INFORMATION PACKAGING CORRELATES OF SEMANTIC INFORMATION STRUCTURE CATEGORIES

Doina Jitcă*

Abstract: This paper presents an Information Structure (IS) model at the information packaging (IPk) level and its usage in utterance partitioning and in explaining semantic IS category realizations at the pragmatic level. The IPk model proposes a hierarchical view of F0 contours that transforms utterances into binary contrast unit (CU) hierarchies. CUs have binary IPk partitions with two independent and overlapping structures and a nuclear element which project its IPk functions to the whole units it belongs to. Two nuclear accent identification rules are formulated in this paper in order to be used in decoding IPk partition hierarchy by F0 contour analysis. In the second part of the paper several intonational contours of English sentences, having different semantic IS events, are interpreted by correlating semantic IS analysis results with those of the IPk model-based analysis. By decoding IPk structure and functional constituents from F0 contours we can advance our knowledge about the relationship between prosody and intonational meaning.

Keywords: intonational meaning, utterance partitioning, nucleus, prominence, focus, topic

1. Introduction

This paper presents an Information Structure (IS) model at the information packaging (IPk) level and uses it in utterance partitioning and in explaining semantic IS category realizations at the pragmatic level. This paper does not propose a new semantic IS model. It proposes a unique basis for cross-linguistic interpretations of intonational contours that captures the low level aspects of speech information structure related to the cortical word packaging process. This is a pre-linguistic or cognitive IS level where concepts (words) are transformed into speech information.

The history of semantic IS models presented in (von Heusinger 2002) gives us arguments to reconsider IS at the cognitive level because the first IS models of von der Gabelentz (1869) and Paul ([1880] 1920) treat utterance constituents in terms of "(psychological) concepts or groups of concepts produced in the mind of the speaker". They are named psychological subject (PS) and psychological predicate (PP). Von Heusinger (2002) observes that the latter IS models, after the two ones mentioned above, have the tendency to transform PS and PP into "theme" and "rheme", concepts deduced at the sentence organization level, and he concludes that IS modelling changes the psycholinguistic view into the communication perspective. The Prague School (Daneš 1970) and the modern Prague School (Sgall et al. 1973) are in line with this tendency. They have introduced two levels of IS at the sentence level: (i) comment or rheme vs. topic or theme; (ii) topic and focus concepts assigned to two semantic categories: givenness and newness.

Halliday (1967) makes a crucial change and proposes an IS model which keeps only one structure (theme-rheme) at the sentence level and relates the second structural level to tonal groups (phonological units) where old and new information elements must

* Institute of Computer Science of the Romanian Academy, Iaşi Branch, doina.jitca@iit.academiaromana-is.ro.

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be identified in terms of background and focus concepts. Steedman (2000, 2008, 2014) who uses IS along the lines of Halliday tried to associate different tonal group patterns to different partition types. Pattern variation cannot be described by only two partition types: background-focus or focus-background and he introduces additional semantic devices in order to assign different semantic IS descriptions to different intonational variants of tonal groups. We conclude that intonational variations related to utterances of the same text are not linked only to semantic IS context changes and other meaning can be deduced from F0 contours in order to explain the respective prosodic variations.

Recent research also tries to associate focus realization patterns to phonetic and phonological features. Tonhauser (2019) investigates certain factors that can influence information-structural focus realizations, but she cannot explain all their prosodic variations concluding that: "the phonetic and phonological properties of utterances are not only implicated in conveying focus".

Vander Klok et al. (2017) tests two potential phonological causes of cross-linguistic variation in focus marking and formulate two hypotheses: (i) "focus is not prosodically marked"; (ii) "a phonological property other than prominence marks the scope of focus". In English pitch accent is an important focus cue but in languages as French where prominence cue are searched on the initial word in focused phrase, no other phonological property is observed on the focus words within the respective phrase. In the information packaging view on phrases presented in this paper we can define the "low prominence" of one word with the lowest target tone in phrase (nuclear word) and this can explain the role of the nucleus in marking the focus function of the respective word.

Lee et al. (2015) observes that in Seoul Korean target word in applying focus function has lower target tone than that of the next word of the respective utterance. This observation makes them to conclude that "prosodic modulation by focus was weak, ambiguous and unclear", by comparison with American English and Mandarin Chinese. The information packaging model which will be presented in this paper evaluates only pairs of prosodic events into binary partitions (phrases) where the lower target tone element may bear the "low prominence" and nuclear function which can also marked it for focus function.

Cole et al. (2017) accept the general idea that "phrasal prominence is assigned to the word that is the structural nucleus of the prosodic phrase" and they observe differences among languages in the specification of prominence within prosodic phrase. Thus,

> whereas in English a tonally specified pitch accent can be used to mark prominence related to the discourse meaning of words (focus) […] in Spanish an F0 excursion on a word in a phrasal context may signal nothing more than the location of a word-level stress [...]. In French, [...] at the phrase level, prominent syllable are usually in the final position in the phrase, so that an F0 excursion signals information about both prominence and phrasal structure.

Cole et al. (2017) aim to understand if there are common factors underlying perceived prominence in languages that differ in the phonological patterning of prominence. Discussing effects of word-level acoustic prominence, they conclude that "there were no significant differences between the languages in the effects of acoustic factors" and that

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"words are more likely to be rated as prominent if they have lower phone rate (i.e. are slower, with longer duration), higher intensity and higher peak F0". The effects of other several linguistic aspects on prominence rating are investigated in order to determine if there are differences in native listeners' perception of prominence across the three languages.

We conclude that recent researches which investigate the relationship between prosody and intonational meaning are focused on the acoustic and linguistic factors that can determine and influence the perception of prosodic prominence. They relate semantic IS events to phonetic and phonological events deduced from F0 contours and they observe that not all prosodic variations can be explained by semantic IS changes. This paper proposes a key for understanding intonational contours by introducing a pre-linguistic level for discussing utterance structure. At this level F0 contours variations can be thought in structural terms and not in terms of phonetic and phonological cues with prominence within phrase/utterance. Nucleus prominence has pre-linguistic reasons and it does not always produce effect at the perception level. Words become nuclear elements at the cortical level within the word packaging process where their evocation patterns are in competition with the evocation patterns of other words/phrases. The paper proposes a key to be used in deducing nuclear positions and utterance structure conveyed by F0 contours.

Structures that pack words within utterances have a pre-linguistic or cognitive nature and that explains why we separate utterance partitioning from semantic IS analysis of utterances. Then, we propose a set of IPk categories to be used in annotating functional constituents of partitions. In this view the functional constituents of IPk partitions have roles firstly at the information packaging level but they may bear also linguistic meaning according to syntactic, semantic and discourse contexts (Figure 1). IPk structures are related to an intrinsic aspect of cortical speech generation. The paper formulates the hypothesis that prosodic words of one utterance are IPk marks which reflect its word packaging at the cortical level and proposes an IPk model to be used in utterance partitioning (the word unpackaging process). The model was used in Jitcă (2019) for explaining nuclear positions of Romanian *yes-no* question and *wh*-question contours which are also discussed in Dascălu-Jinga (1998), Ladd (2008: 228), Jitcă et al. (2015).

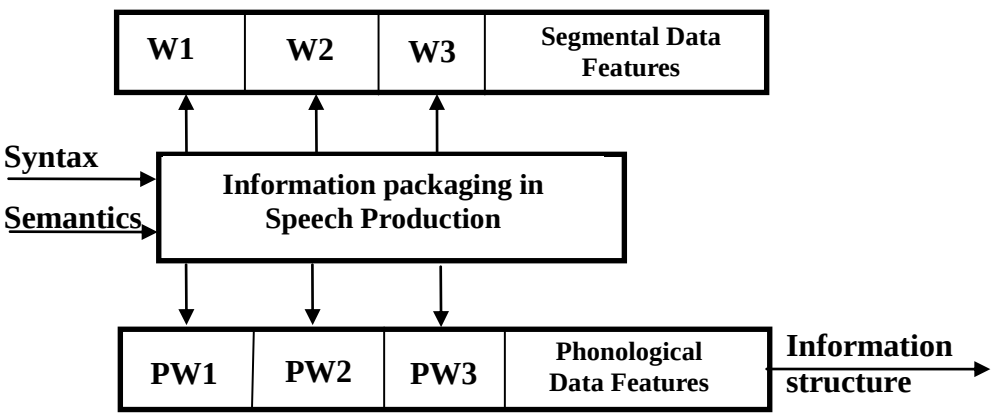

Figure 1. An information packaging view on IS of utterances (W = word; PW = prosodic word)

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Utterance partitioning in the IPk perspective lead us in relating semantic IS events of utterances not directly to their F0 contour events but to the IPk constituents deduced at the intonational contour level where the respective events are realized. In the rest of the section we give few examples that justify the importance of correlations between semantic IS events and their realization at the IPk level.

The first case is that of the focus function on a given information element when it is under focus-sensitive particle *only*. It is the case of the noun *rice* in (1) that is also discussed in Rooth (1992) and in Büring (2015). The problem raised by the sentence in (1) refers to the de-accentuation of the second occurrence of the word *rice* having no pitch accent and the lowest target tone of intonational contour:

(1) People who grow rice only EAT rice.

Krifka & Musan (2012) claim that "given constituents can be in focus, and in that case they bear an accent in languages like English or German... it is possible to focus on pronouns". They exemplify with the pronoun *him* in sentence (2). We must differentiate between the implicit intonation that produces focus function on the verb *saw* and de-accentuates the pronoun *him*, and the intonation that applies focus function on the pronoun *him*, produced when a special focus indication on the pronoun is required.

(2) Mary only saw HIM.

Another example of special case of focus function presented in Krifka & Musan (2012) is that related to contrastive topic elements. It is exemplified by the sentence in (3) where, the pronoun *I* is annotated for topic and focus functions and a second focus label annotates the sentence-final word *home*. The paper explains how the two foci are implemented in this short contrastive-topic sentence.

(3) [I$_{\text{"Focus"}}$]$_{\text{"Topic"}}$ [was (at HOME)$_{\text{"Focus"}}$]$_{\text{"Comment"}}$.

The above considerations justify our choice in separating the semantic IS analysis from utterance partitioning which has to be viewed as an information unpackaging process modelled by an IPk model. IPk structure of utterances can be used to explain different aspects related to focus events as their focus projection function and their focus domain size.

Krifka & Musan (2012) is a good presentation of different types of semantic IS categories which are also defined by other semantic IS models. We selected some of the sentences presented in this paper, for explaining IS semantic event realizations at the IPk level. Pragmatic aspects discussed in the paper refer the IPk unit description and the unit hierarchical organization within utterance. A two-dimensional IPk model is proposed in section 2 in order to be used in describing unit structures and their constituents at the information packaging level. The IPk model is presented by defining the main concepts: informational unit, the functional categories including nuclear attribute and rules for nucleus identification within IPk partitions. The IPk model is used in section 3 to present

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prosodic realizations of different types of semantic IS events within English sentences in correlation with IPk unit structures and their functional constituents produced within the corresponding utterances.

2. The IPk model

In the information packaging view, prosodic words apply IPk functions on the corresponding words within information units. The IPk model defines contrast unit (CU) as a binary information unit with binary IPk partition having two functionally contrasted constituents. This view transforms utterances into CU hierarchies. CU may be related to one prosodic phrase, to only a part of it (lower level CUs) or to one compound of prosodic phrases (higher level CUs). For example, statements with Subject-Verb-Object (SVO) syntactic structure may be uttered with the verb and the object paired within an imbricate CU. The subject and the imbricate CU are the two constituents of the global CU related to the intonational phrase.

IPk model-based analysis of intonational contours consists in interpreting contours of all prosodic words related to grammatical accented constituents (with pitch accent or not) and in deducing their IPk functions. Functional elements are paired into CUs which are then structured into a logical hierarchy. Target tone levels and temporal features related to pitch movements are relevant acoustic cues in decoding IPk functions of CU constituents. Assigning functions at the IPk level to all words within their CUs, improves the intonational contour comprehension given by the ToBI annotation system (Pierrehumbert 1980) and intonational phonology (Ladd 2008).

2.1 Structural levels of the IPk partitions

The IPk model defines two overlapping structural levels for describing partitions of contrast units (CUs). This overlapping is possible because two kinds of features can independently vary within prosodic words leading to two independent functional marks on the same constituent. These features involve target tone levels and temporal characteristics of pitch movements within prosodic words.

One of the two structural levels within IPk partition conveys a contrast between a psychological subject (PS) and a psychological predicate (PP) in terms of von der Gabelentz' psycholinguistic IS model or as an association of a "unique" element (the subject) with a "multiple" element (the predicate), as the Eleatic School of philosophy defines judgments. We use the second variant of predicate-argument structure for describing the functional contrast of CUs and introduce the derived terms "CU_ predicate" and "CU_argument". Thus, we reconsider the concepts of psychological IS models that describe utterances at the global level and apply them to in describing all lower level IPk partitions.

The first IPk structural level is viewed as a relationship between two information "objects": one of them bears the "first or general reference" within IPk partition (CU_predicate element) and the second one bears the "added reference" or "specific

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reference" (CU_argument element). This is the meaning of the predicate-argument structure at the cortical IPk process level reflected by intonational contour at the utterance level. Hurford (2003) also states that "neural evidence exists for predicate-argument structure as the core of phylogenetically and ontogenetically primitive (pre-linguistic) mental representations". Hurford (2003) further writes that "the structures of modern natural languages can be mapped onto these primitive representations". We cited (Hurford 2003: 261) despite the fact that he refers to "objects" in the visual field of humans and other primates, whereas we apply predicate-argument structure in speech information structuring.

The *CU_* predicate and CU_argument structure is marked at the phonetic level by the tonal contrast between the target tones (dominant tone during accented syllables) of functional elements of IPk partitions. The CU_predicate constituent is marked by the lower target tone within IPk partition and the CU_argument element is marked by the higher target tone within the same partition. In this manner any two words may be related into a CU_predicate-CU_argument structure.

The second structural level of IPk partition involves a contrast between an emotional element (CU_emotional element) and a rational element (CU_rational element). CU_emotional element is marked by slow pitch changes without pitch excursion limitation while CU_rational element by abrupt pitch changes with pitch excursion limitation. These two contrasted marks of the elements of IPk partitions suggest that the research on emotion and cognition must include the study of micro-structures of information units produced under these psychological macro-phenomena produced.

At the neurobiological level, these two contrasted functions are implemented by neurons with different behavioural features in integrating word evocation patterns within IPk partitions. They have different activation functions: with saturating nonlinearities for the neuron related to the CU_rational constituent and with non-saturating nonlinearities, for the neuron that integrates CU_emotional constituent. In the former case the activation function may produce consistent limitation of firing rate of neuron that is reflected in speech output by the limitation of pitch excursions during the prosodic words of the respective constituent. The two different activation functions can be reached by different inhibition level of the two neurons that is higher in the CU_rational constituent case and lower in the CU_emotional constituent case. We paraphrase Hurford (2003) and claim that neural evidence exists for both CU_predicate-CU_argument and CU_emotional-CU_rational element structures as the core of pre-linguistic mental representations.

Each constituent of IPk partition have two functions at the two structural levels. One of the two constituents may bear a third function, the nuclear function, becoming the nucleus of the respective partition. Nuclei are involved in building IPk partition hierarchies which decompose utterances into nested IPk partition architectures.

2.2 Nucleus in IPk partitions

Nuclear attribute is related to the prominent constituent of one IPk partition. The prominence is not always an acoustical one but it is a functional one. Its acoustical feature (high or low) depends on the F0 contour type of the respective CU. Within CUs where one of the constituents subordinates its paired element, nuclear accent has high

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prominence. It is the case of nucleus generated by local or global emphasis. Within a CU with non-emphasized contour, produced by two coordinated functional elements, the functional prominence has low tonal level and the element of IPk partition with the lowest tone on its accented syllable bears nucleus. The IPk model formulates two related rules for the nuclear accent identification (NSR-Nuclear Stress Rule): the NSR_NE rule, in (4), for Non-Emphasized contours; the NSR_E rule for Emphasized contours, in (5):

(4) NSR_NE: In IPk partition with non-emphasized contour the nuclear accent is assigned to the CU_predicate element related to the low prominence produced by the lowest target tone.
(5) NSR_E: In IPk partition with emphasized contour the nuclear accent is assigned to the CU_argument element related to the high prominence produced by the highest target tone.

From the IPk point of view, emphasis has to be viewed as a nuclear event with high prominence. A non-emphasized contour within one CU leads to a nuclear function on its lower target constituent which bears low prominence. The existence of nuclear constituent with low prominence in non-emphasized contours can also explain why in certain cases it is not necessarily an acoustical salience for marking the nuclear event.

2.3. Description system of IPk partitions

In the perspective of the IPk model presented in this paper any simple or complex utterance may be decomposed into a hierarchy of CUs with IPk partition. P and A labels were introduced for annotating CU_Predicate and CU_Argument constituents, and E and R labels for annotating CU_Emotional and CU_Rational elements within partition descriptions. In the proposed IPk description system, two labels are used for annotating each element of IPk partition. They are linked by "+" and enclosed between round parentheses.

The description of one IPk partition is a sequence of two pairs of round parentheses separated by slash that are related to the two CU constituents. All four possible IPk partition variants presented under (6) are possible because CU_predicate-CU_argument and CU_emotional-CU_rational element are two independent levels.

(6) a. (A+E)/(P+R)
b. (A+R)/(P+E)
c. (P+E)/(A+R)
d. (P+R)/(A+E)

The description of one CU with lower level CU(s) as constituents encloses the description of lower level IPk partitions between brackets and places a functional label in the index position after the right bracket. In (7) one IPk partition for a generic sentence with SVO structure is presented, where (F1+F2) / (NF1+NF2) sequence corresponds to one of the IS partition variants described in 6.a-d. The lower level CU with NF1 and NF2

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functions is paired with the first functional constituent (the subject) having contrasted F1 and F2 functions.

(7) $\{(F1+F2)^{Subject}/\{(F1+F2)^{Verb}/(NF1+NF2)^{Object}\}_{NF1+NF2}\}$

Nuclear accent is needed for explaining why lower level CU has NF1+NF2 functional label in the generic description in (7). The role of nuclear accent is to connect CUs within utterance hierarchy by projecting IPk functions of one constituent to the whole CU it belongs. This can be viewed in (7) where the lower level CU of the verbal phrase is a generic NF1+NF2 element because the nuclear element of the embedded CU (the Object) has NF1+NF2 type.

3. An IPk model-based interpretation of semantic focus and topic events

Section 3 presents different semantic focus and topic event realizations in few English utterances by using IPk-model based descriptions of their partitioning. We choose to discuss utterances of several sentences which are analysed at the semantic IS level in Krifka & Musan (2012). In the recent paper we correlate semantic events with IPk structure contexts according to the F0 contours of our database built on the methodological principles presented in subsection 3.1. After the IPk analysis is performed a correspondence between different types of semantic events and their IPk realizations results. Semantic focus event realizations are discussed in subsection 3.2 and different topic event implementation are presented in subsection 3.3. The results are summarized in subsection 3.4.

3.1 Methodology

The database used in this research contains the utterances of 8 English sentences selected from Krifka & Musan (2012) and one sentence presented in (Rooth 1992) and in (Büring 2015). The sentences contain different types of focus and topic events. The discourse context of each sentence is also extracted from the references where the sentences are presented. The sentences with their related context were presented to two English native speakers.

The selected utterances have been processed by using Praat software for extracting their F0 contours. After that a manually partitioning is applied to all F0 contours and utterances were transformed into CU unit hierarchies. Their partitions were annotated at the IPk level by using the labels presented in section 2.3. Praat software was also used in building one figure for each wav file that illustrates the corresponding F0 contour and a bottom-up presentation of IPk partition hierarchy on the tiers displayed below the contour. We consider our IPk model is a valid if the IPk analysis of F0 contours can produce descriptions of IPk partitions accordingly to local F0 contour patterns and then it can link them within logical nucleus-based hierarchies.

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Different types of focus and topic are discussed in this paper in relationship with the IPk descriptions of respective utterances and conclusions about the semantic event implementation at the information packaging level were formulated.

3.2 Focus events

Krifka & Musan (2012) build on work by Rooth (1985, 1992) and claim that "semantic focus indicates the presence of those alternatives that are relevant for the interpretation of linguistic expressions". A focus word is identified within utterance if it can be considered an answer to a test *wh*-question whose *wh*-word refers a set of possible alternatives. Focus event is applied on the word which represents the alternative "selected" by the speaker from the hypothetic set. Different types of semantic focus are presented in Krifka & Musan (2012), in different semantic contexts. We have selected sentences where focus events need few explanations about their pragmatic realizations.

3.2.1 Focus in "narrow focus" statements

In section 3.2.1 narrow focus is illustrated by statements elicited by related *wh*-questions. The *wh*-word of the question introduces a set of alternatives which produces a semantic focus in the answer. The focus word is prosodically marked by an acoustical prominent pitch accent and it is followed by a post-focal pitch range compression as can be seen in the answer of the question (8.a). The F0 contour of the answer is presented in Figure 2 and described in (8b). The utterance of the answer (8b) has three IPk partition levels. The lowest IPk partition corresponds to the group of the verb *showed* and the referent *Mary*, where the verb has CU_predicate function and the referent *Mary* has CU_argument function marked by an acoustically prominent pitch accent. Pitch accent also marks the word *Mary* for semantic focus function accordingly to its new information in respect to the question (8a). The focus element is not nuclear in this partition because the two constituents have overlapping tonal spaces and nuclear element is produced by the low prominence (the lowest target tone) on the verb (NSR_NE rule).

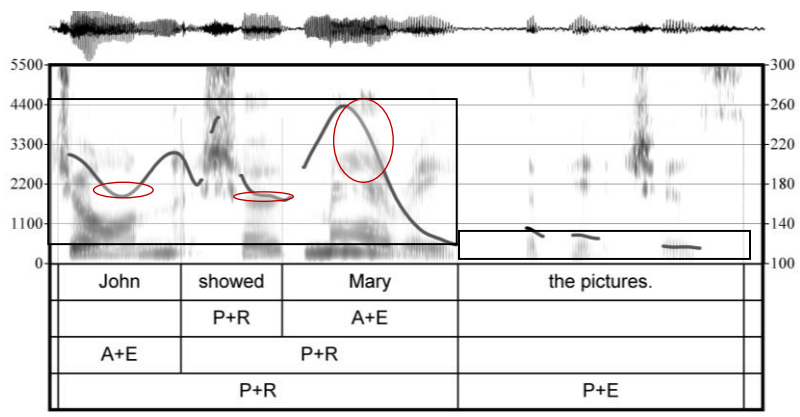

Figure 2. The IPk description of the utterance *John showed$_N$ Mary$_F$ the pictures.*

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(8) a. Who did John show the pictures?
b. [[John^{A+E} /[showed$_{\mathbf{N}}$ $^{P+R}$ / Mary$_{\mathbf{F}}$ $^{A+E}$]$_{P+R}$] $_{P+R}$ / the pictures $^{P+E}$]$_{P+R}$

At the second structural level the noun *Mary* is a CU_emotional element (slow pitch movement and longer duration) and the verb, a CU_rational constituent (without pitch accent). At the higher IPk partition level the referent *John* is in contrast with the group *showed Mary*: the topic element *John* is a CU_emotional and the group is a CU_rational element having the verb as the nuclear and CU_rational element. The low prominence at this higher level (the group *John showed Mary*) is on the verb having the target tone level under that of the lowest tone during the word *John*. Thus, the group *John showed Mary* is also a P+R element as described in (8b).

At the global IPk partition level the group *John showed Mary* is in contrast with the object *(the) pictures*. They have separated tonal spaces and the group is the nuclear element having a local nucleus with higher target tone than that of the noun *(the) pictures.* The group is the CU_argument element at the global level and NSR_E rule say that it bears the high prominence and the nuclear function. It is the CU_ argument and rational element at the global level even it is labelled by P+R label in respect to its nuclear element at the lower IPk partition level. In contrast with the group, the noun *(the) pictures* is the CU_emotional and CU_predicate element (slow downstep pitch movement at very low levels).

Figure 2 illustrates the case of focus event marked by an acoustically prominent pitch accent and a post-focal pitch range compression. The acoustical prominence of focus word (high pitch accent) does not involve its functional prominence and nuclear function at the pre-linguistic level.

In the statement (9b) we present another case of the semantic narrow focus statements where new information element (*a boy*) is in semantic contrast with an old information element (*the girl*) suggested by the articles *a* and *the* of the two nouns. In this case the utterance structure includes all old information words in the topic part and the comment part has a single word with new information. The contour of one utterance of the sentence is illustrated in Figure 3 and described in (9b). The question (9a) introduces a hypothetic alternative set and the answer (9b) extracts the noun *a boy* from the set and semantic focus function applies it.

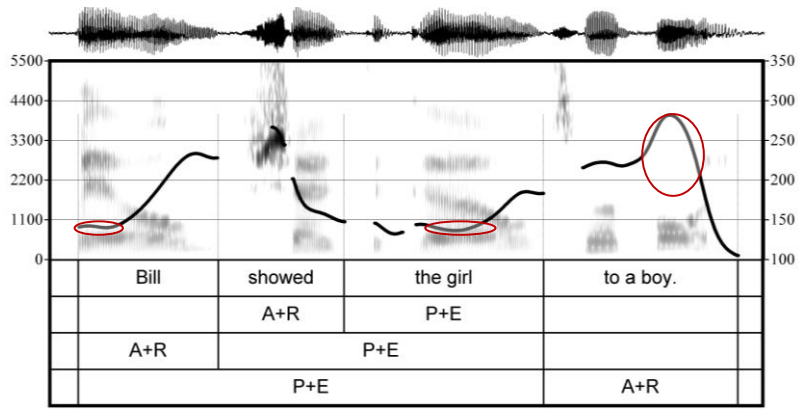

Figure 3. The IPk description of the utterance *Bill showed the girl$_{N}$ to a boy$_{F}$.*

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(9) a. What did Bill show the girl?
b. [Bill $^{A+R}$/ [showed $^{A+R}$ / the girl $_{N}$ $^{P+E}$]$_{P+E}$]$_{P+E}$ /to a boy$_{\mathbf{F}}$ $^{A+R}$.

The old information words of the sentence are organized into two nested CUs. The lower level CU has the referent *the girl* as the CU_predicate element with nuclear function because it bears the low prominence. It also bears the lowest prominence in the higher level IPk partition where the group *showed the girl* is paired with the subject *Bill*. The word *the girl* has lower target tone and bears the low prominence and the nuclear function in the topic part. It is annotated by *N* in (9b).

The group *Bill showed the girl* and the element *a boy* have overlapping tonal spaces and the low prominence is on the noun *the girl*. The noun *a boy* of the comment part is an acoustically prominent focus word (high pitch accent) without nuclear function.

The sentence *Bill showed the boy a girl* presented in (10b) has also a semantic contrast between the referents *the boy* and *a girl* as in sentence (9b) but in the utterance illustrated in Figure 4 and described in (10b) the speaker marks the new information element by a low pitch accent.

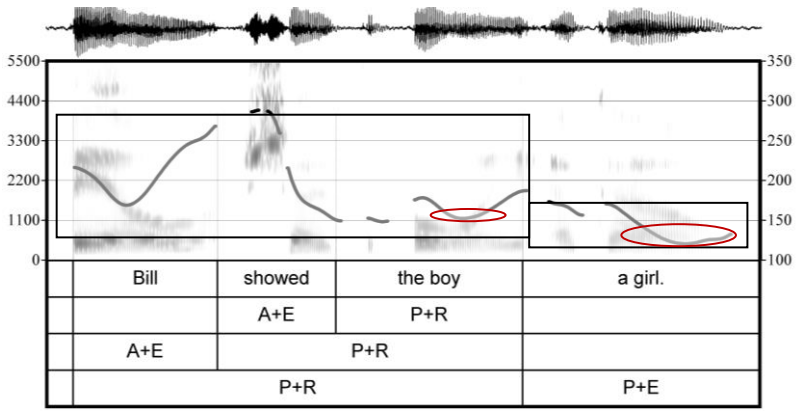

Figure 4. The IPk description of the utterance *Bill showed the boy a girl*$_{\boldsymbol{NF}}$.

(10) a. What did Bill show the boy?
b. [Bill $^{A+R}$ / [(showed^{A+R} /the boy$_{n}$ $^{P+E}$)$_{P+E}$ / a girl $_{\mathbf{NF}}$ $^{P+R}$]$_{P+R}$] $_{P+R}$

We point out the differences at the IPk level between utterance (9b) and (10b). In the lowest IPk partitions of the group *showed the girl/boy* CU_emotional and CU_rational elements have different distribution: the direct complement is a CU_emotional element (*the girl*) in the former case and a CU_rational element in the latter case (*the boy*). The direct complement *the boy/girl* is the nuclear element at the higher IPk partition level where the group *showed the boy/girl* is paired with the subject *Bill*. The subject *Bill* is a CU_emotional element (A+E label) in (9b) and CU_rational element in (10b). We may suppose that the speaker has a preference to mark the female referent as CU_emotional element and the male referent as CU_rational element.

The F0 contour in Figure 4 shows that the group *Bill showed the boy* is in contrast with the last word *a girl* at the global level. The two constituents have overlapped tonal

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spaces and the target tone of the local nuclear element *the boy* is higher than that of the second constituent *a girl*. NSR_NE rule applies the nuclear function at the global level on the second object *a girl*. It has CU_predicate, CU_emotional (slow pitch movement and longer duration) and global nuclear functions.

We conclude that semantic focus element in narrow focus statements elicited by a *wh*-question may bear CU_argument or CU_predicate function in the comment part of the sentence. Focus function is marked by prominent pitch accent with either high or low target tone. In the latter case the focus word with new information bears also global nuclear function and a local nucleus exists in the topic part of the utterance. The contrast at the pre-linguistic level between the new information element bearing narrow focus function in the comment part and the old information element bearing local nucleus in the topic part of the utterance may convey a semantic contrast at the sentence level.

3.2.2 Focus in the "focus sensitive" particle context

Sentence (1) in section 1 is used to illustrate the case of focus elicited by the particle *only* that is applied on the verb and not on the noun *rice* because its second occurrence bears old information. This explains why the focus function shifts on the verb *eat*. The intonational contour produced by an utterance of sentence (1), illustrated in Figure 5 and annotated in (11), shows that the final word is completely de-accented. The focus is on the verb *eat* produced by a more prominent pitch accent than in sentence (8b) because an emphasis occurs on the respective constituent. It has a separated high tonal space in respect to the particle *only* and the noun *rice*. The latter ones are subordinated by the focus word. The focus word *eat* has CU_argument and nuclear functions within both the local group *only eat* and the higher level group *only eat rice* leading to an emphasis in the comment part of the sentence. In this case focus event has prominent high pitch accent as in (8b) but in contrast with (8b) the focus word also bears the nucleus.

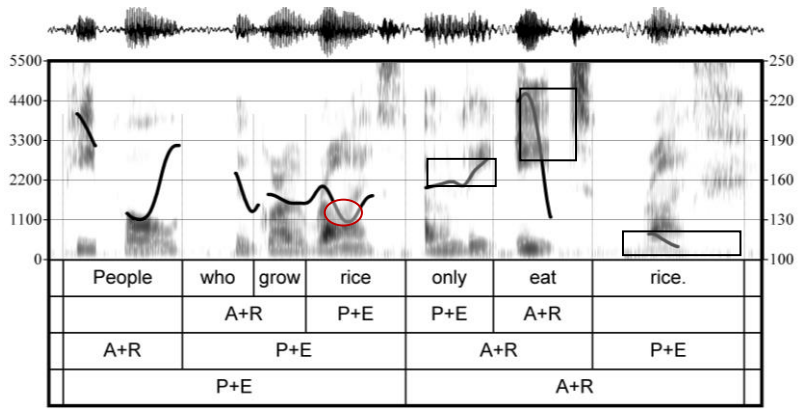

Figure 5. The IPk description of the utterance *People who grow rice only eat rice*.

(11) [People^{A+R} / [(who grow)$^{A+R}$/rice^{P+E}]$_{P+E}$]$_{P+E}$ [(only$^{P+E/}$/eat $_{F\ N}$ $^{A+R}$)$_{A+R}$ / rice $^{P+E}$]$_{A+R}$.

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The verb bears the functional and acoustical high prominence in the second clause of the sentence. At this level the second occurrence of the noun *rice* is a CU_predicate element and it is subordinated by the group *only eat*. The nuclear and focus word *eat* projects its CU_argument and CU_rational functions to the whole partition corresponding to the comment part of the sentence (A+R label).

In the topic part of the sentence, the embedded group *who grow* is the A+R element in the group *who grow rice* and the first occurrence of the noun *rice* is the nuclear element of P+E type. The group becomes a P+E element at the next IPk level that is paired with the subject *people* as CU_argument and CU_rational elements (A+R label). The noun *rice* is nuclear in the first part of the sentence *people who grow rice* due to its lowest tonal level.

At the sentence level the nuclear element *rice* of the first part contrasts with the nuclear element of the second part (the verb *eat*). The contrast is annotated at the IPk functional level by (P+E) *versus* (A+R) labels. The former group wins the competition for the global nuclear attribute having the lowest tonal level (NSR_NE rule).

As already mentioned in section 1, Krifka & Musan (2012) state that "given constituents can be in focus" and they exemplify by sentence (2) where the pronoun *him* is under the focus-sensitive particle *only*. An utterance of the sentence (2) which is not illustrated in our paper has the same F0 contour as that of the sentence (8b) in that it focuses the comment-middle position word with new information (the verb *saw* in (2)), de-accentuates the sentence-final word with old information (the pronoun *him* in (2)) and applies the nuclear function on the comment-initial word (the particle *only*). However, Krifka & Musan (2012) refer to an utterance that applies focus on the pronoun *him* and does not move focus on the verb. One speaker has uttered sentence (2) as broad focus statement and applies the global focus and nuclear functions on the last word. The F0 contour is illustrated in Figure 6 and annotated in (12b).

The verbal phrase is structured by two nested CUs corresponding to the local group *only saw* and the higher level group *only saw him*. At the lowest IPk partition the verb is the CU_predicate and CU_rational element in respect to the particle *only*. The verb is nuclear having the lowest tonal target. At the higher level IPk partition the group *only saw* represented by its nuclear element (the verb) has higher target in respect to the pronoun *him* and becomes the A+R element of the IPk partition of the verbal phrase. Thus, the latter one is the CU_predicate element and bears the low functional prominence which gives it the nuclear function at the whole verbal phrase level due to the overlapping between the tonal spaces of the group *only saw* and the pronoun *him*. The utterance IPk partitioning annotation in (12b) applies both *N* and *F* labels on the pronoun *him*.

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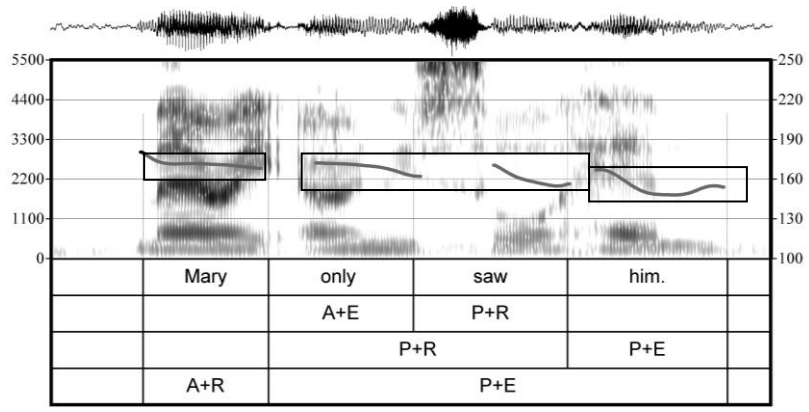

Figure 6. The IPk description of the utterance *Mary only saw*$_{\mathbf{F}}$ *him*$_{\mathbf{N}}$.

(12) a. Mary loves John.
b. [Mary^{A+R}/ [[only^{P+R} / saw $^{A+E}$]$^{P+R}$ / him$_{\mathbf{N\ F}}$ $^{P+E}$]$_{P+E}$]$_{P+E}$

At this level the nucleus is a CU_emotional element due to its slow falling pitch movement during the pronoun *him* (P+E label). At the global level the group *only saw him* is the CU_predicate and CU_emotional element that is paired with the subject *Mary* as A+R element. They have overlapping tonal spaces and the nuclear element has low prominence carried by the pronoun *him*. The intonational contour used by the speaker points out the pronoun *him* by marking it as the nuclear element.

We conclude that in English the focus function within a group under the focus-sensitive particle has an implicit position on the new information element within an emphasized or non-emphasized narrow focus statement. A special requirement to focus an old information element was fulfilled by using an intonation for broad focus statement that marks the focus word as nuclear element with global low prominence.

3.3 Topic events

The "expression topic" is defined in Krifka & Musan (2012) as the part of the sentence "under which the information expressed in the comment constituent should be stored in the common ground content". They differentiate between "expression topic" and "denotation topic". The latter one corresponds to elements bearing old information at the semantic IS level. Krifka & Musan (2012) delimitates from those that consider all constituents of "expression topic" units are old information elements, and all constituents of comment units are new information elements. Sentence (13a) has a topic unit with the new information element *A good friend*. We modified the comment part of the sentence and replaced the proper noun with the pronoun *her* and sentence (13a) changes into sentence (13b). The contour of one utterance of the sentence (13b) is illustrated in Figure 7 and described in (13b).

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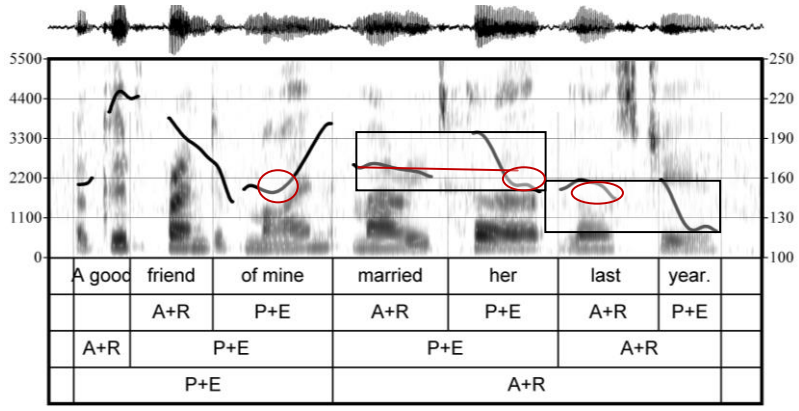

Figure 7. The IPk description of the utterance *A good friend of mine married her last year*.

The unit related to the "expression topic" contains the words *good* and *friend* both of them being CU_argument and CU_rational elements within the two nested partitions. The elements are annotated by A+R labels in (13b). The pronoun *mine* is the CU_predicate and the CU_emotional element (P+E label) marked by the lowest tonal level in the topic expression unit. The P+E constituent projects its functions to the whole "expression topic" unit because it is the nuclear element related to the low prominence (NSR_NE rule) and it is annotated by *N* in (13b).

The comment part of the sentence has two sequenced partitions. In the first partition the verb *married* is the CU_argument and CU_rational element (A+R label) because it holds higher tone level than those reached by the pronoun *her* on the second part of its syllable. Thus, the pronoun *her* is the CU_predicate and CU_emotional element of the first partition and it also bears the low prominence and the nuclear function in the group *married her*.

The second partition of the group *last year* the constituents have non-overlapping tonal spaces and the adjective is a nuclear CU_argument and CU_rational element (NSR_E rule). As presented in Figure 7, the pitch accent of the noun *year* has an acoustical prominence and it can mark the local focus annotated by *f* in (13b). The focus function cannot be projected at the comment part level because the adjective *last* is the nuclear element and it projects its IPk functions (A+R label) at the comment part level.

(13) a. [A good friend of mine]$_{\text{"Topic"}}$ [married Britney Spears last year]$_{\text{"Comment"}}$

b. [A good $^{(A+R)}$/[friend$^{(A+R)}$/of mine$_{\mathbf{N}}$ $^{(P+E)}$]$_{P+E}$]$_{P+E}$
[(married^{A+R}/her $_{\mathbf{F}}$ $^{P+E}$)$_{P+E}$(last$_{n}$ $^{A+R}$/year $_{\mathbf{f}}$ $^{P+E}$) $_{A+R}$]$_{A+R}$

The tonal spaces of the two sequenced partitions are overlapped within a very small pitch range and based on the NSR_NE rule the group *last year* is the nuclear element because the tone of the local nuclear element *last* has lower level than that of the local nuclear element *her*. The nucleus of the last partition is annotated by *n* in (13b.). At the sentence level the pronoun *mine* of the topic unit (P+E element) bears the global low prominence because it has a lower tone in the first part of the syllable than the target tone of the word *last*. Thus, the pronoun *mine* is the global nucleus of the utterance.

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We consider each partition of the comment part has focus event. In the first partition the pronoun *her* bears focus function having both acoustical and functional prominence (at the pre-linguistic level). The second partition has the functional prominence on the adjective *last* and the acoustical prominence on the noun *year* (the last low pitch accent). The noun *year* has sense as alternative from a set of different periods of time (year, month, week, etc.) and this justifies its local focus function and its *f* label within the noun phrase.

In this example the "expression topic" unit contains new information but the nucleus is carried by the denotation topic element, the pronoun *mine*. The comment unit has an old information element (the pronoun *her*) which bears focus function at this level but the nuclear element at the comment part level is related to the new information group *last year*.

3.3.1 Contrastive topic

Krifka & Musan (2012) cite Roberts (1996) and Büring (2003) and characterize the contrastive topic event as a semantic accommodation phenomenon which "splits an issue into two sub-issues". This explains why contrastive topic sentences introduce an acoustical tonal contrast between the two sub-issues: the first one is uttered within a high tonal space and the second one within a low tonal space. The first sub-issue bears the contrastive topic. In sentence (14b) the first sub-issue is the pronoun *I* and the second one is the nominal predicate *was at home*.

The F0 contour of one utterance of sentence (14b) is illustrated in Figure 8 and it is described in (14c). The F0 contour during the pronoun *I* can be thought as one unit with two constituents because both of them are of considerable duration: the first part of the syllable is related to a high tone (A+R) constituent and the second part is related to the low tone before the last rising pitch movement. The low tone (marked by the ellipsis under the horizontal line) marks the nucleus of the two parts of the pronoun *I* and its level will be compared with that of the nuclear word of the verbal phrase.

(14) a. Where were you (at a time of murder)?
b. [I$_{\text{"Focus"}}$]$_{\text{"Topic"}}$ [was (at HOME)$_{\text{"Focus"}}$]$_{\text{"Comment"}}$.
c. [I$_{\mathbf{N\,F}}^{\text{P+E}}$ /[was at$_{\mathbf{n}}^{\text{A+R}}$/ home$_{\mathbf{f}}^{\text{P+E}}$] $_{\text{A+R}}$]$_{\text{P+E}}$

The local IPk partition of the verbal phrase has the verb *was (at)* and the noun *home* as constituents. They have non-overlapping tonal spaces and the nucleus is on first one because it has the high tonal space (CU_argument function). The verb subordinates the noun *home* justified by the NSR_E rule which states that the element with higher tonal space is nuclear. The verb is the CU_rational element with a constant level F0 contour. The noun *home* is the CU_predicate and CU_emotional element due to slow pitch movement to the lowest level of the F0 contour (low acoustical prominence).

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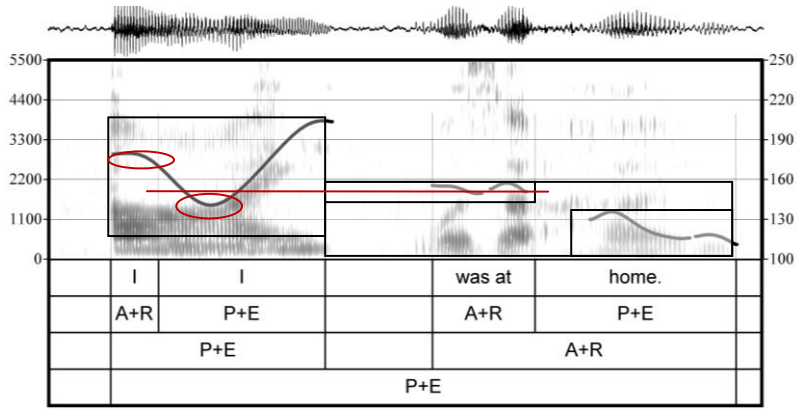

Figure 8. The IPk description of the utterance *I was at home*.

The noun *home* bears the focus function only at this local level because it represents an alternative from a set of possible locations. It is not nuclear and it cannot project its focus function at the whole verbal phrase level. Its focus function is marked by the salient pitch accent with the lowest target tone. It is annotated by the *f* label in (14c).

At the global level the pronoun *I* and the verbal phrase are two constituents with overlapping tonal spaces and the global nucleus is on the element bearing the low prominence. In Figure 8 we observe that constant pitch level during the verb is higher than the minimum tone reached during the pronoun *I* (the nuclear part of the pronoun). The target tone of the verb is compared with that of the subject because the verb is the nucleus of the verbal phrase. This explains why the subject bears the functional low prominence and the global nuclear function at the IPk level.

The first sub-issue, the pronoun *I*, bears focus function at the semantic level because it refers to one of a hypothetic set of suspects in the context of the question (13a). At the IPK level it is implemented by the nuclear element of the utterance without acoustical low prominence which is carried by the second sub-issue of the last word with the local focus function.

In this manner it can be explained how topic and focus functions can be carried by the same element, the pronoun *I*. In contrastive topic sentences the nucleus is on the topic word and the last word loses the IPk functional low prominence even it has the lowest tonal target of the utterance. The second focus event, on the last word, is marked only by the acoustical salience of the last pitch accent.

3.3.2 Frame setter

In Krifka & Musan (2012) topic elements with frame setter role are presented as sentence elements that "set the frame in which the following expression should be interpreted" and in Chafe (1976), as the elements that "limit the applicability of the main predication". We analyse sentence (15b), also used in Krifka & (Musan 2012) to exemplify utterances with frame setters. The sentence has two clauses and corresponding two frame setter words: *(in) Germany* and *(in) America*, respectively. The F0 contour of one utterance was divided into two intonational phrases related to the two clauses of the

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sentence. Figure 9 illustrates the intonational phrase of the first clause and, and Figure 10 that of the second clause.

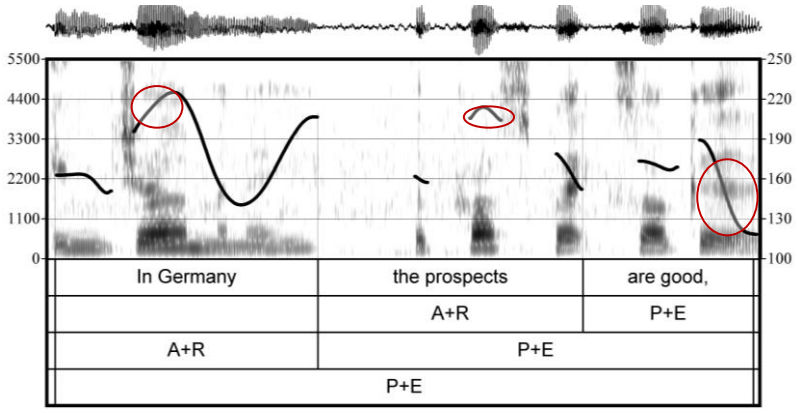

Figure 9. The IPk description of the first intonational phrase of the utterance *In Germany the prospects are good but in America they are losing money.*

In the comment part of the first clause, the clause-final word *good* is a CU_predicate and CU_emotional element (P+E label) and it is packed at the lowest IPk level with the CU_argument and CU_rational element *prospects*. The former one bears the nuclear function having the lowest target tone. At the first intonational phrase level the embedded CU of the group *the prospects are good* is the P+E element (its nucleus is a P+E element) and the frame setter *In Germany* is the CU_argument and CU_rational element (A+R label). The frame setter and the embedded CU have overlapping tonal spaces leading to the clause-final nuclear event on the word *good* annotated by *N* label in (15c). As presented in (Krifka&Musan 2012) and reproduced in (15b), the adjective *good* bears focus function because it represents an alternative from all possible qualifiers of the noun *prospects*. The first clause is the focus domain of the focus word *good*.

In the second clause, the frame setter *(but) in America* is a CU_emotional element (longer duration and slow pitch variations) and this conveys that it is paired with the first frame setter which is marked as CU_rational element. In the comment part of the second clause the last word is also realized as a CU_predicate and CU_emotional element as in the case of the word *good* of the first clause (P+E label) but it differs in that it is not nuclear because it is packed with the group *they are /losing*, the two constituents having separated tonal spaces. This leads to the nuclear function on the group *they are /losing* as the A+R element (NSR_E rule).

(15) a. How is business going for Daimler-Chrysler?

b. [(In Germany)$_{Frame}$/ the prospects are (good)$_{F}$)]
[but (in America)$_{Frame}$ they are (losing money)$_{F}$)]

c. [In Germany $^{A+R}$/ (the prospects $^{A+R}$ /are good $_{\mathbf{NF}}{}^{P+E}$) $_{P+E}$]$_{P+E}$
[but in America $^{A+R}$/ [(they are^{P+E}/ losing$_{\mathbf{N}}{}^{A+R}$) $^{A+R}$ /money$_{f}{}^{P+E}$] $_{A+R}$]$_{A+R}$

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At its turn the group *they are /losing* has two constituents with separated tonal spaces: the word *losing* has higher tonal space (A+R element) and the constituent *they are* has the low tonal space (P+E element). NSR_E rule indicates the word *losing* as nucleus in a short group *they are /losing* and in the higher group *they are /losing/ money*. At the second intonational phrase level the word *losing* is the nucleus having a lower target level than that reached during the word *America*.

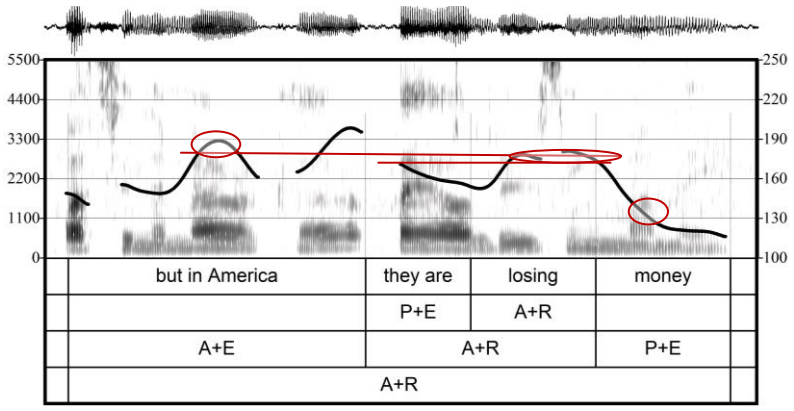

Figure 10. The IPk description of the second intonational phrase of the utterance
In Germany the prospects are good but in America they are losing money.

At the semantic level a local focus event is produced on the word *money* in the group *they are losing money* marked by a jump to the lowest target tone. It is not marked at the IPk level by a functional prominence (nuclear function) and it cannot project its focus function to the whole clause as the word *good* does in the first clause. We can conclude that focus events and nuclear events have their own reasons and rules and they do not always share the same position within utterance/phrase.

At the utterance level the contrast between the two intonational phrases is conveyed at the IPk level by the contrast between the nuclear word *good* of the first phrase, as the P+E element and the nuclear word *losing* of the second phrase, as the A+R element. The NSR_NE rule gives the global nuclear function to the word *good* having the lowest tonal level.

We conclude that frame setter is a topic element with CU_argument function with the highest target tone (high acoustical prominence) within utterance/phrase. It introduces the comment part which contains the nuclear and the focus elements of clause/sentence.

3.4 Results

In Table 1 different types of focus and topic realizations with related IPk functional features are summarized. Focus realizations can be divided into two main categories: (i) focus elements without nuclear function having acoustical high or low prominence (lines 1-2); (ii) focus elements with nuclear function having functional high or low prominence (lines 3-4). Focus realizations of the former case can be further divided by taking into account their domain size. Focus domains may be comment parts of sentences

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or only a local group of comment part. The former sub-case can be exemplified by the noun *Mary* in (8b) and by the noun *a boy* in (9b), and the latter sub-case can be exemplified with the noun *home* in the contrastive topic sentence (14c) where the noun has only a local focus function at the verbal phrase level. It is not nuclear and cannot project its focus function to the whole group *was at home*. Another example is the noun *year* in sentence (13c) that bears a focus function in the noun phrase *last year* where it is not the local focus element which is not projected at the comment part level.

Table 1. IPk functional correlates of the semantic IS functions

No.	Semantic function	IPk functional correlates
1.	Focus	CU_argument element with salient pitch accent
2.	Focus	CU_predicate element with local prominent pitch accent
3.	Focus	CU_argument/ CU_predicate + nucleus in broad focus statement
4.	Focus	CU_argument/ CU_predicate + nucleus in narrow focus statement
5.	Topic	CU_argument with acoustical low prominence
6.	Topic	CU_predicate + nucleus with acoustical low prominence
7.	Contrastive Topic	CU_predicate + nucleus without acoustical low prominence
8.	Frame setter	CU_argument with acoustical high prominence

The case of focus realizations presented in lines 3-4 refers to focus elements which are also nuclear constituents. We distinguish between two sub-cases of nuclear focus events: in broad focus context (line 3) and in narrow focus context (line 4). In the first sub-case the nuclear element of one group projects the focus function to the higher level. This is the case of the word *good* of the first clause in sentence (15c) that is the CU_predicate and nuclear element in the group *the prospects are good*. It projects its focus function and the whole group bears focus function because the clause is uttered as a broad focus statement. The focus on the pronoun *him* in sentence (12b) is also obtain in a broad focus statement where it is the nuclear and focus element in the comment part and it projects its function to the verbal phrase *only saw him*.

The second sub-case of nuclear focus elements includes focus events in narrow focus statement. In the comment part of such statements focus element may have global CU_argument function (the word *eat* in sentence (11)) or global CU_predicate function (the word *girl* in sentence (10b)).

We conclude that semantic focus events are marked at the utterance level either by synchronizing them with nuclear position of their domain (sentence parts or groups) or by associating them to pitch accent.

Three topic types are presented in Table 1. Line 5 is related to the denotation topic realized as non-nuclear and old information elements with CU_argument function at the topic part level as the noun *John* in (8b) or the noun *Bill* in (9b-10b). The denotation topic type presented in line 6 refers nuclear and old information element at the topic part level. It has CU_predicate function and bears both the functional low prominence and the

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acoustical low prominence. We can exemplify by the noun *the girl* / *the boy* in sentences (9b) and (10b), respectively or by the pronoun *mine* in (13c).

Contrastive topic elements presented in line 7 of Table 1 are denotation topic elements which further bear a focus function marked as CU_predicate and global nuclear element at the utterance level. Thus, it bears the low IPk functional prominence but it has not an absolute low level because its prosodic word has an acoustical high prominence (high tonal space). We exemplify with the pronoun *I* in sentence (14c) that produces lower target tone than that of the nuclear element *was (at)* of the comment part. Thus, contrastive topic element bears the global nucleus that marks it with focus function.

Frame setter is the third type of topic presented in line 8 of Table 1. Frame setter events are CU_argument elements at the utterance/phrase level. They have acoustical high prominence but they do not bear nuclear function. This is the case of the first word of the two clauses of sentence (15c), the noun *(in) Germany and (in) America*, respectively. Their target tones have the highest levels in the corresponding phrases.

We conclude that semantic IS functions have different implementation in different intonational contour types and they must be understood only at the pragmatic level, by relating them to IPk partition descriptions in terms of IPk functional constituents and acoustical and functional prominence.

4. Conclusions

In the paper we define an IPk model which can explain word packaging within utterances. Based on this model we dessociate utterance partitioning from semantic IS analysis, and then, focus and topic events are thought in correlations with pragmatic IPk aspects: binary CUs with partitions having functional constituents and nuclear positions. IPk partitions have two structural dimensions: CU_predicate-CU argument and CU_emotional-CU_rational element structures. The association of constituents with IPk functional categories, including nucleus category, leads to utterance descriptions as functional contrast hierarchies. The paper explains that nuclear events and focus/topic events have their own reasons and rules at pre-linguistic and linguistic levels, respectively. Only in certain cases they share the same position within utterance. Thus we use nuclear attribute to distinguish between two main types of topic or focus realizations: as nuclear or non-nuclear elements.

The NSR rules of the IPk model claim the existence of two modalities in producing nuclear accent: by emphasis when nucleus is related to one high functional prominence and without emphasis, when nucleus is related to low functional prominence. This helps us to differentiate between focus event with emphasis (elicited in certain cases by the focus-sensitive particle *only*) and focus event without emphasis (e.g. narrow focus with high pitch accent) both of them having high acoustical prominence which is higher in the former case where the focus constituent is also nuclear and subordinates the other elements of the group.

NSR_NE rule help us in understanding the nuclear function of constituents with no pitch accent which are in the same partition with an acoustical prominent element with focus function (e.g. the nuclear verb *showed vs.* the narrow focus element *Mary* in the

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comment part of sentence (8b)). The nuclear function of the former constituent is due to the lowest tone of the group *showed Mary*. In certain cases of focus element with the lowest target tone within IPk partition with non-emphasized F0 contour, focus element and nuclear element may share the same position (e.g. the noun *girl* as narrow focus element with low pitch accent in (10b)). NSR_NE is also responsible for the projection of focus function of the final word to the whole comment part of broad focus sentences (e.g. the pronoun *him* in the broad focus utterance of sentence (12b)).

NSR_E rule can explain why focus function of element with low pitch accent in IPk partitions with non-overlapping tonal space elements, cannot be projected at the higher level because focus nuclear is not nuclear. It is the case of the focus noun *home* in the comment part of the contrastive topic sentence in (14c) and of the noun *year* in the comment part of sentence (13c), both of them being local focus elements. In the former example the local focus element allows the presence of another focus event in the utterance, on the pronoun *I*, and in the latter case it can justify the presence of another focus element in the comment part, the group *married her*.

Contrastive topic function implementation involves the overlapping of topic and focus functions on the same element. This can be understood in the case of the pronoun *I* in sentence (13c) by observing its prosodic word has a topic pitch pattern with ascending and descending pitch movements in the high part of the tonal space. Further, the prosodic word of contrastive topic element produces a minimum tone under the level of the nuclear element of the comment part leading to a sentence-initial position of the global nuclear element. The focus function of the pronoun *I* is marked by the low functional prominence of the utterance even it is not also an acoustical low prominence as in other case of nuclear elements which bears both IPk functional and acoustical prominence (the lowest target tone of utterance).

The paper is in line with (Tonhauser 2019)'s idea that "phonological properties of utterances are not only implicated in conveying focus" or other semantic events but it actually offers a model to understand in what they are always implicated: in encoding word packaging within utterances, no matter if the respective words bear semantic focus or topic functions or not.

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