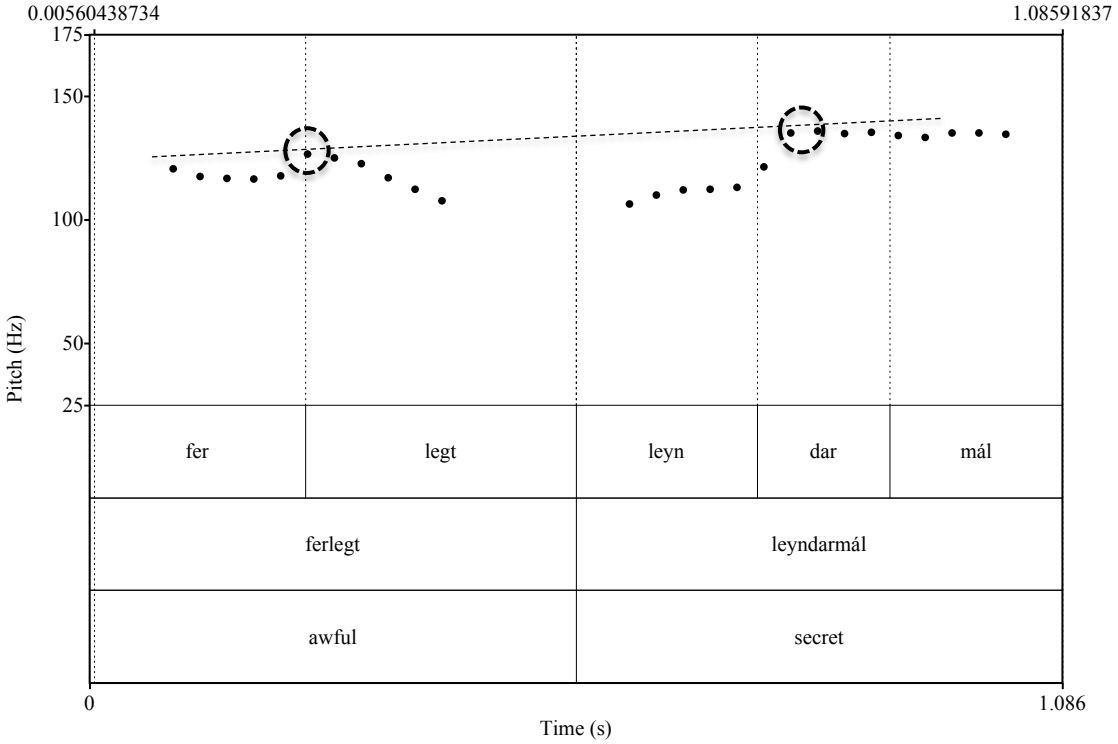
In the remaining eight languages, we see a different pattern. Here the second peak is typically as high as the first, or even higher:

[4] The discarding of data involving pitch tracks like those in (10) was the only attempt I made to correct for the distinction between Norwegian's two lexical accent patterns, the phonetic details of which differ from dialect to dialect. In future work I hope to return to this distinction and control for the accent patterns more carefully.

(12) (*French*)



(13) (*Icelandic*)



Considering, again, the ratio between the height of the first word and the height of the second, we arrive at the data in (14):

(14)

language	average	standard deviation	number of examples
Zulu	1.07	0.25	39
Basque	1.06	0.08	69
Italian	1.06	0.19	33
Bulgarian	1.04	0.15	111
Icelandic	1.03	0.14	51
Portuguese	1	0.13	114
French	0.95	0.11	111
Russian	0.87	0.18	52

1.3 Comparing Left-active and Right-active languages

The facts for the Left-active and Right-active languages are shown together in (15):

(15)

language	average	standard deviation	number of examples
Korean	1.24	0.18	31
English	1.19	0.22	111
Norwegian	1.19	0.19	27
Zulu	1.07	0.25	39
Basque	1.06	0.08	69
Italian	1.06	0.19	33
Bulgarian	1.04	0.15	111
Icelandic	1.03	0.14	51
Portuguese	1	0.13	114
French	0.95	0.11	111
Russian	0.87	0.18	52

The table in (15) can be seen as depicting two groups of languages: one in which the average pitch ratio is around 1.2 (Korean, English, Norwegian), and another in which the average pitch ratio is around 1 or below (Zulu, Basque, Italian, Bulgarian, Icelandic, Portuguese, French, Russian). As the standard deviations reveal, however, there is a great deal of variability in the data. It is certainly not the case that every utterance in the first group has a pitch ratio around

1.2, or even a pitch ratio above 1; similarly, there are examples from languages in the second group in which the pitch ratio equals or even exceeds 1.2. Because of this overlap, a given language cannot be classified just on the basis of a single utterance.

To address one worry which audiences and reviewers have sometimes raised: it is not the case that the division into Left-active and Right-active languages is simply a division into languages with prenominal and postnominal adjectives. The three Left-active languages listed above do have prenominal adjectives, but among the eight Right-active languages there are three (Bulgarian, Icelandic, and Russian) with prenominal adjectives, and five (Zulu, Basque, Italian, Portuguese, and French) with postnominal adjectives. In future work I hope to find out whether there is any detectable connection at all between adjective direction and position of activity, but in this sample there seems to be no significant correlation.

In order to confirm that the difference between Left-active languages and Right-active languages is statistically significant, I first performed a k-means clustering analysis on Euclidean distance on the average ratios in the table in (15), using CCC to determine the optimal number of clusters (R Core Team 2017)[5]. The analysis confirmed the description given here, describing the data as best captured by clustering into two groups, one consisting of the averages for Korean, English, and Norwegian, and the other of the averages for Zulu, Basque, Italian, Bulgarian, Icelandic, Portuguese, French, and Russian.

K-means clustering is not typically used for data like those underlying the table in (15), in which objects of study (in this case, languages) are associated with repeated observations of the same kind (in this case, observations of pitch ratios). A more typical kind of clustering problem involves objects of study with multiple properties of interest, with each property being

[5] I am very grateful to Adam Albright, and also to data science specialist Steven Worthington at the Institute for Quantitative Social Science, Harvard University, for their statistical support.

represented by a single number. One classic example of k-means clustering involves an analysis of crime statistics from different American states; the objects of study are the states, and each state is associated with a set of single numbers describing the incidence of crimes of different types (murder, theft, etc.).

By applying k-means clustering to the average pitch ratios in the table in (15), I have converted the problem into one to which k-means clustering can apply; each language is associated with a single number. At the same time, the average pitch ratios in (15) represent a wider range of data, and the k-clustering analysis that I used makes no reference to this range itself, only to the average values of the range.

As an additional test for significance, I performed another kind of analysis. This involved randomly dividing the data into two parts, each subjected to a different type of analysis; by dividing the data in two in this way, I avoided the statistical dangers involved in analyzing the same data in two different ways. I used a random number generator to divide the data from each language into two equal halves[6]. I applied the k-means clustering analysis with CCC again to the average pitch ratios in one half of the data, again receiving the result that the best number of clusters for the data is two, and that the clusters are composed as previously described.

With the second half of the data, I used a mixed-effects model to check for statistical significance, using the model in (16):

(16) ratio ~ position * language + (1 + position | speaker)

Here the fixed effects are *position*, which checks for differences between subjects and objects, and *language*, which has two values, one for the Left-prominent languages and the other for the Right-prominent languages. I also used random slopes for position and speaker.

[6] In cases in which a language was associated with an odd number of observations, the choice of which group received more data was also made randomly. In the end, the two groups were of equal size.

R makes the following report for the fixed effects:

(17)	Estimate	Std. Error	df	t value	*p*
(Intercept)	1.087893	0.017999	43.065429	60.443	< 2e-16 ***
position1	-0.012083	0.011560	39.038636	-1.045	0.302
language1	0.080965	0.017999	43.065429	4.498	5.12e-05 ***
position1:language1	0.004862	0.011560	39.038636	0.421	0.676

In (17), *position1* is the effect of position (subjects vs. objects), abstracting away from particular languages. This effect is not statistically significant.

The effect of interest to us is *language1*, which divides the data into ratios from Left-prominent languages and ratios from Right-active languages. Here we see that this difference is very significant ($p<.0001$). I take this as support for the hypothesis; not only does k-means clustering recommend dividing the languages as described above, but having divided the data in the way that the clustering analysis indicates, we arrive at a division of data in which the ratios of interest behave in statistically significantly different ways in the two groups.

As the summary in (17) shows, the distinction between subjects and objects (*position*) had no statistically significant effect either in the entire body of data or either of the two groups of languages (that is, there is no significant interaction between *language* and *position*). The two languages on the edges of the Right-active group, Zulu and Russian, do appear to have especially extreme differences between subjects and objects; on average, the ratios for subjects and objects in the languages in this study differ by a factor of around 7%, but for Zulu the figure is 18%, and for Russian it is 16%. Among the Left-active languages, the language with the largest difference between subjects and objects is Korean, in which the ratio is 11% greater for objects than for subjects; again, Korean is the Left-active language with the largest overall ratio. I hope to study in future work the question of why these differences should exist. Perhaps these are languages in which subjects and objects are information-theoretically different, in ways which have an effect

on their prosody; serious investigation of this possibility will have to wait for careful investigation of the effects of information structure on the ratios discussed here[7].

As a reviewer points out, there is a substantial literature on downstep which takes it to be a relation specifically between tones of certain kinds. Downstep was originally invoked to describe the behavior of tones in tonal languages like Efik (Benue-Congo, Nigeria), in which downstep specifically targets High tones (see Connell 2011 for a useful overview). Similarly, the literature on Japanese characterizes downstep as involving an interaction between the tones associated with lexical accent (Poser 1984, Pierrehumbert and Beckman 1988, Kubozono 1989, Selkirk and Tateishi 1991). As classically described, these are languages in which individual lexical items may have, or lack, the tones to which downstep applies, and downstep appears just if the relevant tones are present.

From the standpoint of the theory under development here, a natural question is whether languages of the type described in the last paragraph share relevant syntactic properties, to be described in section 4 below, with the Left-prominent languages discussed in this paper. If they do not, then we would want to draw a distinction between the kind of downstep discussed here, which applies to every type of word, and the kind discussed in the last paragraph, which applies just to words with particular tones in them.

But if languages with the classic kind of tonal downstep do pattern syntactically with the Left-prominent languages described here, then running the experiment described here on these languages should improve our understanding of the phonological representation of downstep, and of how this representation is realized phonetically in different languages. Depending on the facts, for example, we might be inclined to posit phonological representations in which downstep

[7] It may also be relevant that Zulu is tonal, a fact I made no attempt to control for in gathering the Zulu data.

is uniformly underlyingly present in Left-prominent languages, but must interact with certain kinds of tones, in some languages, in order to have phonetic realization. For now, I will have to leave these questions here.

1.4 Beyond the experiment

The experiment described in the preceding sections divides languages into two groups; the Left-active languages, with downstep between the first word of the branching NP and the second, and the Right-active languages, which lack this downstep.

With this division in mind, we can consider pitch tracks in other languages, which will allow us to provisionally classify the languages as Left-active or Right-active. As mentioned above, multiple researchers have documented the existence of downstep in Japanese:

(18) (Kubozono 1989, 41)

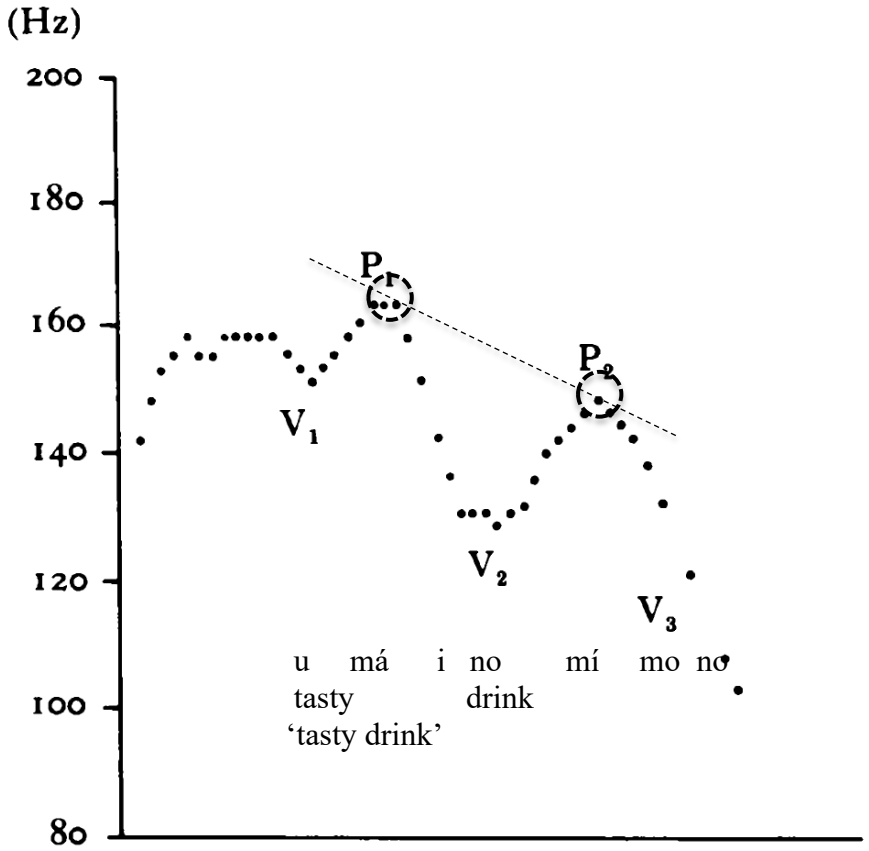
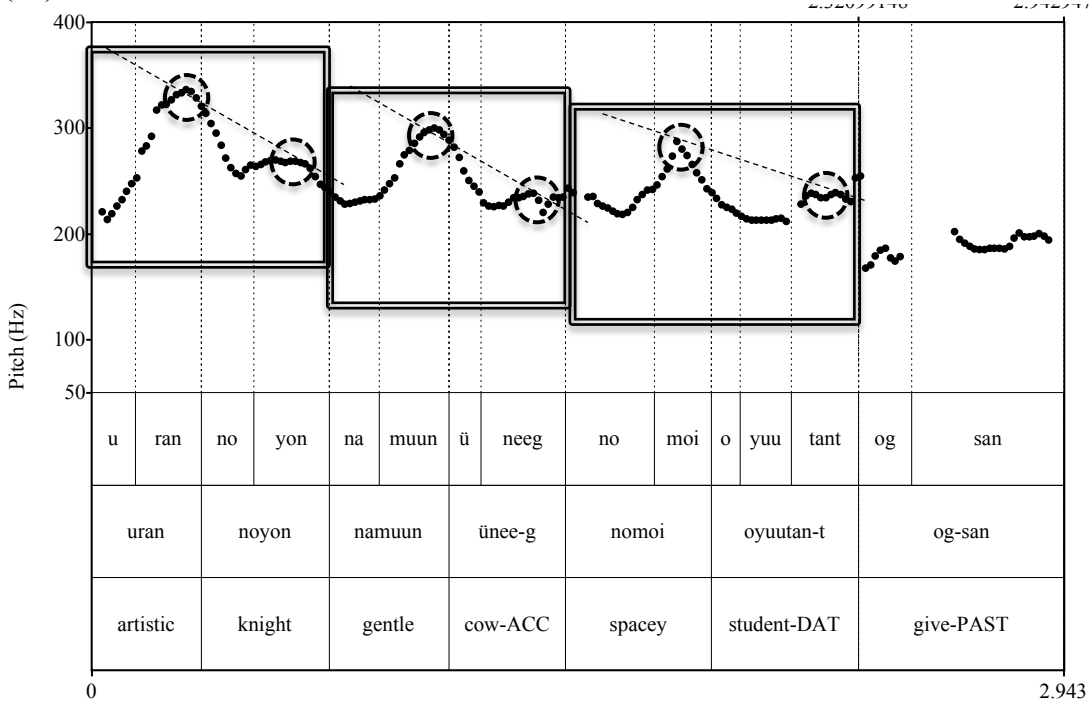


Figure 1

We will have to run the experiment for Japanese to be certain, but pitch tracks like the one in (18) allow us to hope that Japanese will prove to be a Left-active language, since it has downstep between adjectives and nouns.

Similarly, the Mongolian pitch track given above in (3) looks like the pitch track of a Left-active language:

(19)

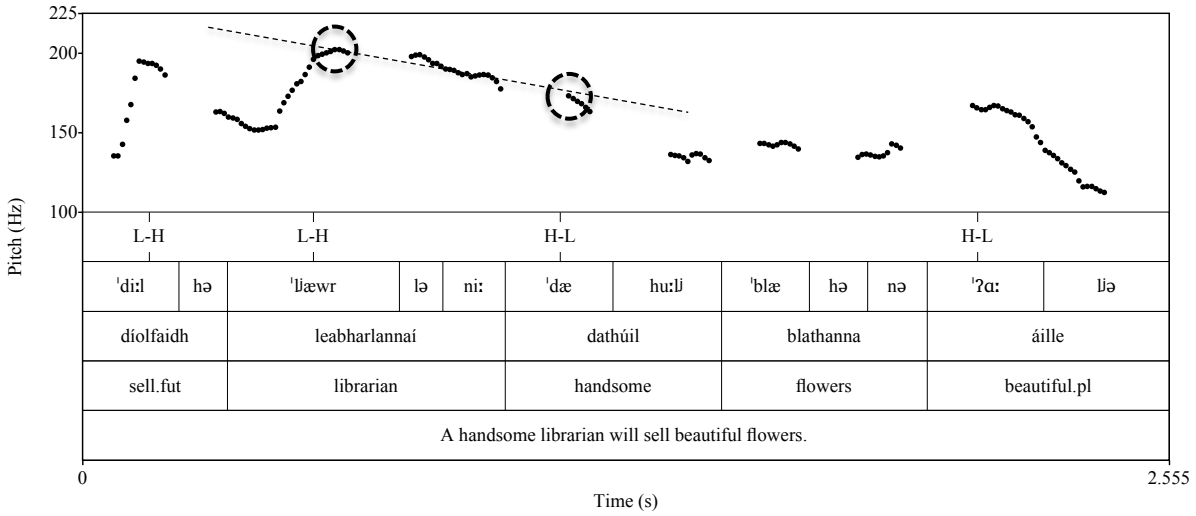


'The artistic knight gave a gentle cow to the spacey student'

The pitch tracks given by Elfner (2012, 56) for Connemara Irish also look like Left-active pitch tracks[8]:

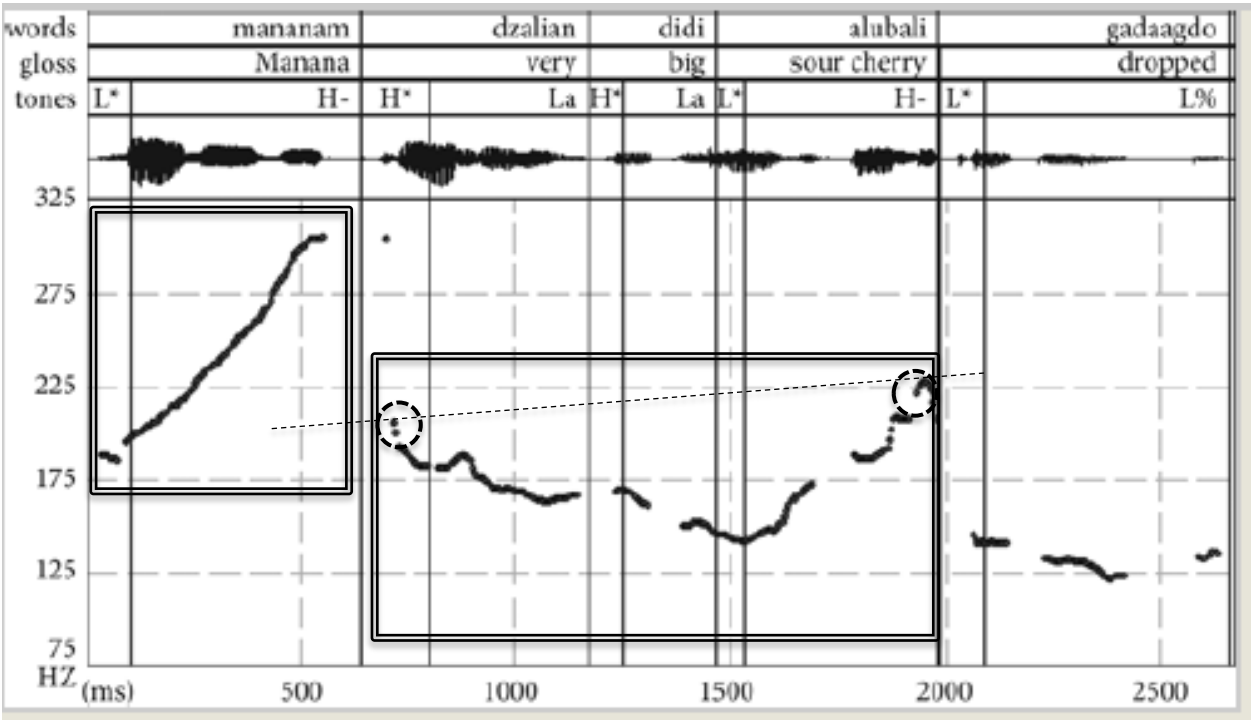
[8] If this is the correct result for Irish, Irish would represent our first Left-active language with postnominal adjectives.

(20)



Conversely, Georgian appears to be a Right-active language, with a higher pitch at the end of the noun phrase than at the beginning:

(21) (Vicenik and Jun 2014, 163)



Again, we would have to run experiments on these languages to be certain, but these pitch tracks allow us to make a guess about what the results of the experiment would be. In some cases, the

results are clearly welcome ones. As mentioned before, Irish is a language that was difficult to classify by just looking at which side of a phonological phrase seemed to be associated with prosodic phenomena, as Richards (2016) had recommended, because Elfner (2012) argues that both edges of the Irish phonological phrase can have tonal melodies associated with them. The method developed here for detecting prosodic activity allows us to say that Irish is Left-active, which is the desired result (see discussion in Richards 2016).

2. A second test: the Length experiment

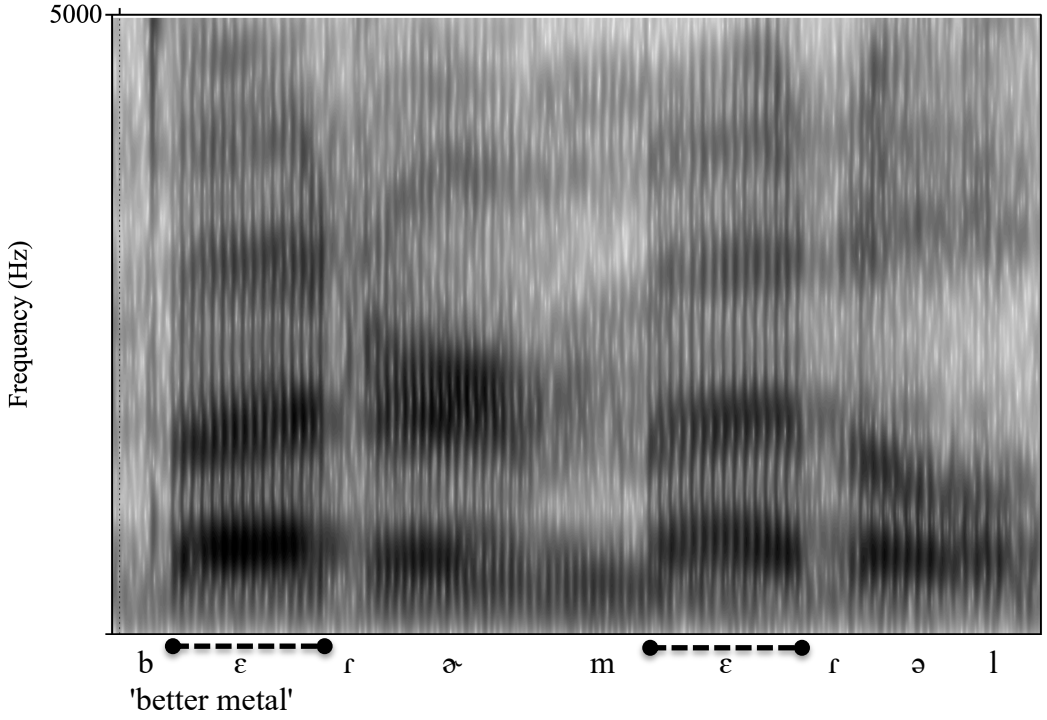
A second test for the location of prosodic activity involves measuring the length of stressed vowels[9] in sentences like:

(22) The company needs to start using a **better metal** for its products.

The goal, again, is to try to discover the position of prosodic activity within a noun phrase consisting of an adjective and a noun. Examples were constructed so that the stressed vowels of the two words were the same height (most often they were the same vowel, as in (22)), and were both in open syllables, followed by the same kind of consonant (generally both stops, either both voiced or both unvoiced). I was not as careful with the consonants preceding the vowels to be measured, which meant that I had to discard some English data in which a vowel was preceded by an aspirated stop, since the vowels following such stops were markedly shorter than vowels in other contexts.

[9] Many thanks to Edward Flemming for helpful discussion of how to run this test.

(23)



The experimental setup was much like that of the first experiment; speakers were given twenty sentences to pronounce, and asked to pronounce them as conversationally as possible, imagining a context in which a conversation had just been initiated. They were recorded in a quiet room using a Blue Yeti USB microphone. After measuring the stressed vowels, I found the ratio of the length of the first vowel to that of the second. I ran this test on the following languages:

(24)

Brazilian Portuguese	2 speakers (1 female, 1 male)
English	3 speakers (2 female, 1 male)
German	3 speakers (all female)
Italian	3 speakers (1 female, 2 male)
Norwegian	4 speakers (3 female, 1 male)
Russian	3 speakers (1 female, 2 male)

The average length ratios for these languages were as follows:

(25)

language	average	standard deviation	number of examples
German	1.01	0.24	47
English	1.00	0.17	47
Norwegian	1.00	0.22	20
Russian	0.87	0.16	46
Portuguese	0.80	0.24	38
Italian	0.77	0.25	56

As with the pitch experiment, we see a division between two kinds of languages: German, English, and Norwegian have a comparatively large ratio (around 1, meaning that the stressed vowels of the adjective and the noun are of roughly equal length), while Russian, Portuguese, and Italian have smaller ratios (so in these languages, the stressed vowel of the second word is generally longer than the stressed vowel of the first word)[10]. We can also see, as in the pitch experiment, that there is a great deal of variation in the data, with some overlap in the ratios from even the most dissimilar languages.

As with the pitch experiment, the k-means clustering algorithm on Euclidean distance between the averages in (25), using CCC, recommends that the data be clustered into the two groups described above, one consisting of German, English, and Norwegian, and the other of Russian, Portuguese, and Italian. Because I have gathered more data in the pitch experiment, I was able to do a further check on this result, which involved randomly dividing the data in half and subjecting the two halves to different kinds of analysis. I have not yet gathered enough data using the length experiment to be able to do this more statistically rigorous kind of analysis in this case.

[10] These contrasts are reminiscent of the effects of the Iambic-Trochaic Law of Hayes (1995), which proposes that within a word, trochaic (left-headed) feet generally feature beats of equal length, while iambic (right-headed) feet involve a second beat which is longer than the first.

Using a mixed-effects model on the same data, without dividing the data in half, does seem to support the conclusion that the two groups described above are the correct ones. Just as in the pitch experiment, the model was the one in (26):

(26) ratio ~ position * language + (1 + position | speaker)

Again, *language* in this case has two values, one for Left-active languages and another for Right-active languages. And, as before, *position* refers to differences between subjects and objects. The results are given in (27):

(27)	Estimate	Std. Error	df	t value	*p*
(Intercept)	9.094e-01	1.690e-02	1.469e+01	53.818	< 2e-16 ***
position1	5.953e-03	1.344e-02	1.768e+02	0.443	0.658
language1	9.509e-02	1.686e-02	1.496e+01	5.639	4.76e-05 ***

This analysis is not based on as much data as the preceding analysis of pitch differences, but it has a similar result; there is a statistically significant difference between Left-active and Right-active languages (represented again as *language1*; $p<.0001$), and the effect of *position* is not significant.

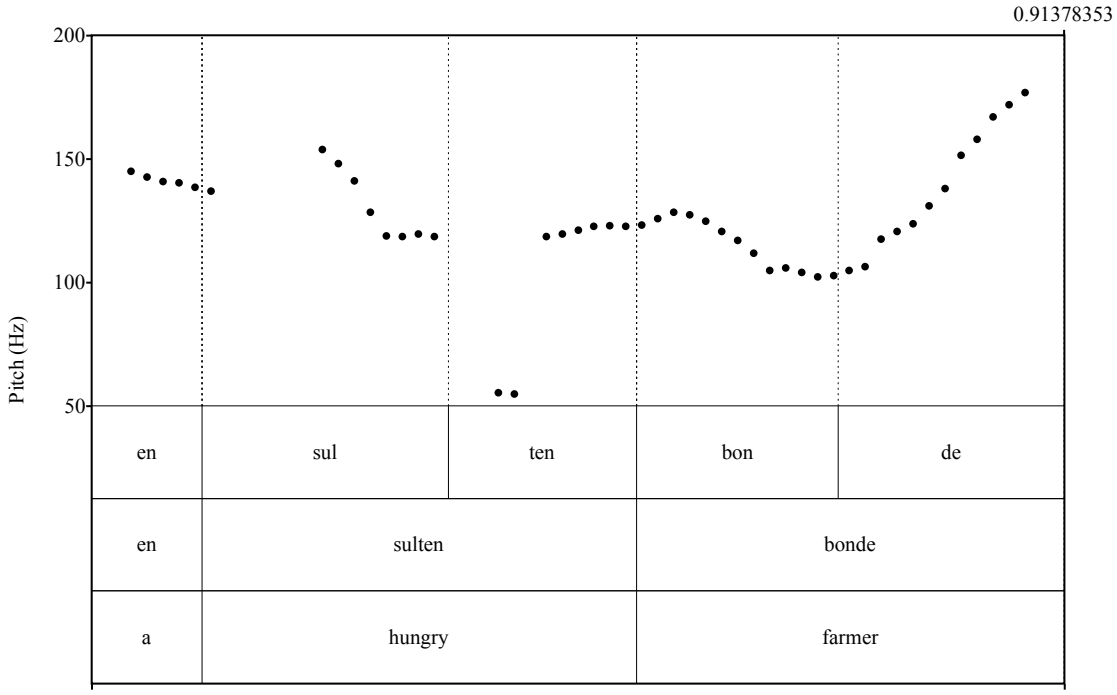
For the languages that have undergone both the pitch test and the length test, the tests agree: English and Norwegian are Left-active, and Russian, Italian, and Portuguese are Right-active. Prosodic activity is apparently associated, not only with a boost in pitch, but also with lengthening.

Several languages have undergone the Pitch test but not the Length test. Only one, namely German, has undergone only the Length test. In the next section I will briefly discuss German pitch.

3. Aside: German pitch

Recall that it was important, in the discussion of Norwegian, to exclude certain examples from the analysis. The (slim) majority of the Norwegian examples had pitch peaks reliably on stressed syllables, but there were also Norwegian examples that added a final rise:

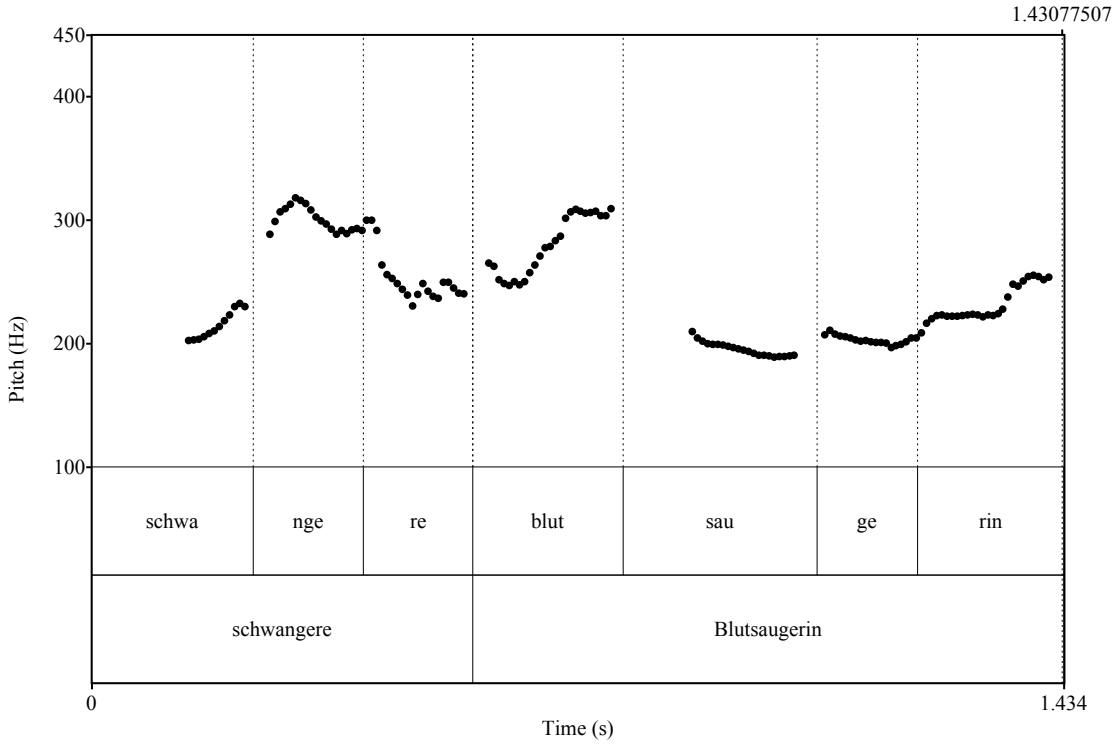
(28) (*Norwegian*)



I excluded these data for purposes of the pitch analysis. An alternative, which I explored, would have been to include these examples but to measure only the pitch peak on the stressed syllable, but it turned out that even these earlier pitch peaks were higher in the presence of a final rise.

In attempts to run the pitch experiment on German, final rises of the type found in Norwegian were extremely common. In German nouns in which stress was distant enough from the end of the word for a final rise to be perceptible, final rises appeared in 5/6 of the examples:

(29) (*German*)



'pregnant vampire'

Here *Blutsaugerin* 'vampire (fem.)' has two pitch peaks, one on the initial stressed syllable, and the other at the end of the word. Excluding these data in German, as I did in Norwegian, would mean excluding too much of the data for statistical analysis to be meaningful. It is possible that a more careful version of this experiment that controls information-structural factors more precisely would be able to run a version of the pitch test on German. For now, I will rely on the length test to classify German as Left-active.

It may be worth emphasizing the nature of the claim about German here. In principle, both the pitch and the length tests ought to be informative for German, but an identifiable additional factor (in this case, the recurring presence of a final rise) obscures the effects of the pitch test. The goal in future work should be to find some way to prevent final rises from occurring, or to determine a way of compensating for their effect. The picture in Richards

(2016), by contrast, was one in which the tests that classify languages as Left-active or Right-active can simply differ from language to language. Richards (2016) referred, for example, to the fact that Japanese exhibits Initial Lowering (Selkirk and Tateishi 1991), a Low tone at the left edge of maximal projections, as evidence that Japanese is Left-active. The claim was not that every language has Initial Lowering in some form; rather, we were to take this particular, Japanese-specific phenomenon as a piece of evidence for the position of activity in Japanese. The goal of this paper is to find cross-linguistically applicable tests for activity; what the German case shows is that the effects of these tests can sometimes be obscured by other factors, which will necessitate study in their own right.

4. Contiguity Theory

The preceding sections have discussed two tests that can be used to classify a language as Left-active or Right-active; languages either associate the left or the right edge of a phonological phrase (at least, the phonological phrases corresponding to NP) with a boost in pitch and in length. As we will see, this prosodic parameter has a number of syntactic consequences.

One of the core claims of Richards (2016) can be summarized as follows[11]:

(30) Given a Probe P and its Goal G, there must be nothing between P and G which is more prosodically prominent than G.

We can define the relevant notion of prosodic prominence as follows:

(31) a. An XP is always more prominent than a head.

b. a parameter: given multiple XPs in a string[12],

a language realizes prominence on the {Leftmost, Rightmost}.

[11] I am very grateful to Kenyon Branan for helpful discussion.
[12] I will take an XP to be 'in a string' if all of the terminals dominated by the XP are members of the string.

(31a) is a familiar fact about heads and phrases[13]; if a string contains both a head and a phrase, the phrase is more prosodically prominent than the head. In (31b), we see the effects of a binary parameter; when a string contains multiple XPs, some languages assign prominence to the Leftmost element, while others assign it to the Rightmost[14]. These are the Left-active and Right-active languages.

We will also need to define the technical term *between*, used in (30) above. We can define it as follows:

(32) For any phrase ZP, let ***z*** be the terminal dominated by ZP which appears at the linear edge of ZP to which the parameter in (33b) makes reference. Then for any X, P, and G, X is *between* P and G if for some asymmetric linear relation R, R holds between P and ***x***, and between ***x*** and ***g***.

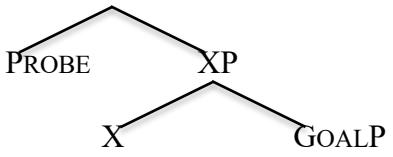
In cases in which no dominance relation holds between X and G, the definition in (32) will correspond to linear intervention: X is *between* P and G if P precedes X and X precedes G, or if G precedes X and X precedes P. Most of the cases to be considered below will be of this type.

If X dominates G, then X will be between P and G if the terminal dominated by X which stands at prominent edge of X (the edge referred to by the parameter in (31b)) is between P and the prominent edge of G. In a language in which prominence is realized on the Left edge, for example, XP would be between P and the Goal in a configuration like the one in (33a):

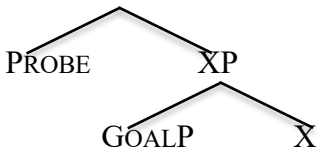
[13] See, for example, Truckenbrodt's (1995) STRESS-XP and Kratzer and Selkirk's (2019) HEAVYSISTERPROMINENCE.

[14] This discussion leaves open the question of whether, in a string consisting of multiple non-XPs, one of them is realized as the most prominent (that is, whether there is a parameter like the one in (31b), designating one of the non-XPs as more prominent than the others). Since the answer to this question will not matter in this paper, I will continue to leave it open for now, though in fact I believe that facts about Contiguity relations between heads will be best captured by a parameter of just this kind.

(33) a.



b.



In (33a), the terminal X, which stands at XP's Left edge, linearly intervenes between the Probe and the Goal. If the language in question has prominence on the Left edges of maximal projections, then in (33a), XP is *between* the Probe and the Goal, in the relevant sense. We will see an example of this kind in section 4.3.

The two trees in (33) are hierarchically identical, but differ in their ordering, in a way which is relevant for the definitions just given. In a Left-active language, XP would be *between* the Probe and the Goal in (33a), as we have just seen, but this would not be the case in (33b). In (33b), the terminal node dominated by XP which stands at XP's active Left edge is the Goal itself, and there is therefore no linear relation of precedence holding between XP's active edge, in the relevant sense, and the Goal. In other words, XP is *between* the Probe and the Goal, in a Left-active language, in (33a), but not in (33b).

With these definitions in place, we can turn to the predictions made by the condition in (30). Consider first cases in which a Probe and a Goal are adjacent (and I will assume, throughout, that Goals are invariably phrases, and that Probes are not). Such cases will always satisfy the requirement in (30); if a Probe and a Goal are adjacent, then there cannot be anything linearly intervening between them which is more prosodically prominent than the Goal. The position of prosodic activity will never matter in such a case[15].

The same would be true in a case in which the Probe and the Goal are not adjacent, but in which the material linearly separating them is not a maximal projection. Since phrases are

[15] The same would be true, in a tree like the one in (33a), if (for example) X had undergone head movement into the Probe; there would then be no terminal node of XP intervening between the Probe and the Goal.

always more prominent than heads and Goals are always phrases, a non-phrase intervening between a Probe and a Goal will never be more prosodically prominent than the Goal. The relation between the English verb and the object, for example, shows an adjacency requirement of the kind that this theory is well-suited to handle; verbs and objects can be separated by particles, but not by full phrases (such as adverbs, including adverbs that modify particles):

(34) a. She looked the reference *up*.

b. She looked *up* the reference.

c. She looked the reference *right up*.

d. * She looked *right up* the reference.

e. *She looked *quickly* the reference *up*.

In (34b), for example, there is a string *looked up the reference* in which the only XP is the object *the reference*; the object is therefore the most prominent element of that string, regardless of the position of prosodic activity in English[16].

Finally, consider cases in which some maximal projection intervenes between the Probe and the Goal:

(35) a. PROBE XP GOALP

b. GOALP XP PROBE

In order to know whether the Goal is the most prominent element in these examples, we must learn how the language in question decides where to assign prominence when a string contains multiple maximal projections; that is, we must know the value of the parameter in (31b). In a

[16] This account constrains the possible syntactic parses we can assign to this string; there cannot, for example, be a maximal projection which dominates the substring *up the reference* and excludes *looked*. Such a maximal projection would be between *v* and the object, in the relevant sense, since it would have *up* at its left edge (and English, as we have seen, is Left-active).

Right-active language, the string in (35a) will be acceptable, because the Goal is the rightmost XP in the string. Similarly, in a Left-active language, the string in (35b) will be acceptable.

On the other hand, in a Left-active language, (35a) will be impossible; in such a language, the most prominent element in that string will be XP, the leftmost maximal projection, rather than the Goal. A Left-active language is therefore predicted to be unable to leave a Goal in situ if it is preceded by its Probe and there are maximal projections linearly intervening between them; some operation (such as leftward movement of the Goal) will have to take place to make the Probe and the Goal adjacent.

Similarly, a Right-active language should be unable to tolerate the string in (35b), since, again, the intervening XP in this string will be more prosodically prominent than the Goal in such a language. In a Right-active language, then, if the Probe follows the Goal, the Probe and the Goal must be adjacent (more precisely, they cannot be linearly separated by maximal projections).

The above discussion can be summarized as in (36):

(36) a. PROBE XP GOALP [*Left-active, √Right-active]

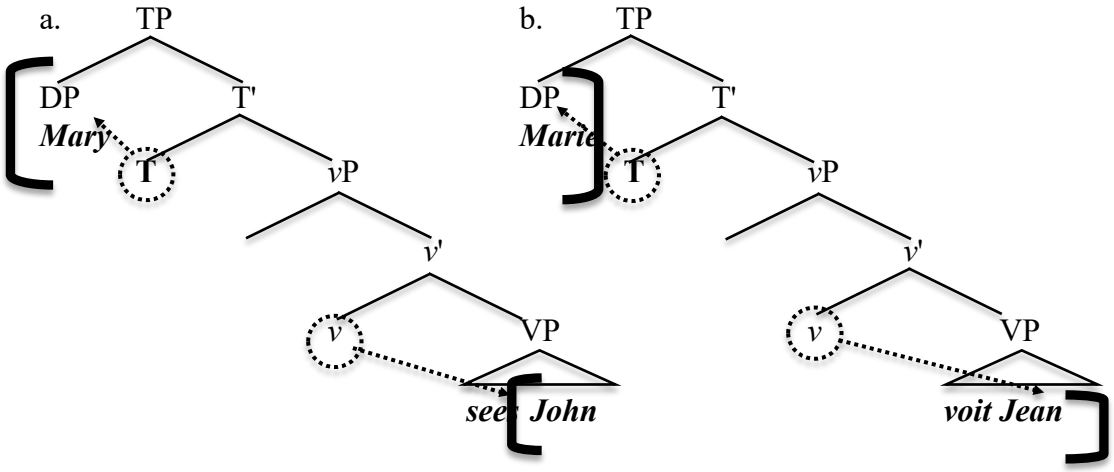
b. GOALP XP PROBE [√Left-active, *Right-active]

If the minimal string containing the Probe and the Goal also contains a linearly intervening XP, the string will be acceptable just if the Goal is more prominent than the intervening XP. Thus, the string in (36a) is acceptable in Right-active languages, since the Goal is to the right of the intervener, and the string in (36b) is acceptable in Left-active languages, since the Goal is the left of the intervener. In the following sections I will review several cases of this principle in action; we will see that the experiments from sections 1-2 sort languages correctly.

4.1 "Verb movement to T"

We have now seen evidence (from the pitch and length experiments) that English is Left-active, and (from the pitch experiment) that French is Right-active. Consider the Contiguity relations that must hold in an SVO sentence in these languages (in the trees below, I have marked the direction of activity with parentheses):

(37) a. b.



In English, for example, there must be a string containing *v* and the object in which the object is the leftmost XP; this is the only way the object can be Contiguity-prominent in the string, since English is Left-active. In other words, there must be a string containing *v* and the object in which no XP precedes the object. To put it yet another way, no XP can intervene between *v* and the object; if there is such an intervener, then any string that contains *v* and the object will also contain the intervening XP, and the object will fail to be Contiguity-prominent. As mentioned before, this is famously true; no adverb can intervene between the verb and the object in English[17]:

[17] By the definition of *between* given in (32) above, we must also be concerned with the status of the VP, which threatens to be between *v* and the direct object in the tree in (37a) (because English is Left-active, and the left edge of VP is between *v* and the direct object). As long as V and *v* are related by head-movement (either by movement of V into *v*, or by lowering of *v* to V), there will be no terminal dominated by VP which linearly intervenes between *v* and the direct object, and VP will therefore not block the Contiguity relation; this is the distinction drawn in the discussion of the two trees in (33).

(38) Mary sees (***often**) John.

By the same reasoning, we expect that in French, T and the subject should be required to be adjacent. Since French is Right-active, the French subject must be the rightmost XP in a string containing the subject and T, and this is only possible if no XP intervenes between the subject and T. Again, this is true:

(39) Marie (***souvent**) voit Jean.

We do not expect to see adjacency requirements on the relation between *v* and the object in French, or between T and the subject in English. In the latter case, for example, since English is Left-active, Contiguity requires only that there be a string containing T and the subject in which the subject is the leftmost XP. As long as the subject precedes T, then, the requirement will be satisfied, no matter how many XPs intervene between the subject and T. The same reasoning applies to *v* and the object in French; since French is Right-active, any string in which the object follows *v* will be acceptable, even if the two are not adjacent. Again, the predictions are true:

(40) Mary (**often**) sees John.

(41) Marie voit (**souvent**) Jean.

The adjacency requirement between the verb and the object in English has traditionally been attributed to a special condition on the assignment of Case in English--in particular, on the assignment of <u>accusative</u> Case, since no such adjacency requirement holds between the subject and T, as we have just seen. In the account given above, the crucial difference between T and *v* is that T typically follows the subject in English, while *v* precedes the object. If we arrange for T to precede the subject in English, an adjacency requirement appears, as we expect:

(42) a. Probably Mary is happy.

b. Is (***probably**) Mary happy?

Once T precedes the subject, as in (42b), English, being Left-active, requires the subject to be the leftmost XP in the smallest string containing T and the subject; as a consequence, no adverb may intervene between them, just in this configuration.

The contrasts between English and French described above have classically (Pollock 1989 and much subsequent work) been described as reflecting a difference in the movement of heads in the two languages; French verbs move to some higher functional head, perhaps T, while English verbs do not. The same literature standardly stipulates that French verbs fail to raise to T in infinitives, in order to account for facts like those in (43):

(43) a. Jean parle **pas** l'italien
Jean speaks not Italian
'Jean doesn't speak Italian'

b. * Jean **pas** parle l'italien
Jean not speaks Italian

c. **Pas** parler l'italien…
not to.speak Italian
'To not speak Italian…'

The data in (43a-b) are familiar, as long as we regard *pas* as a specifier or an adjunct, rather than a head in the clausal spine; like any other XP, *pas* may not appear between the subject and T in French, but may appear between *v* and the object, for reasons that we now understand. When the subject is not pronounced, as in (43c), then the condition requiring T to be adjacent to the subject no longer applies; there is no pronounced subject for T to be adjacent to. There is therefore nothing wrong with *pas* preceding the verb in such clauses, as (43c) shows. For further discussion of the details of the French and English facts, see Richards (2016).

In the Pitch experiment, discussed in section 1 above, we learned that Norwegian is like English in being Left-active, and Icelandic is like French in being Right-active. And as long as we confine ourselves to non-V2 clauses, the rules for the positioning of adverbs in Norwegian are like those in English, and the rules for Icelandic are like those for French (Wiklund et al 2007):

(44) Jeg vet [hvorfor Hedda (**ofte**) kjøper (* **ofte**) sko] [*Norwegian*]
I know why Hedda often buys often shoes

(45) Ég veit [af hverju Hedda (* **oft**) kaupir (**oft**) skó] [*Icelandic*]
I know why Hedda often buys often shoes
'I know why Hedda often buys shoes'

In order to discover that Norwegian is like English and Icelandic is like French, we must consider non-V2 clauses. In V2 clauses, the two languages share the familiar V2 profile. We must apparently think of the conditions on word order that we are discussing as being subject to disruption by various grammatical forces; the requirement that the verb be adjacent to the object in Norwegian, for example, holds in (44), but would not hold in a V2 clause, because the V2 requirement would override the condition of Contiguity between *v* and the object. Richards (2016) proposed that the relation between different grammatical forces should be regulated by cyclicity, and by phase spellout; Contiguity relations must be created in the phase in which Agree takes place, and are enforced until that phase is spelled out, but can then be disrupted by later operations (see also Branan 2018 for much further discussion). Surface order is taken to be the product of multiple simple forces, interacting to create apparent complexity. The claim is that Contiguity for T and *v* are among the forces constraining the behavior of subjects and

objects, and when we find behavior that Contiguity alone does not explain, we should try to find the additional operations responsible.

In all of the preceding examples, we have been concerned with the position of the verb with respect to subjects and objects. Contiguity Theory, of course, regulates only the positions of heads like T and *v*, which participate in Probe-Goal relations with the subject and the object. The observation that French and Icelandic subjects must be adjacent to the verb follows from the theory given here, in other words, only on the additional assumption that the verb in these languages must be pronounced in the position of T; I am grateful to Maša Bešlin for pointing this out to me.

French and Icelandic are arguably alike in imposing an EPP requirement of the classic type; T in these languages is required, not only to be in a Contiguity relation with the subject, but to have a specifier. For a Contiguity-Theoretic account of why some languages exhibit the EPP and others do not, I will direct interested readers to Richards (2016), which posits a condition known as Affix Support to account for the distribution of EPP effects. Bearing Bešlin's point in mind, we can then ask; in French and Italian, is the verb pronounced in T (and, therefore, adjacent to the subject) because of the Contiguity relation between T and the subject, or because of T's EPP requirement? And in fact, if we turn to Right-prominent languages which lack EPP effects of the classic type, adjacency between the subject and the verb seems not to be enforced.

Languages like Italian, Portuguese, Russian, and Bulgarian, for example, do allow adverbs between the subject and T:

(46) Giovanni **spesso** parla italiano [*Italian*]
Giovanni often speaks Italian
'Giovanni often speaks Italian'

(47) O Pedro **provavelmente** sabe esta receita [*Portuguese*]
the Pedro probably knows this recipe (Schifano 2018, 73)

(48) Ivan **často** celuet Mašu. [*Russian*]
Ivan often kisses Maša.ACC
'John often kisses Mary' (Bailyn 1995, 43)

(49) Ivan **pravilno** otgovori na văprosa im [*Bulgarian*]
Ivan correctly answered to the-question their
'Ivan correctly answered their question' (Izvorski 1995, 57)

Zulu also has elements which may intervene between the subject and the main verb, which have the interpretation of adverbs. They are standardly analyzed as verbal, as they show noun class agreement with the preverbal DP:

(50) abazali bami **ba-yaye** ba- vuk -e ngo-five
AUG.2parents 2POSS.my 2S-usually 2S- awake SJC NGA.AUG-1.five
'My parents usually wake up at five'

As we expect, these Right-prominent languages are generally like French and Icelandic in not requiring the verb and the object to be adjacent:

(51) Giovanni parla **spesso** italiano [*Italian*]
Giovanni speaks often Italian

(52) O João termina **completamente** suas tarefas [*Portuguese*]
the João finishes complete his tasks
antes de começar novas
before of begin.INF new.ones (Schifano 2018, 73)

(53) Ivan podade **bărzo** pismoto na Maria [*Bulgarian*]

Ivan gave quicklythe-letter to Maria

'Ivan gave the letter to Maria quickly' (Izvorski 1995, 56)

(54) Ngi- si- khulum -a **kahle** isiXhosa [*Zulu*]

1S.SBJ- 7.OBJ speak -FV well AUG.7Xhosa

'I speak Xhosa well' (Buell 2005, 184)

Russian adverbs, surprisingly, cannot intervene between the verb and the object without special focus (Bailyn 1995, 43):

(55) a. Ivan **často** celuet Mašu.

Ivan often kisses Mary.ACC

'John often kisses Mary'

b. ??? Ivan celuet **často** Mašu.

Ivan kisses often Mary.ACC

On the other hand, as Dyakonova (2009) points out, Russian adverbs also cannot intervene between verbs and following PPs:

(56) a. On **bešeno** kričit na ženu.

he madly shouts at wife.ACC

'He shouts madly at his wife'

b.* On kričit **bešeno** na ženu.

he shouts madly at wife.ACC

Indeed, it is apparently impossible for this kind of adverb to follow the verb at all, in a wide-focus context, even if no other material follows the verb (Mitya Privoznov, p.c.):

(57) a. On **bešeno** kričit.
he madly shouts
'He shouts madly'

b.* On kričit **bešeno**
he shouts madly

As Dyakonova (2009) points out, the Russian situation is therefore quite different from the English one, in which adverbs may follow verbs as long as they do not intervene between *v* and the object:

(58) a. *John kisses **often** Mary

b. He shouts **madly** at his wife

c. He shouts **madly**

Russian adverbs, then, are apparently subject to an additional condition, beyond those discussed in this paper, and I will have to leave the further investigation of this condition for future work.

The data on the position of main verbs discussed in this section could be captured by the principles listed in (59):

(59) a. The position of the verb is determined as soon as all of the affixes to be attached to the verb have been introduced.

b. At the point in the derivation described in (59a), consider all of the affixes in the spellout domain currently under construction which require specifiers (in Richards' (2016) terms, the affixes which require Affix Support).

c. Realize the verb in the lowest position in the spellout domain currently under construction which is compatible with Contiguity requirements imposed by the heads, if any, described in (59b).

By "spellout domain" I mean what is commonly meant in phase theory (Chomsky 2000, 2001 and much subsequent work); phase heads trigger spellout of their complements to the interfaces, and these spelled-out constituents are the spellout domains. C, for example, is a phase head, and TP is its spellout domain.

A consequence of this definition is that if C is itself the lowest affix to attach to the verb, then the verb will be required to appear in C, since C, as a phase head, is the lowest head in the spellout domain containing it. This will be the case of V2; in a V2 clause, C is a (typically null) affix, requiring a specifier and triggering movement of the verb to itself.

When C is not an affix, the main verb will appear somewhere inside the complement of C. Here there are three kinds of languages of interest.

The first kind of language is Right-active, and has a version of T which requires a specifier (in Richards' (2016) terms, a version of T which is subject to Affix Support). Since T in this language requires a specifier, T will be one of the heads which (59b) requires us to consider. Moreover, since the language is Right-active, the subject preceding T must be adjacent to T. Consequently, the verb in this kind of language must appear in T, adjacent to the subject; if the verb were any lower, T would no longer satisfy its Contiguity requirements, in violation of (59c). This is the case of languages like French (and, in non-V2 clauses, Icelandic).

A second kind of language is also Right-active, like French, but has a version of T which does not require a specifier. As in French, T in this language must be adjacent to the subject; no adverbs can appear between them. However, since T in this language does not require a specifier, T is not one of the heads which (59b) requires us to pay attention to. Consequently, the verb can be placed in a way which disregards the needs of T; the verb appears as low as possible in the Spellout domain containing TP, possibly with adverbs intervening between the subject and

the verb. This is the case of languages like Italian, which, as we have seen, are Right-prominent but have no EPP requirement on T, and thus do not require the subject to remain string-adjacent to where the verb is pronounced.

Finally, we can consider a Left-active language with an Affix Support requirement (that is, an EPP requirement) on T. Such a language requires us to consider the Contiguity requirements of T when placing the verb—but because the language is Left-active, the subject may precede T at an arbitrary distance, without breaking the Contiguity relation between T and the subject. In this language, then, there will be no need for the main verb to appear in a structurally high position, and it will in fact be required to remain low. This is the English case.

The discussion thus far leaves open the possibility of a fourth kind of language, one which is Left-prominent like English, but which lacks the requirement of Affix Support which English has. Such a language would also allow the verb to remain low, just as in English; since T in this language has no Affix Support requirement, its needs are irrelevant for the placement of the verb. I have no reason to suspect that this language is impossible, though I have not yet found it.

There is much more work to do on this topic. The account of head-movement given above touches only on main verbs, without any discussion of auxiliaries, which are notorious for behaving differently. I have simply referred to adverbs as 'adverbs', without attempting to distinguish adverbs of different types, which future work will surely need to do. I have only talked about the needs of T, but we typically posit a richer range of structural projections dominating the verb, all with heads whose properties should be relevant for the precise placement of the verb. A full account of all of the data will have to wait for a complete discussion of the conditions on head-movement in Contiguity Theory. But the basic predictions

of the theory appear to be correct; Left-prominent head-initial languages require the verb to be adjacent to the object (in non-V2 clauses), and Right-prominent head-initial languages require the verb to be adjacent to the subject, just if they have EPP effects.

4.2 Intervention by experiencers

Branan (2018) points out that Contiguity Theory makes accurate predictions about the cross-linguistic conditions on raising across experiencers:

(60) a. John seems (**to Mary**) __ to be talented. [*English*]

b. Sofie ferekom (**ham**) __ at være helt enig. [*Norwegian*]
Sofie appears him to be.INF completely agreed
'Sofie appears (to him) to completely agree'

c. Jean semble (*** á Marie**) __ avoir du talent. [*French*]
Jean seems to Marie to.have of.the talent
'Jean seems (to Marie) to have talent'

d. Ólafur hefur virst (***mér**) __ vera gáfaður. [*Icelandic*]
Olaf.NOM has seemed me.DAT be.INF smart
'Olaf seemed (to me) to be smart'

e. Gianni sembra (*** a Maria**) __ essere stanco. [*Italian*]
Gianni seems to Maria to.be tired
'Gianni seems (to Maria) to be tired' (Rizzi 1986)

f. O alunos parecem (***ao professor**) __ estar exaustos. [*Portuguese*]
the students seem to.the professor to.be exhausted
'The students seem to the teacher to be exhausted' (Petersen 2016, 5)

As Branan points out, if it is the case that Contiguity relations must be maintained during the phase in which they were created, and if we follow Chomsky (2000) in claiming that the unaccusative *v* head associated with *seem* is not a phase head, then the raised subjects in (60) must be Contiguous, not only with the T of the matrix clause, but also with the T of the embedded clause out of which they raised.

This approach derives the facts in (60). To begin with, English and Norwegian are Left-active languages, as we have already seen. Just as adverbs may intervene between the subject and T in these languages, for reasons we now understand, experiencers may also intervene between raised subjects and the embedded T, as we see in (60a-b).

On the other hand, French, Icelandic, Italian, and Portuguese, as the tests in sections 1-2 demonstrated, are Right-active languages, in which Probes cannot be separated from Goals that precede them by any full XP. This was why adverbs cannot intervene between the subject and T in French or (in non-V2 clauses) in Icelandic. If this requirement of near-adjacency holds, not only for the subject and matrix T, but for the subject and embedded T, then we expect that the experiencer, being a maximal projection, will be banned from intervening between the subject and embedded T. This is what we see in (60c-f). Crucially, the requirement is not one of strict linear adjacency; even without the intervening experiencer, the raised subject is separated from embedded T by at least the matrix verb. But the matrix verb is a head, not an XP, and therefore does not intervene in the relevant sense; it will never be more prosodically prominent than the raised subject itself. There are also projections in the clausal spine which dominate embedded T and not the raised subject, but these projections will also not intervene in the relevant sense; the languages in question are Right-prominent, and the right edges of these structurally intervening projections are not linearly between T and the subject.

Recall from the previous section that while French and Icelandic (in non-V2 clauses) ban adverbs between the subject and the verb, Portuguese and Italian which are also Right-prominent, exhibit no such ban:

(61) Giovanni **spesso** parla italiano [*Italian*]
Giovanni often speaks Italian
'Giovanni often speaks Italian'

(62) O Pedro **provavelmente** sabe esta receita [*Portuguese*]
the Pedro probably knows this recipe (Schifano 2018, 73)

The proposal I made in the last section was that the facts in (61-62) can be explained once we correctly understand the conditions on the position of the verb. In every Right-prominent language, I claimed, the syntactic head T must be adjacent to its specifier—but in French and Icelandic, the verb must be pronounced in T, while in Italian and Portuguese it can be pronounced in a lower position (a difference I connected to the fact that French and Icelandic T requires a specifier, while Italian and Portuguese T does not). In examples like (61) and (62), in other words, T is immediately after the subject and before the adverb, but the verb is not pronounced in T.

In Branan's Italian and Portuguese examples, however, we can see the effects of Contiguity on the relation between T and the subject. The relevant examples are repeated here:

(63) a. Gianni sembra (*** a Maria**) __ essere stanco. [*Italian*]

Gianni seems to Maria to.be tired

'Gianni seems (to Maria) to be tired' (Rizzi 1986)

b. O alunos parecem (***ao professor**) __ estar exaustos. [*Portuguese*]

the students seem to.the professor to.be exhausted

'The students seem to the teacher to be exhausted' (Petersen 2016, 5)

In (63a-b), on Branan's account, Contiguity relations must hold between the raised subject and both matrix and embedded T. If there is an overt experiencer in the matrix clause, it clearly intervenes between the position of the raised subject and the T of the embedded clause, no matter where any verbs are pronounced. Branan's raising examples, on this account, display the effects of Contiguity more clearly for these languages than the examples involving the positioning of adverbs do.

Not only does Branan's approach successfully predict which languages will ban raising across experiencers and which will not, but his proposal also captures properties of the ban which have always been difficult to account for. Raising across experiencers becomes possible in these languages if the experiencer is a clitic (depriving it of its full prosodic status), or if the experiencer undergoes extraction itself:

(64) Jean **lui** semble __ avoir du talent. [*French*]

Jean to.him seems to.have of.the talent

'Jean seems to him to have talent'

(65) a. **Á Marie**, Jean semble __ avoir du talent. [*French*]

to Marie Jean seems to.have of.the talent

'To Marie, Jean seems to have talent'

b. **Hvem** hestarnir virðast __ vera seinir? [*Icelandic*]

who.DAT the.horses seem to.be slow

'To whom did the horses seem to be slow?'

The well-formedness of (65), in particular, raises problems for cyclicity on conventional approaches to syntactic intervention, since we would expect raising to precede A-bar extraction in the derivation. On Branan's approach, the facts are expected. If raising precedes A-bar extraction of the intervener, then the Contiguity relation between the raised subject and embedded T will indeed be temporarily broken, but that relation can be repaired once the intervener has been extracted, and Contiguity between the raised subject and both instances of T will therefore be satisfied in the representation sent to PF.

For some of the languages under discussion here, Branan's test cannot be run, for independent reasons. Bulgarian lacks infinitives entirely, including raising infinitives. Zulu does not allow raising out of infinitives (Halpert 2019, 124):

(66) *uZinhle u-bonakala __ uku-(zo-)xova ujeqe

AUG.1Zinhle 1S-seem INF-(FUT-)make AUG.1steamed.bread

'It seems that Zinhle will make steamed bread'

Neither does Russian (Stepanov 2007, 84):

(67) *Ivan sčitaetsja __ byt' bol'nym

Ivan is.considered to.be sick.INSTR

'Ivan is considered to be sick'

German does not allow experiencers to intervene between raising verbs and their complement clauses, regardless of whether raising takes place (Verena Hehl, p.c.):

(68) Es scheint (* **mir**), daß er müde ist
it seems me.DAT that he tired is
'It seems to me that he is tired'

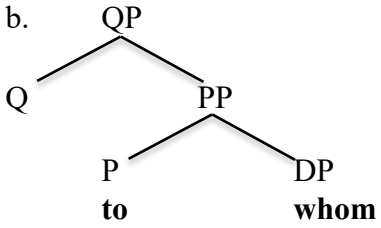
For the languages for which Branan's test can be run, however, raising across experiencers is banned in just the cases where he predicts that it should be.

4.3 Pied-piping

Richards (2020) discusses cross-linguistic differences in pied-piping as another case to be covered by conditions on Contiguity. He adopts Cable's (2007, 2010a, 2010b) approach to pied-piping, positing a functional projection QP which dominates wh-phrases:

(69) a. [To **whom**] are you speaking?

b.



So-called "wh-movement", on this account, is actually movement of QP, and while QP must dominate wh-phrases, it need not immediately dominate them. On this approach, the question of how much material may be pied-piped reduces to a question about the possible structural relations between QP and the wh-phrase.

Still following Cable, Richards posits an Agree relation between Q and the wh-phrase, and claim that the contrasts in (70-78) then follow from the same considerations that derive the contrasts in the previous two sections:

(70) *[**Q** Paintings of **what**] did you see at the museum? [*English*]

(71) *[**Q** Fotografier av **hvem**] kjøpte hun? [*Norwegian*]

photographs of **who** bought she

'**Who** did she buy photographs of?' (Øystein Vangsnes, p.c.)

(72)*[**Q** Bilder von **was**] hast du gesehen? [*German*]

pictures of what have you seen

'[Pictures of **what**] did you see?' (Verena Hehl, p.c.)

(73) [**Q** Málverk eftir **hvern**] sást þú? [*Icelandic*]

painting by **who** saw you

'[A painting by **who**] did you see?' (Hrafnhildur Bragadóttir, Stefan Olafsson, Helgi Gunnarsson, p.c.)

(74) ?[**Q** Des peintures de **quoi** de Monet] as-tu vu au musée? [*French*]

of.the paintings of **what** by Monet have-you seen at.the museum

'[Paintings of **what** by Monet] did you see at the museum?' (Sophie Moracchini, Paul Marty, p.c.)

(75) [**Q** Isibonelo **sika-bani**] oku-melwe si-si-landel-e? [*Zulu*]

AUG.7.example **7.ASSOC.1-1.who** 17.REL-ought 1PL.S-7.O-follow-SUBJ

'[The example of **who**] ought we to follow?' (Claire Halpert, p.c.)

(76) [**Q** As fotos de **quem**] você comprou? [*Portuguese*]

the photos of **who** you bought (Suzana Fong, p.c.)

'[Photos of **who**] did you buy?'

(77) [**Q** Snimki na **kakvo**] vidja v muzeja? [*Bulgarian*]

pictures of **what** you.saw at museum.the

'[Pictures of **what**] did you see at the museum?' (Nadia Dimitrova, p.c.)

(78) [**Q** Fotografii **čego**] ty videl v muzee? [*Russian*]

photographs **what.GEN.SG** you saw in museum

'[Photographs of **what**] did you see at the museum?' (Mitya Privoznov, Anton Kukhto, p.c.)

Assuming that QP is head-initial in these languages, the ill-formedness of (70-72) is by now a familiar effect. These are Left-active languages, in which Probes must be nearly adjacent to Goals which follow them, and in (70-72), the wh-phrase is too distant from the Q at the beginning of the wh-phrase; in particular, the DP *paintings of what* dominates the wh-phrase *what*, and has its Left edge linearly intervening between Q and the wh-phrase. In (73-78), on the other hand, we are considering Right-active languages, in which Q should be able to be separated from the following wh-phrase, and we can see that this is indeed the case.

The one outlier in our sample is Italian. Italian, like the languages in (73-78), is a Right-active language, but unlike the other Right-active languages, it does not allow pied-piping by deeply embedded material:

(79) *[**Q** Foto di **cosa**] hai visto nel museo? [*Italian*]

photos of what have.2SG seen at.the museum

'[Photos of **what**] did you see at the museum?' (Enrico Flor, Stanislao Zompì, p.c.)

We will see shortly that Italian wh-questions are unusual in another way. I will revisit the issue of the ill-formedness of (79) then, though I will be unable to explain it.

4.4 Wh-movement

Richards (2010) originally began developing Contiguity Theory as a way of dealing with the behavior of wh-phrases. Let us consider the predictions the theory now makes.

First, in head-final languages, we expect to find two kinds of wh-questions. In Left-active languages like Japanese and Korean, wh-in-situ should be possible:

(80) a. **Dare**-ga pan-o katta (**C**)? [*Japanese*]
who-NOM bread-ACC bought
'Who bought bread?'

b. Pan-o **dare**-ga katta (**C**)?
bread-ACC who-NOM bought

(81) a. **nwukwu**-ka ppang-ul sa-ess **-ni**? [*Korean*]
who-NOM bread-ACC buy-PAST-Q
'Who bought bread?'

b. ppang-ul **nwukwu**-ka sa-ess **-ni**?
bread-ACC who-NOM buy-PAST-Q

On the other hand, in Right-active head-final languages, it should be impossible for full XPs to intervene between the wh-phrase and the Probe at the end of the clause:

(82) a. * **vin** p'ur-i iq'ida (**C**)? [*Georgian*: Erschler 2015]
who.ERG bread-NOM bought
'Who bought bread?'

b. p'ur-i **vin** iq'ida (**C**)?
bread-NOM who.ERG bought

(83) a. ***señek** Jon ikusi rau (**C**)? [*Ondarroa Basque*:
who.ERG Jon see.PRF AUX Arregi 2002, 165]
'Who saw Jon?'

b. Jon **señek** ikusi rau (**C**)?
Jon who.ERG see.PRF AUX

In (82a) and (83a), Contiguity between final C[18] and the wh-phrase is not respected; since Georgian and Basque are Right-active, in a string containing an XP intervening between the wh-phrase and C, the most prosodically prominent element would be the intervening XP, and not the wh-phrase. Georgian and Basque both independently have scrambling as an option (for reasons I will not try to derive here), and perhaps it is scrambling that makes the word orders in (82b) and (83b) possible, satisfying the Contiguity condition.

Turning to left-headed languages, we again expect to see two kinds of behavior. In Left-active languages, it should be impossible for the wh-phrase to be separated from the initial C by any XP:

(84) a. **Who (C)**-did you see? [*English*]

b. * (**C**) you saw **who**?

In Right-active languages, on the other hand, we expect no such requirement of adjacency; wh-phrases should be able to remain in situ. For several of the languages we have identified above as Right-active, this is true:

[18] I will continue to call this head C, but it is worth noting that Erschler (2015) argues that Georgian interrogative C is in fact head-initial. Since Georgian is generally head-final, I may have to assume that the relevant Probe-Goal relation involves some other head (or perhaps that Georgian C begins the derivation in a head-final position and undergoes head-movement to an initial position). Thanks to Tanya Bondarenko for discussion of this problem.

(85) (**C**) Tu as vu **qui**? [*French*]

you have seen who

'Who did you see?'

(86) (**C**) O Bill comprou **o que**? [*Portuguese*]

Bill bought what

'What did Bill buy?'

(87) (**C**) ku- fik -e **bani**? [*Zulu*: Sabel and Zeller 2006]

17S arrive -PFV 1who

'Who came?'

However, there are also several Right-active languages in which wh-in-situ is banned:

(88) *(**C**) Pétur hefur talað við **hvern**? [*Icelandic*]

Peter has spoken with who.ACC

'Who has Peter spoken with?'

(89) *(**C**) Hai visto **chi**? [*Italian*]

have.2SG seen who

'Who did you see?'

(90) *(**C**) Ty videl **kogo**? [*Russian*]

you saw who.ACC

'Who did you see?'

(91) *(**C**) Ivan e kupil **kakvo**? [*Bulgarian*]

Ivan AUX bought what

'What did Ivan buy?'

Richards (2016) made a proposal about why wh-in-situ is unexpectedly banned in Icelandic; Icelandic is V2, and V2 languages typically ban wh-in-situ. See Richards (2016) for further discussion of this ban.

The following section will turn to the surprising ill-formedness of wh-in-situ in (89-91). Italian, Russian, and Bulgarian are not V2 languages, and they are Right-active. Why can they not leave wh-phrases in situ?

5. Unexpected wh-movements

Italian, Russian, and Bulgarian have another property that distinguishes them from the other languages above; they have a general ban on wh-in-situ, even in multiple-wh questions:

(92) a. ***Chi** ha comprato **che cosa**?
who has bought what [*Italian*]

b. **Kto** **čto** kupil?
who what bought [*Russian*]

c. **Koj** **kakvo** e kupil?
who what AUX bought [*Bulgarian*]

Italian does not allow multiple-wh questions at all (Rizzi 1982)[19], and Russian and Bulgarian move all wh-phrases. In this regard these languages are different, for example, from Icelandic, which has multiple wh-questions of the kind familiar from English:

(93) **Hver** bauð **hverjum** í veisluna [*Icelandic*]
who invited whom in the.dinner
'Who invited who to the dinner?'

[19] Here there is apparently a generational split, about which I will have nothing to say; some younger Italians do in fact allow multiple-wh questions like the one in (92a) (Stanislao Zompì, p.c.).

Italian is unique in our sample in banning multiple wh-questions entirely (though it is certainly not unique in the literature; see, for example, Fortin 2009 on Indonesian and McCloskey 1979 on Irish). I will have nothing to say here about why this is, or about whether this property of Italian can be linked to its surprisingly strict limitations on pied-piping, discussed in section 4.3 above.

The fact that the conditions described in section 4 cannot drive wh-movement in Italian, Bulgarian, and Russian, then, is arguably not completely undesirable; wh-movement in these languages has characteristics which distinguish them from the other languages under study. The question is then how to guarantee that these languages not only have overt wh-movement, but cannot leave wh-phrases in situ at all. I will have to leave this question for future research (though see Francis (2015) for one proposal that seems very promising to me).

6. Conclusions

I have argued in this paper that it is a mistake to grant ourselves the power to independently specify, for a given type of movement, whether it is overt or covert in a given language. At least for this type of phenomenon, it is possible that there are no strictly syntactic parameters at all; what there are, rather, are universal conditions on the prosodic consequences of Probe-Goal relations, interacting with a cross-linguistically invariant syntax, and cross-linguistic variation which is confined to facts about phonology. For this paper, those facts involved the position of prosodic prominence. We have seen that, as usual, the comparatively simple requirements imposed by this theory interact with other requirements (hopefully also simple in their own right) to yield apparent complexity. Icelandic, for example, should have wh-in-situ as an option, given its distribution of prosodic prominence, but it does not, because of independent properties of V2 languages. Russian adverbs are subject to a condition which requires them to be preverbal; this condition is left mysterious in this paper. The project suggested by this work is a familiar one:

we should continue to apply the general approach to more languages[20] and more kinds of movement, to develop an inventory of the kinds of forces that drive the patterns that we find.

[20] See, for example, Tan (2017) on Singapore English (Singlish) and Moran (2017) on Modern Standard Arabic.

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