

# Grounding topic and focus in biological codes

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## Abstract

A compositional theory of English intonational meaning is presented that is firmly grounded in (indeed, fully derived from) Gussenhoven's [1] *biological codes*. The resulting theory is compared to the more top-down approaches to *focus* and *contrastive topic* in the literature, suggesting how such stipulated semantic/pragmatic notions as 'alternative' and 'strategy' can be grounded – and revealing how they might be amended.

**Index Terms:** Intonational meaning, biological codes, pragmatics, topic and focus.

## 1. Introduction

This paper presents a compositional theory of English intonational meaning.<sup>1</sup> The atomic meanings assumed are explicitly derived from the natural, biological meanings captured in Gussenhoven's *biological codes* [1]. The paper concentrates on the meanings of *nuclear accents* and *boundary tones* in English, combinations of which form the phonological realizations of semantic/pragmatic notions such as *focus* and *contrastive topic*.

I assume that the meanings of nuclear accents (section 2) and high boundary tones (section 3) derive from Gussenhoven's *effort code* and *production code*, respectively, through initial volitional production, and subsequent grammaticalization ('phonologicalization'), of the relevant biological codes. Hence, I will not *reduce* phonology to phonetics, but *ground* phonology in phonetics. In each case, I shall argue on conceptual grounds for a particular pathway of grammaticalization. I explore the empirical repercussions of the semantic theory derived thus (mainly section 4), and compare it with the more 'top-down' semantics/pragmatics-driven approaches to these topics [2, 3, 4, 5]. Some of the core concepts these theories stipulate, such as 'alternative' and 'strategy', can be grounded in more basic concepts. However, I will also point out essential differences that seem to favour the theory proposed here.

## 2. Nuclear accents: relevant alternatives

### 2.1. Focus and the effort code

I assume that *focus* is expressed by *nuclear accents*, in the sense of Ladd [6] (although additional phonological or phonetic features may disambiguate between *broad* and *narrow* focus, a topic that I shall not discuss). I follow Gussenhoven [1] in assuming that focus is a grammaticalization of the *effort code*, which correlates the effort expended on producing a certain part of a sentence with the *importance* of reliably conveying it to the

hearer. So, the natural, biological meaning of (1), where CAPS indicate the nuclear accent, is that the word "party" is somehow important:

(1) John came to the PARTY.

The question is: what does it mean for part of a sentence to be *important* (and how, if at all, was this meaning fine-tuned by grammaticalization)?

I argue that the only way in which a constituent can be *important* to get across, is if the constituent *could have been different*, i.e., if it *could not have been predicted*. For if it could not have been different – e.g., if the hearer had already known that John was at the party – there would have been no risk of misunderstanding, and any extra effort spent on its communication would have been wasted. Thus, a constituent could have been different only if an *alternative* exists that, as far as the hearer knows, could have taken its place. The importance of a constituent therefore implies the existence of alternatives for the constituent. I suspect this argument is not new (it echoes Wittgenstein's remarks on tautologies being meaningless [7]); however, to my awareness it is rarely made explicit.

The only analysis of 'importance' that seems defensible to me at the *biological/phonetic level* is one in terms of *left-to-right* predictability: hearers use whatever is said up to a point (plus world knowledge, contextual knowledge, etcetera, as an anonymous reviewer kindly pointed out), to predict the word that comes next. (Of course *right-to-left* 'prediction' is also used, e.g., when a hearer tries to reconstruct a word she missed earlier in the sentence, but it seems that the necessity of such a repair should rather be avoided, precisely by emphasizing those words whose left-to-right predictability is lower.) The kinds of alternatives that an important constituent evokes, therefore, can be obtained by replacing in the utterance the important constituent *plus all material to its right* (and perhaps some semantically empty material to its left, but I shall leave this open). Thus, (1) may have "John came to SCHOOL" as an alternative.

The above already paves part of the way towards a Roothian [2] *Alternative Semantics*-style account of focus, according to which focus 'evokes' (or indicates the existence of) relevant alternatives. However, in section 4 examples are given where left-to-right predictability is too weak a criterion for focus. Furthermore, current theories of focus require that the alternatives are somehow *relevant*, which seems to require a less automatic, more purposeful use of the effort code. These details, I argue, can only be understood if the grammaticalization of the effort code is taken into account.

### 2.2. Grammaticalization of the effort code

I assume that the meaning of accent has become *more semantic/pragmatic*, reflecting its non-automatic, volitional production. I assume more concretely that this is reflected in the following two minimal changes:

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1. The criterion of predictability becomes more pragmatic, i.e., sensitive primarily to the *contextual relevance* of an alternative;
2. In languages where semantic scope and linear order are dissociated (e.g., English, but not German), left-to-right predictability is replaced by ‘top-to-bottom’ predictability, i.e., the importance of a constituent is no longer its predictability given what comes to its left, but its predictability given *what takes scope over it*.

Thus, I assume the following meaning for accent, which can be understood as a minimal, grammaticalized refinement of the effort code:

(2) **Assumption 1: Nuclear accents**

A nuclear accent indicates the existence of a relevant alternative, sharing with the actual utterance all material semantically outscoping the accented constituent.

**Phonetic ground:** The effort code, with greater effort marking greater importance, construed as left-to-right predictability, in turn grammaticalized as top-down, contextual predictability.

In the meantime, the original effort code has of course not disappeared. The resulting two-channel view of stress/accent is in line with Beaver and Velleman [8], who argue on empirical grounds that the *importance* of a constituent has *two* components: (i) its general non-predictability, and (ii) its importance for the present purposes of the conversation. These components can be identified with the effort code and its grammaticalization, focus, respectively, thus *explaining* why Beaver and Velleman’s theory may be correct.

### 2.3. Focus alternatives

My proposal yields considerably *weaker* restrictions on the set of alternatives than existing theories of focus, e.g., Rooth’s [2]. For instance, assuming surface scope in the following sentences, the following is predicted (CAPS on the nuclear accent):

- (3) a. John came to the PARTY.  
*Alternatives: John came to ⟨ X ⟩*
- b. JOHN came to the party.  
*Alternatives: ⟨ X ⟩ [i.e., anything!]*

Example (3a) is perhaps as one would expect, and the prediction is in line with current theories of focus. Example (3b), however, seem *too weak*; one might think that the relevant alternatives to (3b) must be of the form “X came to the party”. Indeed, the latter is what a Rooth-style focus semantics predicts [2]. However, I take (4) to show that such an account would in fact be too strong:

- (4) [B, who is known to hate John, and to have headache problems, came home early from a party.]  
 A: Wow, you’re back already? Was John at the party, perhaps, or did you have a headache again?  
 B: JOHN was there.

Here the response is felicitous *without* the existence of relevant alternatives of the form “X was there”. (To test: such alternatives would get to be pragmatically excluded. The only relevant alternative is that B had a headache, which is indeed pragmatically excluded by the response.)

But why does (3b) nevertheless *feel* like the relevant alternatives must be of the form “X came to the party”, i.e., what has misled Rooth into thinking that they are? I explain this pragmatically as follows:

1. That “John” was said, was not predictable.
2. *Given* that “John” was said, that he came to the party *was* predictable.
3. We could not have known beforehand that John came to the party, for then the utterance would not have been informative, and should not have been made.
4. To reconcile 2. and 3., we must have known something slightly weaker, *plausibly*, that the utterance would answer the question “who came to the party?”.

Hence, my theory’s weak restriction on alternatives is necessary in light of (4), but the perceived strength in (3b), as modeled by existing theories of focus, can nevertheless be explained.

## 3. Final rises: maxim violations

Let us call a high boundary tone (ToBI’s ‘H%’) an ‘IP-final rise’ if it occurs at the end of an *intonation phrase* (utterance), and an ‘iP-final rise’ if it occurs at the end of an *intermediate phrase*. As detailed below, I assume that these phonological features are grammaticalizations of Gussenhoven’s *production code* [1].

Conflating, *for now*, steep rises and shallow rises, the IP-final rise has several quite distinct uses, three salient kinds given in (5)–(7). Throughout this paper, I shall indicate both IP-final and iP-final rises by ‘↗’, and falls by ‘↘’.

- (5) **Uncertainty about proposition expressed** [9, 10]  
 (typically a steep, question-kinda rise, see below)
- a. [Seeing someone arrive with an umbrella]  
 It’s RAINing ↗
- b. A: John went to pick up his sister.  
 B: John has a SISTER ↗
- (6) **Uncertain relevance** [11]  
 (more typically ‘(rise-)fall-rise’, cf. section 4)
- a. A: Was John at the party?  
 B: (Well,) there was ALcohol ↗
- b. A: Does your friend live far away?  
 B: In Philadelphia ↗
- (7) **Partial answerhood / list** [12, 13]  
 A: Who was at the party?  
 B: JOHN was there ↗ (, MARY was there ↗, etc.)

In earlier work [16] I have proposed that an IP-final rise conveys that a *conversational maxim*, in the sense of Grice [14], is being violated, and have shown that it generates existing accounts that have been proposed for each use in isolation, and accounts for part of the phonetic variation between the different uses. The theory was not grounded in phonetics; nor was it intended to cover also iP-final rises. In the present section, this work is extended in these two respects.

### 3.1. The natural meaning of IP-final high pitch

Gussenhoven’s [1] *production code* captures that high pitch marks the beginning of an utterance and low pitch the end, because the energy one can produce depends biologically, involuntarily, on the speaker’s remaining breath. When a speaker exploits this code by voluntarily manipulating pitch, *almost* the same natural meaning results – “almost”, because a voluntarily produced phonetic feature may gain a *new* meaning precisely *in virtue of* its voluntary production. The latter is not mentioned by Gussenhoven, but I think it is crucial for understanding how the final rise came to mean what it means.

For instance, a high pitch would normally ‘mean’ that the speaker’s breath group is still unfinished. But when produced voluntarily it may occur at what would normally be the perfect ending for a breath group, e.g., the end of a sentence, and a richer meaning must be attached to them: not that the speaker’s breath group is unfinished, but that the speaker’s utterance is unfinished *in some other sense*. If a high pitch occurs at the end of a sentence, it cannot mean syntactic or semantic unfinishedness either. I assume, therefore, that it must imply a kind of *pragmatic* unfinishedness (for what other kinds of unfinishedness could there be?), where an utterance is *pragmatically unfinished* if, on its own, it does not constitute a wholly *cooperative* contribution to the discourse, given the present purposes of the conversation. In Gricean [14] terms: the utterance violates a conversational maxim. Indeed, this is the meaning I assume for a *voluntarily produced, sentence-final high pitch*: that the utterance violates some maxim or other.

What this meaning – violating a maxim – amounts to, depends of course on one’s pragmatic theory, which I define two subsections below. First, let us consider why, and how, this meaning has grammaticalized.

### 3.2. Grammaticalizing to IP-final rise

A cooperative speaker may well violate a maxim, provided she has good reason to do so, and does so *openly* to avoid misleading the hearer [14]. In light of this required transparency, it will be communicatively beneficial for the sentence-final high pitch to *grammaticalize* into a binary phonological feature, indicating the presence/absence of a maxim violation. Indeed, I assume that this has happened, and the result is the distinction between sentence-final high and low boundary tones, with the former indicating the violation of a maxim. That is:

- (8) **Assumption 2: IP-final rises** The IP-final rise indicates that the utterance violates a conversational maxim.

**Phonetic ground:** A grammaticalization of voluntary sentence-final high pitch, which marks degree of pragmatic unfinishedness, as a derivative of involuntary high pitch, which marks breath group unfinishedness, in accordance with the production code.

A final *fall*, i.e., a sentence-final low boundary tone, can be seen as the semantically vacuous unmarked case. However, it can equally well be said to indicate *full compliance* with the maxims, simply in virtue of it not being a final rise, and because maxim violations must be indicated.

As in the case of accents, this grammaticalization too does not mean that the original *production code* has disappeared. It seems that the relative height of the final pitch is still indicative of the severity of the maxim violation, i.e., the *degree* of pragmatic unfinishedness. Assuming that potential *falsity* is more severe than potential *irrelevance* or *partiality* [14], this explains why the examples in (5) are associated with a higher rise than (6) or (7). Thus, I assume the following (which is already formulated in a way that applies to both IP-final and iP-final rises, although the latter have yet to be discussed):

- (9) **Assumption 3: Height of an IP/iP-final rise**

The relative height of an IP/iP-final rise indicates the importance of the maxim violated.

**Phonetic ground:** The production code: higher pitch indicates greater degree of unfinishedness, i.e., when voluntarily produced, a more severe maxim violation.

### 3.3. The required maxims

To spell out what it means to violate a maxim, I adopt the maxims from my earlier account of scalar implicatures [15]. These are defined relative to a contextual set of possibilities (pieces of information) that are mutually (by speaker and audience) taken to be relevant. Given such a set, his maxims together require that one should at least *mention*, and, if possible, truthfully *confirm*, all and only (sets of) live possibilities that are mutually taken to be relevant, i.e. (for the precise definition and motivation, I refer to [15]):

1. **Maxim of Quality:** Say only that which you (take yourself to) know.
2. **Maxim of Relation:** (Take yourself to) mention all (and only) *live* possibilities mutually known to be relevant.
3. **Maxim of Quantity:** (Take yourself to) confirm all (and only) possibilities mutually known to be relevant, respecting Quality.

The Maxim of Quality is straightforward, and violating it implies not knowing (or not taking oneself to know) the proposition expressed, which corresponds with Truckenbrodt’s [10] account of the readings in (5).

To see how the uses in (6) and (7) derive, I shall first illustrate what *compliance* with the maxims of Relation and Quantity implies. Consider the response in (10) (where the question serves to fix the contextual set of relevant possibilities).

- (10) Who (among John, Bill, Mary) was at the party?  
– John was, or both John and Bill.  
*Implicated: Mary wasn’t, not sure about Bill.*

The response doesn’t mention Mary’s presence, so it must not be a live possibility for the responder (Relation); Bill’s presence is mentioned, so it has to be a live possibility (Relation), but not confirmed, so it cannot be *more* than a live possibility (Quantity), i.e., the responder is unsure about Bill’s presence. This is what *compliance* with the maxims implies.

Now, *violating* these maxims yields the uses in (6) and (7), as follows. In (6), the speaker is unsure how her answer maps onto the set of relevant possibilities, hence she does not take herself to have either mentioned (Relation) or confirmed (Quantity) any particular one of them. In (7), the speaker simply hasn’t mentioned (Relation) or confirmed (Quantity) *all* of them (*yet* – if she is making a list). In both cases, that Relation or Quantity is violated is precisely what the IP-final rise indicates. (In [16] I show that the precise predictions align with [11], among others.)

### 3.4. Generalizing to iP-final rises

The reasoning in section 3.1 does not directly apply to the level of intermediate phrases, i.e., to iP-final rises, because (non-)cooperativity is, primarily at least, a property only of utterances as a whole. Nevertheless, the function of iP-final rises turns out to be a natural generalization of that of the IP-final rise, once it is seen that what a maxim violation amounts to depends importantly on the accented constituent. If a rise expresses, e.g., disbelief (Quality violation), this disbelief can only be due to the identity of the accented constituent – all other constituents, after all, should have been predictable. For instance, the accents in (11) provide the *two* reasons for this disbelief, namely that John usually skips breakfast and hasn’t seen his mother in years:

- (11) John had BREAKfast ↗, with his MOTHER ↗.

Likewise, if a rise expresses partial answerhood (Quantity or Relation violation), this can only be due to alternative answers not having been mentioned or confirmed – alternative answers which must have been evoked by the accented constituent. For instance, the rise in (12) indicates that there are unmentioned, possible relevant alternatives that differ in “John” and everything in its scope:

(12) JOHN<sup>↗</sup>, had the BEANS<sup>↘</sup>.

Given that every iP comes with its own accent [6], the role of iP-final rises must be as follows: they are used to indicate whether a maxim is violated *with respect to the accented constituent*.

In sum, the meaning that I assume for iP-final rises is a straightforward generalization (indeed, *hardly* a generalization) from the meaning of an IP-final rise:

(13) **Assumption 4: iP-final rises** The iP-final rise indicates that the utterance violates a conversational maxim with respect to the accented constituent in the iP.

**Phonetic ground:** As a generalized version of the IP-final rise, which derived from the production code.

I have already assumed (Assumption 3 above) that iP-final rises are subject to gradience similar to IP-final rises. This predicts, correctly I think, that the iP-final rises in (11) are higher than the iP-final rise in (12).

Finally, let us pause at one aspect of example (12) that might appear puzzling: the utterance as a whole ends with a fall (which I assume the IP shares with the last iP), but contains a rise. But how can the utterance as a whole be cooperative, while a maxim is violated with respect to the first accented constituent? I propose the following explanation. The cooperativity of the utterance as a whole is evaluated only relative to the context as it was *prior to the utterance*, in particular the set of possibilities mutually believed to be relevant – after all, it would be strange if an utterance were free to set its own goals. Although nuclear accents, by evoking alternatives, potentially *extend* the set of possibilities mutually believed to be relevant, these new possibilities (if truly new to the context) cannot yet affect the cooperativity of the utterance as a whole. Thus, (12) conveys that the resolution of John-alternatives, which the first accent indicates exist, was not an immediate conversational goal (although this will *become* the goal for the next speaker). I will discuss this example again, and in more detail, in the next section.

## 4. Some additional predictions

### 4.1. Contrastive topic and scope

Let us consider again example (12), repeated below. For semantic transparency, I will indicate the last iP-final boundary and the IP-final boundary separately, even though, when identical, they can be (I assume) prosodically realized as one. I mark them with indices a, b, c to link them to their respective semantic contributions given immediately below.

(14) JOHN<sup>↗<sup>a</sup></sup> had the BEANS<sup>↘<sup>b</sup>↘<sup>c</sup></sup>.

- Something else could have happened, that I consider possible (or know) but have not mentioned (or confirmed). (Pragmatically enriched: other people could have eaten something (section 2.3)).
- John could have eaten something else, but I have mentioned all alternatives I consider possible; i.e., John had only beans.

- As far as the conversational goal prior to the utterance goes, the utterance is fully cooperative.

This is usually called a (contrastive) topic-focus construction, where John would be the contrastive topic. The same utterance, but with the rise and fall interchanged, yields:

(15) JOHN<sup>↘<sup>a</sup></sup> had the BEANS<sup>↗<sup>b</sup>↗<sup>c</sup></sup>. (John <sup>></sup> the beans)

- Something else could have happened, but I have mentioned everything I consider possible, i.e., nothing happened except John’s eating beans.
- John could have eaten something else, and I have not mentioned all alternatives I consider possible; i.e., John may have had an additional dish.
- As far as the conversational goal prior to the utterance goes, the utterance is *not* fully cooperative.

In this case the meaning components (a) and (b) are contradictory. Hence, this is predicted not to be a possible reading for this sentence. The *inverse-scope* reading, on the contrary, is semantically felicitous (for this, having replaced left-to-right by top-down predictability in section 2 is crucial):

(16) JOHN<sup>↘<sup>a</sup></sup> had the BEANS<sup>↗<sup>b</sup>↗<sup>c</sup></sup>. (the beans <sup>></sup> John)

- Someone else could have had the beans, but I have mentioned all alternatives I consider possible; i.e., only John had beans.
- Something else could have happened, that I consider possible (or know) but have not mentioned (or confirmed). (Pragmatically enriched: other things could have been eaten by someone).
- As far as the conversational goal prior to the utterance goes, the utterance is not fully cooperative.

My semantics thus predicts that *contrastive topic must always take scope over focus*. Indeed, that this must be the case has been proposed on empirical grounds [4, 5]. For instance, the intonation pattern in (15)/(16) is completely unavailable in German, where scope and linear order are less dissociated. To my awareness, my theory is the first to *explain* why contrastive topic must take scope over focus: they must do so in virtue of their intonational meanings, which they have in virtue of the biological codes.

### 4.2. Strategies

Existing accounts of contrastive topic and focus are phrased in terms of *strategies* for answering a question [3, 4]. For instance, (14) and (16) would both be part of a strategy to answer the question “who had what?”, but (14) would answer it ‘by individual’ and (16) ‘by food item’. Indeed, the *existence* of alternative answers to “who had what?” is implied by both examples (albeit pragmatically). However, this does not mean that answering that question was also a *conversational goal* when the utterance was made. Indeed, the third meaning component of (14) combined with the first *entails* that the conversational goal could not have been so demanding (as I briefly discussed in the previous section). Hence, only (16) can be truly part of a strategy for answering “who had what?”.

This predicts (correctly, I believe) a feeling of unease when “who had what?” is responded to with (14). In addition, it explains why (16) is fine in *lists* (17a), while (14) is rather marked (17b):

(17) a. JOHN<sup>↘</sup> had the BEANS<sup>↗</sup>. MARY<sup>↘</sup> had the PASTa<sup>↗</sup>. . . .

- b. ?? JOHN ↗ had the BEANS ↘. MARY ↗ had the PASTA ↘. . . .

The list in (17b) is appropriate only when imagined as a *series* of answers to a *series* of individual questions, say, when explicitly moving down a checklist – “What did John have?”, “What did Mary have?” etc. – each answer fully cooperative in light of its own private question. I think this contrast will be difficult to accommodate in theories based on the notion of a strategy.

Finally, because my theory is not formulated in terms of strategies, it extends without problems to what appear to be cases of ‘mixed’ strategies:

- (18) JOHN ↘ had the BEANS ↗. And MARY ↗ had the PASTA ↘.

These sentences felicitously combine not despite, but in virtue of, their phonological meanings.

### 4.3. The fall-rise contour

Consider again example (6a), here repeated with fall-rise:

- (19) A: Was John at the party?  
B: (Well,) there was ALcohol ↘.

I assume fall-rise is composed of an iP-final fall directly followed by an IP-final rise. What then is the intonational meaning of this utterance? The iP-final fall indicates that there is nothing about there being alcohol, or about there being relevant alternatives for alcohol, with respect to which speaker B violates a maxim. Nevertheless, the utterance *as a whole* is marked as non-cooperative. The only reading for which this combination is possible, is one of *uncertain relevance*, where nothing about the utterance itself violates a maxim, but only its relation to the conversational goal. This explains why readings of uncertain relevance are typically realized by the fall-rise contour [11], not by a mere rise (although I predict it to be available also for the latter).

## 5. Final remarks

I have shown how core concepts like contrastive topic and focus, and contours such as fall rise, can be grounded in (not reduced to) universal, biological codes in the sense of Gussenhoven [1]. Concretely, I have argued that a nuclear accent’s evoking relevant alternatives, and a high boundary tone’s marking a maxim violation, can be understood as natural grammaticalizations of Gussenhoven’s production and effort codes. The predictions of the semantic theory thus derived achieve at least the same (and arguably a finer) granularity compared to the predictions made in the more semantic/pragmatic-driven literature, which, in contrast to the approach pursued here, *stipulate* particular meanings only based on the data they want to explain. I have pointed out correspondences but also crucial differences, such as the weaker restriction on focus alternatives predicted here, as well as the differences highlighted in the previous section. Where differences occurred, it seems that my predictions are more accurate. Of course, a more systematic comparison is necessary - and underway. An application of the theory to intonation on interrogatives is a work in progress (as encouraged by an anonymous reviewer).

The relative ease with which intonational meaning in English can be grounded in universal biological codes, suggests that this approach generalizes to other languages (for how coincidental would it be otherwise!). This does not mean how-

ever that the phonological features themselves, and their association with particular meanings, are also uniformly *realized* across languages (an anonymous reviewer mentions Chickasaw, where the function of final falls and rises seems to be reversed compared to English). Despite the universality of the biological codes, differences may occur already at the phonetic level, and grammaticalization may further introduce arbitrariness. Perhaps the grammaticalization steps that I have assumed and argued to be ‘natural’ are in fact not the only natural pathways. But the latter need not threaten the general approach pursued in this paper: as long as at most a handful of natural pathways can be identified, I am quite confident that this approach is better than nothing.

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