



Intonational meaning

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Traditionally, prosodic studies have focused on the study of intonational form and the study of intonational meaning has been relatively neglected. Similarly, the fields of semantics and pragmatics have paid little attention to the pragmatic uses of intonation. As a result, there is no firm agreement within the linguistic community on how to integrate the analysis of intonational meaning across languages into a unified prosodic, semantic, and pragmatic approach. This article provides an overview of the literature on intonational meaning, describing the recent advances made in the fields of prosody, semantics/pragmatics, and syntax. Several theoretical approaches to explaining the semantics and pragmatics of intonation are presented. A common feature to most frameworks is that intonation (1) should be regarded as an integral part of linguistic grammar; and (2) typically encodes meanings related to the modal aspect of propositions. However, features such as compositionality, duality of structure, and context-dependency are still hotly debated issues. These features will be discussed from different theoretical perspectives, and we will identify potential advances related to the full integration of intonational meaning into dynamic and multidimensional models of meaning.

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INTRODUCTION

One of the key aspects of human interaction is the fact that communication involves not only the expression of propositional content in the form of spoken words but also the expression of the intentions, beliefs, commitments, and feelings of the interlocutors with respect to those propositions. In Bally's terms,¹ utterances can be analyzed as the sum of the *dictum* (or propositional content of the utterance) and the *modus* (which corresponds to the attitude of the speaker towards this proposition). It is well known that in many languages pitch contours (together with other prosodic features) are key contributors to the *modus* aspects of sentences. For example, depending on how a speaker utters the sentence *I am cold*, it can convey a set of nonpropositional meanings such as 'can you please close the window?', 'I am surprisingly cold', 'I am contradicting you', 'I believe you should

know', or 'I am uncomfortably cold', among other things. Language researchers agree that intonation conveys various communicative functions that range from semantico-pragmatic functions such as speech act marking (assertion, question, etc.), information status (focus, given vs new information), belief status (epistemic position of the speaker with respect to the information exchange), politeness, affective, and emotional states, to indexical functions such as gender, age, and the sociolectal and dialectal status of the speaker.

In the last few decades, the *field of prosody* has focused on the study of the suprasegmental properties of natural languages (e.g., intonation, tone, duration, and rhythm), and specifically on how these properties of speech should be described both as phonetic entities and as phonologically relevant units in the linguistic system. In recent decades, the standard Autosegmental-Metrical model of intonation has helped foster the idea that intonation should be regarded as a phonological component of linguistic systems, thus leading to the coining of the term *intonational phonology*. This work has focused on the representational issue (i.e., how to encode linguistically relevant pitch movements in an efficient way

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1 while being faithful at the same time to the phonetic
2 realization of the tunes) and has hardly dealt with the
3 issue of the semantic and pragmatic interpretation of
4 intonation contours. This is one of the reasons behind
5 Bolinger's² metaphorical characterization of intonation
6 as 'a half-tamed savage', which has been taken up so
7 vividly by Gussenhoven in their books on intonational
8 phonology.^{3,4} However, the *fields of semantics and*
9 *pragmatics* have addressed, albeit somewhat hesi-
10 tantly, the issue of intonational meaning. Researchers
11 working within the Gricean and post-Gricean prag-
12 matic models have focused on trying to show where
13 intonational meaning fits into semantic and pragmatic
14 theory, as well as to disentangle its conventional-
15 ized (or context-invariant) versus context-dependent
16 aspects. Some authors have proposed that intonation
17 contributes to the calculation of *conversational impli-*
18 *catures*⁵⁻⁷ or the calculation of *conventional impli-*
19 *catures*.⁸⁻¹² Recent semantic models, such as dynamic
20 and multidimensional models of meaning, have also
21 worked partially on intonational meaning, reflecting
22 an increasing integration of semantics and prosody.

23 The separation between the fields of intonational
24 phonology and formal semantics/pragmatics has led
25 to a lack of unified depiction of intonational meaning
26 within the linguistic community. The lack of a uni-
27 fied approach to tune meaning is currently affecting
28 related research dealing with the cognitive processing
29 of intonation, the acquisition of tunes in a first or a
30 second language, and the assessment and treatment of
31 prosody in clinical populations. As a push towards
32 convergence, this article will highlight the common
33 issues under discussion across the two disciplines
34 and will offer some suggestions about future avenues
35 for research. First, two common features shared by
36 most frameworks in the fields of prosody and seman-
37 tics/pragmatics are the following: (1) intonation needs
38 to be considered an integral part of language; and (2)
39 intonation can encode meanings related to the modal
40 (and nonpropositional) aspect of propositions. Sec-
41 ond, an overview of the research performed in recent
42 decades from different perspectives shows that sev-
43 eral important questions are still under debate: do we
44 have a standard way to represent intonation contours
45 across languages? if tunes are complex entities, what
46 are their components? which dimensions of mean-
47 ing are conveyed by intonation? are these dimensions
48 of meaning context-invariant or context-dependent?
49 how do they interact with other modules such as dis-
50 course particles or morphosyntactic patterns? is there
51 a clear-cut distinction between linguistic and paralin-
52 guistic functions of tune meaning? This article presents
53 the different views currently being put forward on
54 these questions, which are related to three broader and

long-debated issues, namely, (1) *compositionality*, (2)
1 *duality of structure*, and (3) and *context-dependency*. 2

3 4 5 **PROSODIC APPROACHES** 6 **TO INTONATIONAL MEANING:** 7 **THE AUTOSEGMENTAL-METRICAL** 8 **FRAMEWORK** 9

10 Thanks to the advent of the Autosegmental-Metrical 10
11 framework of intonation (henceforth, AM 11
12 framework^{13,14,3,4,15,16}) and its establishment as 12
13 one of the standard and most influential models 13
14 of intonation analysis, there is currently an ample 14
15 consensus among prosody researchers that intonation 15
16 has a phonological status in natural languages. The 16
17 AM model describes intonational pitch contours 17
18 as sequences of two main types of phonologically 18
19 distinctive tonal units, namely *pitch accents* and *edge*
20 *tones*. Pitch accents are intonational movements that 20
21 associate with stressed syllables, rendering them into- 21
22 nationally prominent or accented. Edge tones (which 22
23 can be separated into phrase accents and boundary 23
24 tones) are also fundamental frequency movements 24
25 that associate with the ends of prosodic phrases. 25
26 These units are represented in terms of H(igh) and 26
27 L(ow) targets, and can be monotonal or bitonal. For 27
28 pitch accents, the starredness symbol '*' indicates 28
29 association with prominent positions (e.g., H*, L*, 29
30 L + H*, and H + L*), and for edge tones '%' indicates 30
31 association with the edges of phrase boundaries (L%, 31
32 H%, LH%, and among others). This phonological 32
33 representation of tones is mapped onto a phonetic 33
34 representation through language-particular imple- 34
35 mentation rules (see Ref 4 for a review). The AM 35
36 framework has provided the basis for developing a 36
37 diverse set of ToBI (Tones and Break Indices) anno- 37
38 tation conventions for a large set of typologically 38
39 diverse languages,^{15,16} which have closely followed 39
40 the tenets of the AM model. 40

41 Most of the studies within the AM framework 41
42 have focused on the study of intonational form rather 42
43 than meaning, and attempts to assess intonational 43
44 meaning in a systematic fashion have been relatively 44
45 scarce. Traditional work within the British school of 45
46 intonation^{17,18} and also within the AM model have 46
47 tried to characterize the general meanings conveyed by 47
48 particular tunes and have attributed them to different 48
49 semantic areas, such as speech acts,¹⁹ propositional or 49
50 speaker attitudes,²⁰ as well as information structure.¹⁹ 50
51 In his 1984 book, Gussenhoven attempted to charac- 51
52 terize the meanings of nuclear tones in English in terms 52
53 of the information status relative to the shared back- 53
54 ground, negotiated by interlocutors during the course 54



of the conversation. Pierrehumbert and Hirschberg claimed that neither speech acts nor propositional attitudes provided sufficient characterization of available tunes in English. Instead, they proposed a characterization of pitch accents and boundary tones in terms of mutual beliefs, in the sense that tunes specify a particular relationship between the propositional content of the utterance and the mutual beliefs of participants in the discourse.^{21,20}

Within the AM model, the following three properties of intonational structure have been generally accepted, namely (1) duality of structure, (2) compositionality, and (3) stable form-meaning relations.

Duality of Structure: Linguistic and Paralinguistic Meanings of Intonation

Starting with Pierrehumbert's thesis, the AM framework has traditionally advocated for a clear separation between the phonological and phonetic levels of intonational analysis, which have been assumed to encode the linguistic and paralinguistic meanings of intonation respectively. This feature has been called *duality of structure*.^{3,4} As Gussenhoven contends in his 1984 book (Ref 22, p. 57), 'intonation is like animal communication, having gradient signals which do not show internal structure, and on the other hand it is like the rest of language in having arbitrary form-meaning relations, discreteness, and duality of structure'. Refining Bolinger's metaphor, Ladd and Gussenhoven drew a sharp divide between what they called 'the tamed half and the untamed half' in intonation: while the tamed half corresponds to the group of tonal morphemes that are distinctive and convey discrete differences in *linguistic meaning* (e.g., question and focus), the untamed half corresponds to gradient phonetic variation and conveys differences in *paralinguistic meaning* (e.g., attitudes and emotion).

The distinction between linguistic and paralinguistic meaning opened up the study of universal intonational meanings.^{3,23} Despite the general acceptance of the duality of structure within the AM model, experimental research has experienced difficulties in establishing a clear distinction between discrete intonational events (and their corresponding linguistic functions) and gradient intonational events (and their corresponding paralinguistic functions). The article by Chen, Gussenhoven, and Rietveld²⁴ examined the perception of paralinguistic intonational meanings in British English and Dutch using stimuli which were lexically equivalent but differed in the dimensions of pitch register, peak height, peak alignment, and end pitch. They found that British English and Dutch listeners differed considerably in their perception of

'confident', 'friendly', 'emphatic', and 'surprised', evidence that contradicts the view that the paralinguistic usage of intonation is similar across languages. These results show that the alleged one-to-one association between discrete and linguistic on the one hand and gradual and paralinguistic/universal on the other is far from clear. As Grice and Baumann pointed out, 'it is not possible to state either that categorical means are used to express only linguistic functions, or that gradient means are used only for paralinguistic functions, although this is a widespread assumption' (Ref 25, p. 15). The difficult separation between linguistic (or grammatical) functions and paralinguistic (or natural) functions has also been highlighted by several pragmaticians.^{26,27}

Compositionality

Traditionally, intonation models have been divided into models that advocate for a decomposition of the contour into independent meaningful units² and more holistic models which attach intonational meanings to the contour as a whole.^{19,28} Pierrehumbert and Hirschberg's seminal article was the first to propose a strong *compositional approach to tune interpretation* within the AM framework. They proposed that the main components of intonation in English (pitch accents, phrase accents, and boundary tones) have separate and distinct contributions to discourse interpretation which are related to mutual belief spaces in conversation, capturing the intuition that tunes sharing certain tonal features also share some aspects of meaning.

The property of unlimited compositionality has been challenged by the corpus study presented in Dainora.²⁹ Her results showed (1) that certain combinations of pitch accents and boundary tones are more frequent than others; and (2) the last pitch accent in the final intermediate phrase is found to be a strong predictor of the upcoming boundary tone. She suggested that a tune approach (or a nuclear configuration approach) could better account for the results than a strictly compositional approach. Despite the criticisms, the compositional approach can still be considered the standard position of researchers working within the AM model. Recent proposals on the meaning of English pitch contours^{7,30–32} and French pitch contours³³ have built on Pierrehumbert and Hirschberg's compositional approach. Despite the fact that compositional theories typically argue for a systematic relationship between tonal features and their semantic primitives, they also assume that these meanings are to some extent context-dependent. Many of these proposals regard intonational meaning as encoding basic meanings from which context-dependent



conversational implicatures can be derived^{7,30–33}; see *Gricean Pragmatics* section).

Context Dependency

A general assumption of the AM model is that intonation units tend to provide a set of general one-to-one form-meaning relations which are language-dependent. Thus, both Gussenhoven's book and Pierrehumbert and Hirschberg's article maintained that a given intonational morpheme conveys an inherent meaning that applies across utterances regardless of lexical content and context. As Pierrehumbert and Hirschberg contend, 'although the interpretation of any token of a tune type may vary along many other dimensions—voice quality, pitch range as well as nonintonational features—any instance of a given tune will convey the same relationship.' (p. 285). Despite a general view that prosodic cues convey systematic and *inherent meanings*, for decades intonation studies have failed to find systematic links between elements of prosody and speech acts. As Hirschberg argues,⁵ 'while students of intonational meaning generally look for the regularities in intonational interpretation, such as 'Increased prominence is interpreted as focus' [...], there are too many counter-examples in normal speech production to conclude that particular intonational behavior maps simply to clear interpretations.' Probably the best-studied case of nonisomorphism between intonation and meaning is that of *declarative questions* in English (also called rising declaratives because they end in a rising intonation; in AM notation, an H% boundary tone). Rising declaratives (1) convey a clear semantic bias and (2) are subject to contextual restrictions that do not apply to their interrogative counterparts. The examples in (1b)³⁴ show how declarative questions, as opposed to neutral questions (1a), are not appropriate in situations where the questioner is supposed to be impartial, as in a courtroom or committee hearing. Similarly, assertions like (1c) are not felicitous in this context, as they show an inappropriate commitment of the speaker to the truth of the proposition.

(1) [at a committee hearing]

a. Are you a member of the Communist party?

H%

b. #You're a member of the Communist party?

H%

c. #You're a member of the Communist party

L%

Empirical research has revealed the importance of contextual factors in prosodic interpretation,

highlighting how important it is to factor in contextual knowledge when attempting to describe the mapping between prosody and meaning. In her review article about the relationship between intonation and pragmatics, Hirschberg argued that 'since the interpretation of intonational variation is indeed dependent upon contextual factors, we will define intonational meaning as essentially pragmatic in nature'.³⁵ Indeed, context dependency in language and communication has been widely studied in the fields of pragmatics as well as semantics. The following section reviews the work carried out within pragmatic and semantic models in trying to account for the relationship between intonational variation, contextual factors, and meaning.

SEMANTIC AND PRAGMATIC APPROACHES

Researchers working in semantics and pragmatics have repeatedly pointed out that attempting to delimit the boundaries between these two fields can be a hard task, and in fact the two fields are becoming progressively integrated.^{36,37} Although different aspects of meaning tend to remain in either one camp or the other, intonational meaning has been discussed in both fields. In particular, the study of tune meaning has witnessed new developments that favor integrated models of semantics and pragmatics.

Gricean Pragmatics

Grice's seminal work argued for a pragmatic theory of communication that focused on the implicit and inferential aspects of human linguistic interaction. Grice distinguished between two types of inferences, namely *conventional implicatures* and *conversational implicatures*. Conventional implicatures refer to inferences that the listener makes about the speaker's intended meaning exclusively through the analysis of the proposition expressed, i.e., without accessing the conversational context (e.g., a sentence such as *Jill is English and therefore brave*). By contrast, conversational implicatures require a listener to compare the expressed propositional meaning against the context of the utterance, thus potentially *pragmatically enriching it* in order to arrive at a speaker's intended meaning. In the following exchange, Mark does not actually say that he is not going to the party, but he implies it by saying *I have to work*. The implicature of the response cannot be inferred simply from the conventional meaning of the proposition, but rather depends on the features of the conversational context.



(2) Mary: *Are you going to John's party?*

Mark's response: *I have to work*

Conversational implicatures are calculated on the basis of the observation of the Gricean cooperative principle of communication. In the exchange in (2), the sentence *I have to work* does not literally answer the speaker's question; yet if the questioner assumes his or her interlocutor is cooperative and thus providing information relevant to the conversation, he or she will be able to infer that Mark will not attend the party. Two important diagnostics have been proposed to distinguish conventional implicatures from conversational implicatures, *noncancelability* and *reinforceability*. A conventional implicature is expected to be cancelable, that is while the conventional implicature derived from the sentence *Jill is English and therefore brave* cannot be cancelled, the conversational implicature derived from the sentence *I have to work* can be canceled more easily. The speaker may do this by adding a sentence like *Nonetheless, I will go to the party*, which cancels the implicature offered by the sentence *I have to work*. With respect to reinforceability, in the exchange in (2) Mark can also respond 'I have to work, and thus I cannot come.' The second proposition makes explicit what is implicit in the first proposition without sounding redundant.

Within Gricean pragmatics, and also within other semantic frameworks, intonational meanings have been claimed to contribute *conversational implicatures*⁵⁻⁷ as well as *conventional implicatures*.⁸⁻¹² In their 1985 article, Ward and Hirschberg provided a thorough description of the semantics and pragmatic restrictions regulating the use of the *rise-fall-rise contour* in American English (in AM notation, L + H* L - H%).⁸ They argued that this tune makes an independent contribution to utterance interpretation in terms of a common meaning (uncertainty), which is best characterized as a conventional implicature (see also the study by Krifka to appear for a similar claim for the incredulity contour in English). First, such an implicature is detachable, because it is always possible to substitute the rise-fall-rise intonation with a falling intonation, and the only difference will be the failure of falling intonation to communicate uncertainty. While the responses in (3a) and (3b) are both felicitous to the context, only (3a) conveys uncertainty as to whether the interlocutor will accept B's proposition (examples are taken from Ref 8, p. 752).

(3) A. What interesting people came to the party?

B's response:

a: Veronica L + H* L - H%

b: Veronica L* L - L%

Second, the uncertainty implicature cannot be cancelled without creating an odd scenario. The answer in (4a) conveys doubt about the fact that ninety-eight and a hundred can be close enough for the interlocutor's acceptance of the utterance; by contrast, the answer in (4b) is odd because the distance between a hundred and sixty is too great to allow for such uncertainty (examples are taken from Ref 8, p. 767).

(4) A. Did she get a hundred in the midterm?

B's response:

a. She got a ninety-eight L + H* L - H%

b. #She got a sixty L + H* L - H%

Other authors have highlighted the role of intonation in the listener's extraction of *conversational implicatures* by showing how speakers arrive at meaning by means of conversational inferences, which are arrived at as side-effects of the listener's fundamental need to maintain pragmatic consistency at all costs. In her 2002 article,⁵ Hirschberg proposed an interesting extension of Gricean maxims through the incorporation of the biological codes in intonation,²³ that is, the general knowledge of universal intonational meaning (see *Prosodic Approaches to Intonational Meaning: The Autosegmental-Metrical Framework* section). She proposed to translate the *frequency code* (e.g., the fact that rising contours across languages tend to convey speaker uncertainty and are used in questions) into a Gricean *maxim of pitch* such as 'Try to match the rise or fall in the pitch of your utterances to the degree of confidence you wish to convey [...]' (p. 3). Speakers can obey this maxim when they are truly uncertain or rather can use this shared knowledge of the maxim to violate it and create a different effect, e.g., by using a rising contour to convey *irony* or produce a rhetorical question. The question in (5) *Are we disturbing you, Mr. Smith?* uttered with a final rise H%, can have either a genuine uncertainty meaning or an ironic effect depending on the conversational context (contexts A or B, respectively):

(5) Context A. [students waiting to see Prof. Smith]

Context B. [professor to a student asleep in class]

Are we disturbing you, Mr. Smith? H%

The debate over whether to characterize intonational meaning as conventional or conversational implicatures reflects the problem of the division of labor between convention and context in intonation. However, while some aspects of specific tune meanings appear to be stable and can be considered

propositional in nature, others are more dependent on context. Armstrong and Prieto (2014) showed experimental evidence coming from the listener's assessment of context-utterance pairs that intonation contours (1) are dynamically modulated by context and (2) can differ in terms of the amount and types of meaning they convey. Their evidence points to the dynamic interaction between context and contour and also to the fact that individual intonation contours can differ in the type and number of meanings they convey. In contrast with neutral questions, incredulity questions encode conventional information about the epistemic position of the speaker (see the study by •Krifka³⁸ for a similar analysis of incredulity intonation in English as a conventional implicature). On a similar note, Beaver and Clark³⁸ have shown that the focus-sensitive operators *only* and *always* differ with respect to the property of focus-sensitivity. While *only* lexically encodes a dependency on the placement of focus, *always* does not, showing that the focus-sensitivity properties of *always* are obtained from its stronger dependency on context. Finally, Armstrong and Prieto's³⁹ experiment also revealed that contextual evidence can show different strength values and affect contour meaning to different degrees (see the study by •Büring and Gunlogson³⁹ on the distinction between simple contextual evidence and compelling contextual evidence). Some of these questions still remain open and more research will be needed to firmly characterize intonational meaning and its dependence on context.

Post-Gricean Pragmatics

One of the post-Gricean pragmatic frameworks that has analyzed intonation most extensively is *Relevance Theory*. This theory proposes that utterances encode two basic types of information, namely *conceptual information* and *procedural information*—i.e., information about the representations to be manipulated and information about how to manipulate them for pragmatic inferencing (for a review, see Refs 40–42). For example, expressions like *moreover* or *therefore* do not contribute to the conceptual part of the utterance but instead constitute instructions to the listener on how to manipulate conceptual information. Within this framework, Gricean conventional implicatures are subsumed under the characterization of these procedural elements, and a more dynamic and interactive approach to language emerges. The notion of *procedural encoding* has been applied straightforwardly to the pragmatic function of intonation. Researchers have claimed that intonation contours constitute a form of procedural encoding which signals information specifically geared to guiding the hearer during the

inferential phase of comprehension.^{26,27,43,–50} As Wilson and Wharton argued, 'both natural and properly linguistic prosodic signals might encode procedural information of a type shared by borderline linguistic expressions such as interjections and properly linguistic expressions such as mood indicators, discourse connectives and discourse particles' (Ref 27, p. 30). A well-known example of this is how speakers can optionally use prosodic contrasts (together with situational context and other linguistic markers) to encode *ironic speech* (the so-called 'ironic tone of voice'⁵¹) or to encode *interrogativity*. In the following example, the rising question intonation H% in (6) sounds infelicitous because the previous context states that the speaker is convinced that the listener does not know the answer. By contrast, the assertion intonation (L%) would be fine in this context. Escandell-Vidal contends that the procedural instruction encoded by the intonation contour in (6) (e.g., interrogative function) must be compatible with the discourse context (Ref 48, p. 179).

- (6) # Ya sé que no lo sabes, pero ha llegado Juan? H%
'I know you don't know, but has John arrived?'

Within Relevance Theory, procedural expressions can encode constraints that can act at different levels of the inferential process. An important distinction made by this theory relates to the two kinds of communicated assumptions that the speaker makes, namely *explicatures* and *implicatures*. *Explicatures* are defined as assumptions that are communicated via pragmatic developments of explicitly encoded linguistic meaning (hence 'explicature'), while *implicatures* are inferred entirely from context.^{40,41} Take the simple exchange provided in (7).

- (7) John: How is Michael feeling after his football match?

Mark: They lost and can't continue.

Here, we discern two types of communicated assumptions, namely an *explicature* (Michael's football team did not score enough goals, and, as a result, the team has been eliminated from the football league) and an *implicature* (Michael is not feeling very happy). While both are obtained through pragmatic inference, the difference lies in their dependence on propositional content. That is, while the conceptual content of the implicature that Michael is not feeling happy is supplied entirely by pragmatic inference, the conceptual content of the obtained explicature is based on a mixture of decoded linguistic meaning and pragmatically inferred meaning.

Relevance theorists also refer to higher-level or higher-order explicatures as particular kinds of explicature which refer to the attitude (or speech-act description) of the speaker with respect to the proposition expressed. Many researchers have claimed that intonation patterns constrain the calculation of higher-level explicatures.^{42,48,49} Escandell-Vidal,⁴⁸ e.g., argued that some rising intonation patterns, as well as word-order patterns, negation, and discourse particles in questions, can work together to constrain the calculation of higher-level explicatures in interrogative utterances.

Relevance Theory thus claims that procedural elements like prosodic marking serve to facilitate the identification of the speaker's meaning by narrowing the search space for inferential comprehension, thereby reducing the overall effort required. Recent psycholinguistic studies using eye-tracking or mouse-tracking paradigms in *online processing experiments* have demonstrated that intonation (1) affects how likely implicatures are generated by listeners and (2) serves to speed up inferential processing.^{6–52,–54} A clear insight from Relevance Theory has been to illustrate the importance that prosody plays in the inferencing processes that are continuously active in human interactions. Still, a fiercely debated issue is whether intonational meaning, as an encoder of procedural meaning, is highly conventionalized or more dependent on contextual meaning. In this connection, there has been an increasing need to characterize the *felicity conditions* that constrain the appearance of intonation patterns in discourse. The final theoretical innovations to be discussed in this overview, dynamic and multidimensional models of meaning, have partially addressed the interactional aspects of intonational meaning in discourse.

Multidimensional and Semantic Models of Meaning

Semantic theories have also attempted to account for the role that intonational meaning plays in natural languages. Two especially fruitful approaches have been the semantic multidimensional models and the dynamic/interactional models of sentence interpretation.

Multidimensional Models of Meaning

Multidimensional models focus on the fact that natural language meanings are multifaceted. These models propose to introduce additional aspects of conventionalized meaning into the semantic representation that are typically not encoded by truth-conditional (or at-issue, or entailed) semantics. One of the concepts

that has been thoroughly discussed in this context is the *semantics of focus*.⁵⁵ Rooth proposed to add a so-called focus semantic value alongside the ordinary semantic value of an utterance. Consider the example in (8), reproduced from Ref 10.

(8) You have just gotten the results of an exam that you and five more friends took. Your mother comes and asks:

Mother: Did you pass the exam?

Response: Well, MARK passed.

Rooth proposed that the response in (8) first denotes a proposition, which will be true if Mark passed the exam. Yet the marking of this constituent as *focus* (through the presence of a focal pitch accent) triggers what Rooth calls 'the focus semantic value', which is the search for alternatives and the presupposition that these alternatives are relevant in context in certain ways (that is, John/Mary/etc. did not pass). The reply in (11b) thus carries a (cancellable) conversational implicature that you and your four friends (except Mark) did not pass the exam (assuming you know all the results). This view of focus has been incorporated into what is called the *alternative semantic account of focus*, which in fact represents a multidimensional theory of focus meaning.⁵⁶ It is important to mention that the semantic models sketched above have incorporated conversational pragmatic mechanisms in their theories. As Büring states,⁵⁶ 'it is not the meaning of focus to mark information, express contrast, or 'invoke alternatives'; focus simply reflects certain properties of the discourse context. The relation between such contexts and speakers' intentions is assumed to be a matter of conversational pragmatics.'

In a separate account of multidimensionality, work on conventional implicatures proposed a multidimensional representation of meaning in which expressions project at-issue (or entailed) content and conventionally encoded content in parallel.^{10–12} Potts¹⁰ analyzed the contribution of intonation as a marker of a secondary aspect of meaning through the analysis of a set of case studies that include appositive constructions, quotation constructions, and the accented particle *SO* in English. He claimed that intonation often conveys conventional implicatures. For example, the construction in (9) first denotes that Charlie is at the door. However, the appositive 'an infamous axe murderer' (produced with what has been referred to as *comma intonation*) contributes a second meaning by ascribing the property of being an infamous axe murderer to Charlie. Potts¹² points out that these two dimensions of meaning interact to produce rich, coherent pragmatic interpretations,

highlighting that in many cases secondary dimensions of meaning play an important role in shaping the overall message of an utterance.

(9) Charlie, an infamous axe murderer, is at the door!

The examples in this section have emphasized the role of multidimensionality and multifunctionality of meanings encoded by intonational (and nonintonational) units. Related developments focus on the fact that intonational meaning is highly interactional and needs to be dynamically interpreted in conversation.

Dynamic Models of Meaning

Proposals for *dynamic models of meaning* stem from Stalnaker's proposal from the 1970s that sentences should be regarded not as isolated propositions but rather as interactional and *dynamic updates* and contributors to discourse context. This perspective has as an ultimate goal the *modeling conversational moves* from a discourse perspective and has generated a variety of models, such as *Discourse Representation Theory*, a theory of the interlocutor's ongoing discourse record, which is changed and updated with each new utterance.^{36,37}

Traditionally, tunes have been shown to play an important role in the updating of contexts in relation to the *epistemic commitments of various discourse participants*.^{7,9,21,30,34,57} One of the main motivations for the appearance of *dynamic models of meaning* was the modeling of *question–answer pairs* in discourse. Gunlogson³⁴ analyzed the intonation of *declarative questions* within a dynamic model of discourse and dialogue. She proposed a compositional account of rising and falling declaratives/questions under which (1) the declarative form expresses commitment to the propositional content and (2) rising versus falling intonation on declaratives is responsible for the commitment attribution of both speaker and addressee. Thus, declarative questions (or rising declaratives, (10b)) share an important property with neutral interrogatives (10a), which is that they fail to commit the speaker to the content of his/her proposition. By contrast, falling declarative forms (10c) express a clear commitment on the part of the speaker to the propositional content, something which is at odds with the discourse context in (10).

(10) A: The king of France is bald.

B's response:

- a. Is France a monarchy?
- b. France is a monarchy?
- c. #France is a monarchy

Recently, researchers have emphasized the dialogical status of intonation and the need to take into account interactive and argumentative dimensions of meaning. Portes et al.⁵⁸ showed experimentally that intonational contours in French encode information about speaker commitment and attitude attribution to the addressee. In a forced-choice interpretation task, participants had to choose among four possible reactions (*I get it; I've no idea; I guess you're right; No, really; it's true*) after hearing sentences spoken with one of four contour types, namely a fall L* L%, a rise H* H%, a rise–fall H* L%, and a rise–fall–rise H + !H* H%. The results showed that while L* L% was consistently associated with 'I get it' and H* H% with 'I've no idea', H* L% was associated with 'I guess you're right' and H + !H* H% with 'No, really, it's true'. Importantly, these contours encode both information about the commitment of the speaker to the truth of the proposition and information about listener commitment (e.g., in the case of H + !H* H%, this tune signals anticipated disagreement between speaker and listener), thereby demonstrating that intonation encodes meaning in a dialogical way. Portes and Reyle⁵⁹ presented a unified account of the semantic properties of the rise–fall tune H* L% (the so-called 'intonation d'implication') in French within the dynamic Discourse Representation Theory, suggesting that this contour triggers an underspecified presupposition of contrast (or contradiction). They claimed that the various attitudinal meanings related to this pitch contour (obviousness to exasperation, contrastive focus, politeness) can be obtained in conversation as either conventional or conversational implicatures.

Theories of *speech act dynamics* have analyzed biased questions in detail by assessing the conditions that restrict their appearance in discourse.^{9,57,60} According to these models, speech acts create commitments by the interlocutors and may also introduce *changes in commitments* that can be analyzed as transitions between commitment spaces in a *conversational game*.⁹ Negated polarity questions such the one in (11),⁶⁰ unlike neutral questions, require non-neutral contexts, e.g., they are produced when speakers have compelling evidence against some negative proposition.^{60,61} This is why it sounds infelicitous to utter the negative question in (11) when the context states that the speaker has no beliefs on the matter. The required context would be a presupposed sentence like *The President read the August 6 PDB*.

(11) I just want to know ...

Didn't the President read the August 6 PDB?

1 Within Krifka's proposal⁹ of the interpretation
2 of speech acts as 'spaces of commitments', intona-
3 tion patterns associated with such speech acts can be
4 interpreted as encoders of the REJECT, ASSERT, and
5 REQUEST epistemic operators. In the case of biased
6 questions (incredulity questions, negative and positive
7 questions), in addition to the regular question illocu-
8 tionary operator QU, those epistemic operators can be
9 used. In the case of assertions, these operators can also
10 be added to express contradiction, and crucially, some
11 of them can be encoded through intonation. Krifka's
12 proposal looks especially promising, as it exemplifies
13 'de facto' the progressive integration between prag-
14 matic and semantic models in the treatment of speech
15 acts and intonational meaning. However, it incorpo-
16 rates Gricean inferential pragmatics in the sentence
17 interpretation (e.g., the bias of declarative questions
18 comes about as a conversational implicature, and the
19 bias of incredulity questions is encoded as a semantic
20 operator and comes about as a conventional implica-
21 ture). It also incorporates Rizzi's syntactic model⁶² of a
22 complex system of functional heads at the left periph-
23 ery. Among them, Force Phrase, or ForceP, can con-
24 tain illocutionary operators (or force operators) which
25 transform the syntactic structure into a speech act.
26 These operators typically contain semantic operators
27 like REQUEST or REJECT, encoded through prosodic
28 information.^{49,63}
29

30 CONCLUSION

31 This review article has summarized the different theo-
32 retical perspectives on intonational meaning coming
33 from the fields of *prosody*, *pragmatics*, and *seman-*
34 *tics*. In recent years, we have witnessed a progres-
35 sive melding of prosodic and semantic models which
36 has given rise to more integrative proposals of intona-
37 tional meaning. Researchers are in full agreement
38 that prosody constitutes an integral part of linguis-
39 tic form, shaping its temporal and pitch character-
40 istics to achieve communicative ends. However the
41 way intonation contributes to natural language mean-
42 ing and now it should be modeled has yet to be
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1 agreed upon. We have seen that some of the tradi-
2 tional assumptions on intonational meaning (such as
3 the phonetic vs phonology or the linguistic vs. paralin-
4 guistic/nonlinguistic distinctions) do not stand well
5 with empirical findings. For example, research has not
6 found convincing evidence for the one-to-one asso-
7 ciation between discrete and linguistic meanings on
8 the one hand and gradual and paralinguistic/universal
9 meanings on the other, and for the universality of
10 paralinguistic meanings. These issues will need to be
11 tested through the development of empirically falsifi-
12 able hypotheses about intonational meaning. In my
13 view, it will be only through the increasing integra-
14 tion of formal and computational models of seman-
15 tics and prosody that we will be able to advance in
16 the characterization of the prosody-meaning interface.
17 Within semantic theory, the most important advances
18 in this respect have included the emergence of dynamic
19 and multidimensional theories of meaning, as well
20 as the development of techniques for incorporating
21 context-dependent aspects of content into the repre-
22 sentation. These theories are all in keeping with the
23 growing tendency to integrate the prosodic, pragmatic
24 and semantic aspects of intonational meaning.
25

26 A very promising trend in current research is
27 the effort to address the characterization of intona-
28 tional meaning through the use of a wide variety of
29 *experimental data* and from a crossdisciplinary per-
30 spective. In the last decade, empirical investigations
31 have ranged from the use of computational semantic
32 and prosodic labelling on large corpora to the use of a
33 variety of behavioral and electrophysiological exper-
34 iments on the cognitive processing of intonation. All
35 these (and further) crossdisciplinary efforts will help
36 to tease apart the dimensions of meaning that intonation
37 contributes to in natural languages. And despite these
38 developments in the empirical investigation of intona-
39 tional meaning, a number of debates remain open,
40 and, as Hirschberg contended a decade ago, 'still we
41 have much to learn about the pragmatics of intona-
42 tion' (Ref 35, p. 24).
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