

Predicting Prosodic Phrasing



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PROJECT AIM

Examine the *factors that determine the partition of an utterance into Phonological Phrases* (particularly syntax, discourse and length) by *comparing* two different proposals on the Syntax-Phonology relation, i.e.:

- the set of constraints developed by H.Truckenbrodt(1999) within an Optimality Theory framework and building on an edge-based approach (Selkirk 86) to the conditions governing the syntactic and phonological component interface,
- M.Steedman's(2000) theory according to which the prosody of the utterance is determined in terms of Information Structure alone, the latter reflected on the more flexible syntactic surface structure of Combinatory Categorical Grammar,

CORPUS-METHOD

- Boston University Radio News Corpus. Speaker f2b (451 sentences).
- Prosodic labelling: ToBI phrase break indices; annotation based on perceived boundary strength. Each theory's predictions were compared to the actual distribution of:
 - PB index 3: Intermediate Phrase Boundary
 - PB index 4: Intonational Phrase Boundary

TRUCKENBRODT'S PROPOSED SET OF CONSTRAINTS

Align-XP/R For each XP there is a PP such that the right edge of the XP coincides with the right edge of the PP

Wrap-XP Each XP is contained in one Phonological Phrase

Lexical Category Condition Constraints relating syntactic and prosodic structure apply to lexical elements and their projections

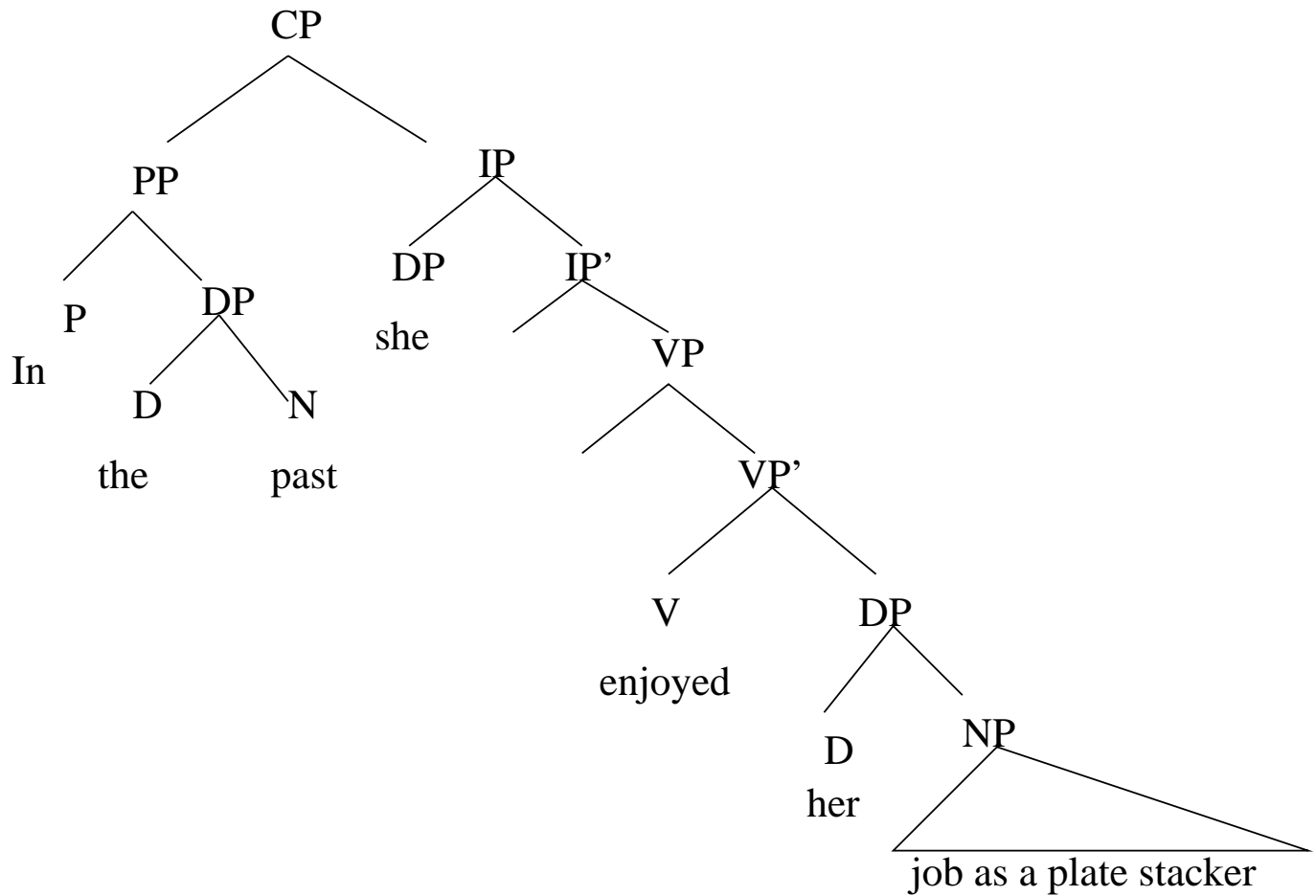
Align Foci Each focus constituent is right-aligned with a PP boundary

***P-Phrase** The insertion of Phonological Phrases is penalized altogether

General Constraints on Prosodic Hierarchy:

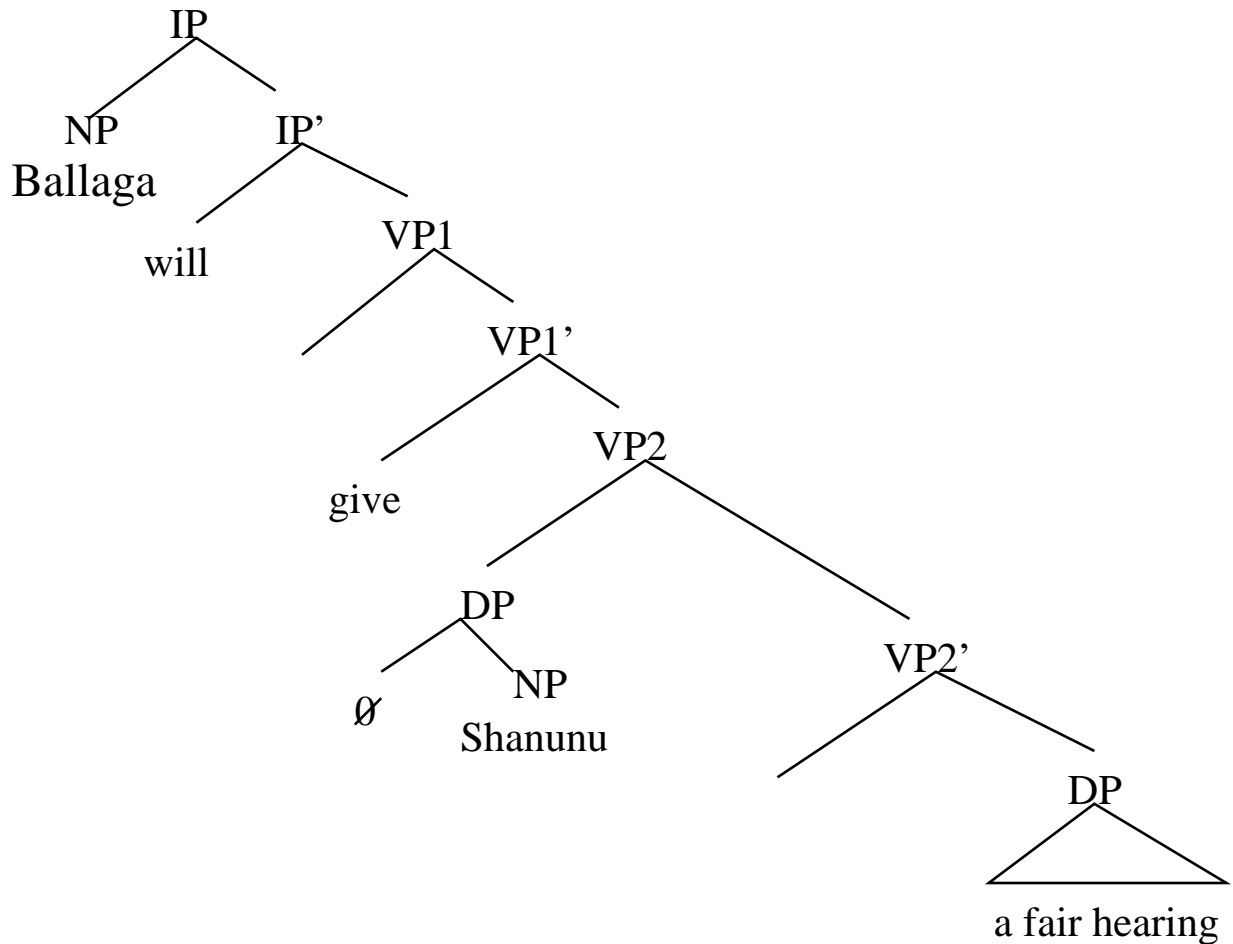
- Layeredness
- Headedness
- Exhaustivity
- Nonrecursivity

AN EXAMPLE



(In the past) (she enjoyed her job as a plate stacker)

AND ANOTHER EXAMPLE



(Ballaga)(will give Shanunu)(a fair hearing)

(Ballaga)(will give Shanunu a fair hearing)

COMPLEXITY PROBLEM

Difference in the nature of the corpus Truckenbrodt based his proposal upon (colloquial, normal rate speech style), and the test corpus used for this project (formal, broadcasting style).

Difference is reflected on sentence complexity. For example:

The cowboy branded the calf

and...

The initiative process worries Beard, who says it can offer simplistic solutions for complex problems such as taxation and nuclear energy

RESULTS

PBs PRED. CORR.	PBs NOT PRED.	PBs PRED. INCOR.
1271	1399	237
47.6%	52.4%	

Evaluation of Truckenbrodt's proposal(Clauses are not dealt with individually)

PBs PRED. CORR.	PBs NOT PRED.	PBs PRED. INCOR.
2020	650	375
75.7%	24.3%	

Evaluation of Truckenbrodt's proposal(Clauses delimited with PP breaks)

PBs PRED. CORR.	PBs NOT PRED.	PBs PRED. INCOR.
1569	650	375

Evaluation of Truckenbrodt's proposal(Clauses delimited with PP breaks), excluding predicted sentence final phrase breaks

A PARTICULARLY PROBLEMATIC CASE

377 out of 650 not predicted phrase breaks were phrase breaks occurring after a phrase head.

e.g. (He dismisses)(claims by the Phoenix police), instead of

(He dismisses claims by the Phoenix police)

Truckenbrodt's proposal has no way of accounting for these cases.

There is one proposal, though, on the mapping of Phonological Phrases to Syntactic Structure, which makes direct reference to the notion of *phrase head*, Nespor & Vogel's (1986). In particular...

NESPOR AND VOGEL'S PROPOSAL

Nespor & Vogel have proposed the following conditions on Phonological Phrase formation :

- A Phonological Phrase consists of a lexical head X and all constituents on the non-recursive side of the head's(X) phrase, which are contained in the same maximal projection. In English the non-recursive side is the left.
e.g. (The absent-minded professor)(has been avidly reading)(about the latest biography)(of Marcel Proust)
- The Phonological Phrase may optionally be extended to include the constituent to the right of the phrase head as long as they are both part of the same projection. This option may be determined by the speech rate or the length of the following the head constituent.
(The initial process) (worries) (Beard)
(The initial process) (worries Beard)

EVALUATION OF NESPOR AND VOGEL'S PROPOSAL

PRED. CORR.	NOT PRED.	PRED. INCORR.	RESTRUCT.
2547	126	312	621
95.3%	4.7%		

Evaluation of Nespor and Vogel's proposal

PBs PRED. CORR.	PBs NOT PRED.	PBs PRED. INCOR.
2427	246	540
90.8%	9.2 %	

Evaluation of Nespor and Vogel's proposal applying restructuring. Restructuring was applied according to the length of the following PP. One and two-word phrases were considered to undergo restructuring.

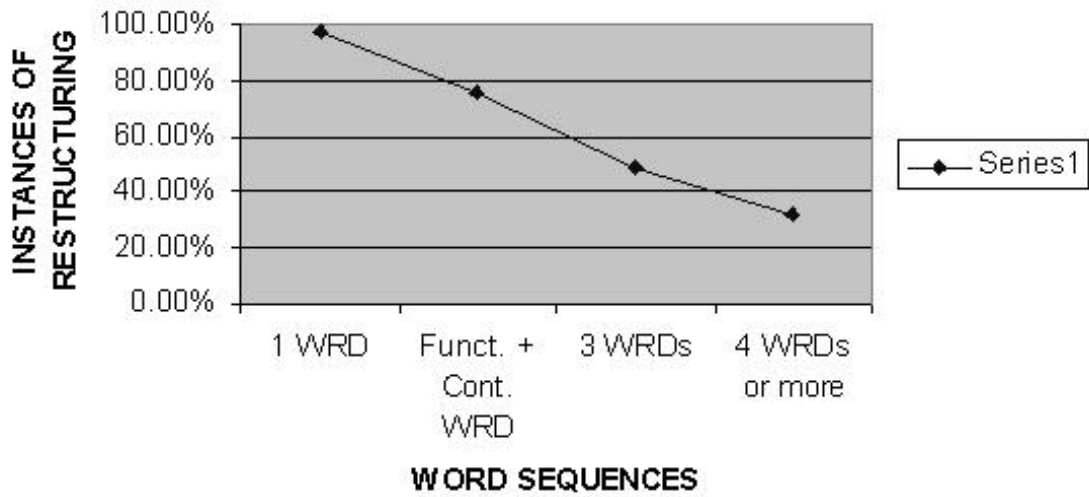
LENGTH

Length was shown to have a significant effect on:

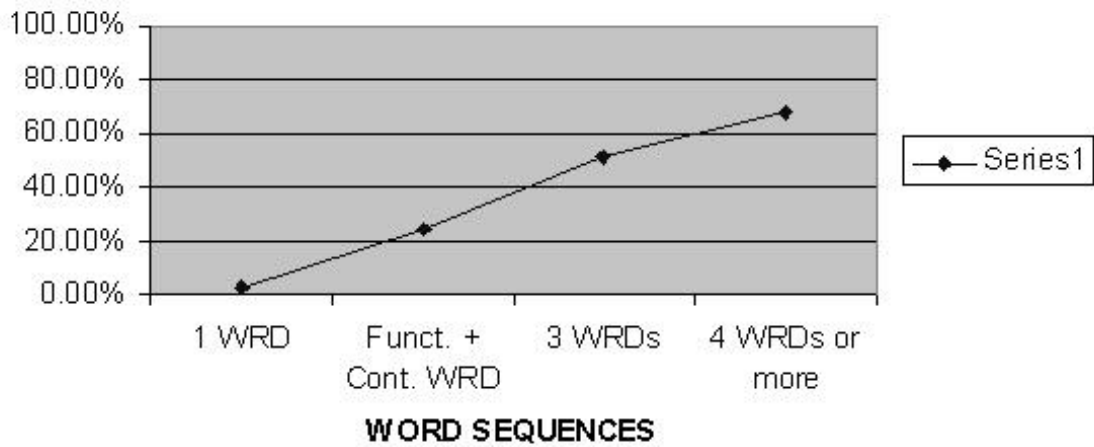
- Restructuring
- Subject - Verb constituents, where a phrase break was incorrectly predicted after the subject, e.g. (The state saved) (about one million dollars)

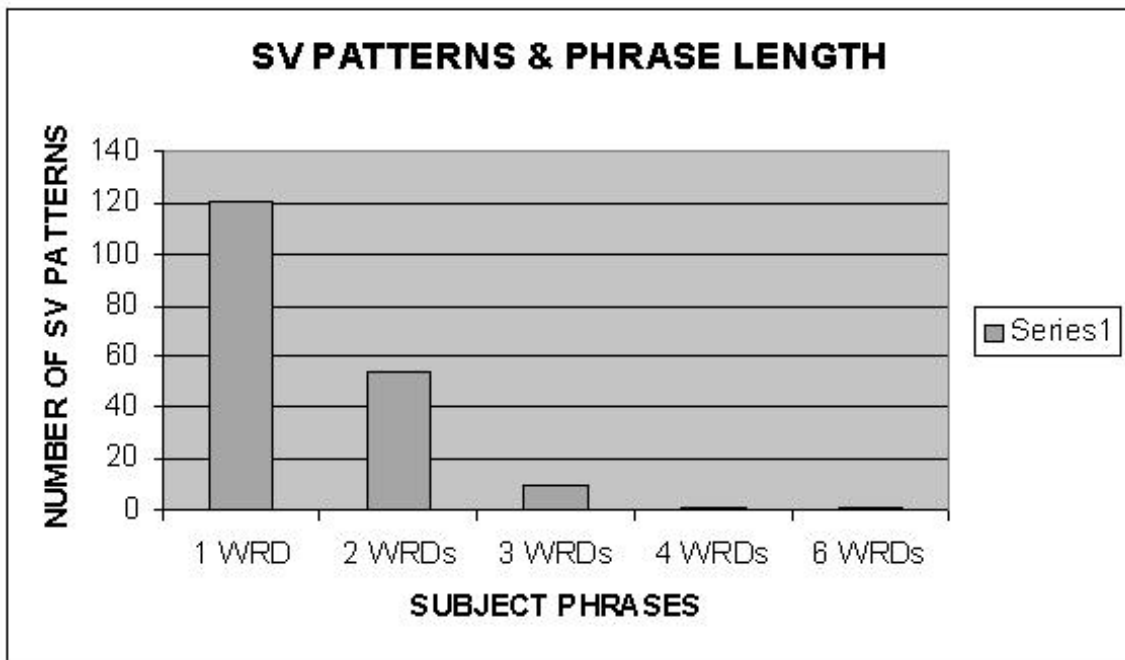
In general both too short and too long phonological phrases tend to be avoided.

RESTRUCTURING & PHRASE LENGTH



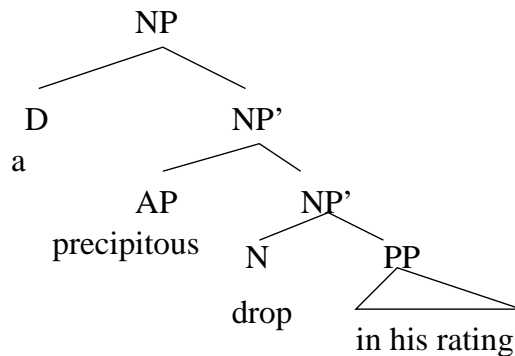
NON OCCURRENCE OF RESTRUCTURING & PHRASE LENGTH





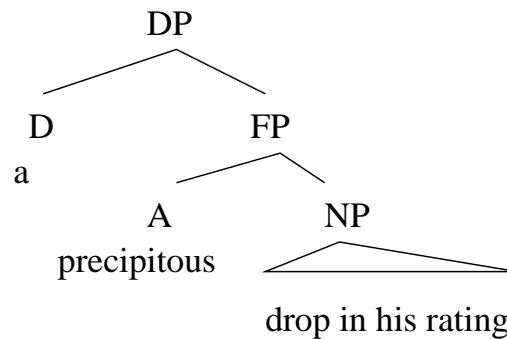
MAXIMAL AND EXTENDED PROJECTIONS

In evaluating the theories, the traditional view of the NP was adopted



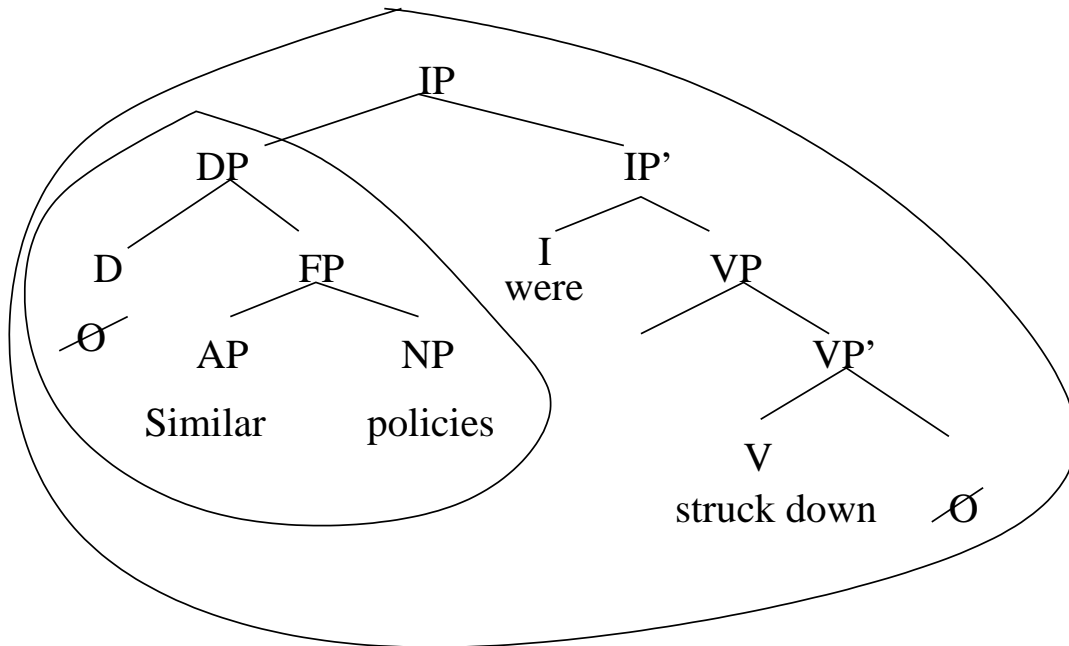
(a precipitous drop in his rating)

However, in the most recent proposals on DP structure, the adjective is outside the NP and thus Wrap-XP no longer requires that it is included in the same as the noun Phonological Phrase



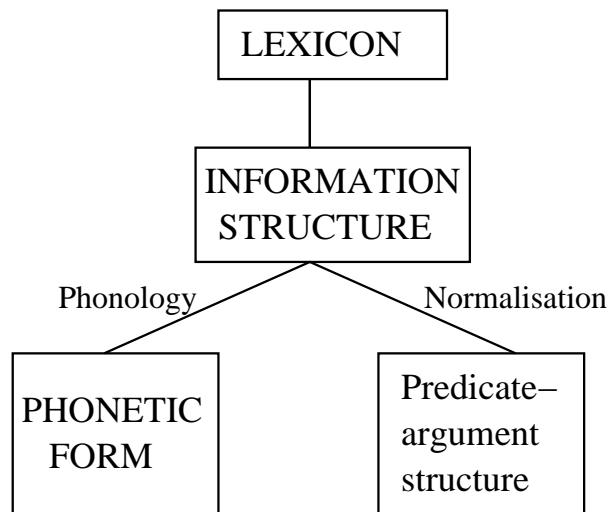
(a precipitous)(drop in his rating)

Constraints for NPs should be restated in terms of extended projections



(Similar policies)(were struck down), instead of
(Similar)(policies)(were struck down)

ARCHITECTURE OF CCG



[Steedman, 2000]

CCG THEORY OF PROSODY

- Pitch accents mark theme or rheme
 - $L^*+H, L+H^*$: THEME
 - $H, L, H^*+L, H+L^*$: RHEME

Theme-rheme distinctions are projected from pitch accents to Phonological Phrases by boundaries

- The partition of the utterance into PPs coincides with the partition into theme and rheme

(The device) _{θ} (is attached to a plastic wristband) _{ρ}
 $L+H^*$ $H_$ H^* $L-L\%$

IDENTIFYING INFORMATION STRUCTURE

In order to evaluate the theory, we had to identify Information Structure in complex sentences, which turned out to be quite difficult. The criteria used were:

- Referential status
- Contrast
- Linguistic marking

The level at which the distinctions between theme and rheme were made was clause-internal, whenever that was possible.

(But when the fetal protection policy took effect) θ_1 , (Green) θ_2 (
was transferred to a low lead area) ρ (Matrix level IS partition)

(But when the fetal protection policy) θ (took effect) ρ , (Green) θ (
was transferred to a low lead area) ρ (Clause internal IS partition)

(But when the fetal protection policy)(took effect),(Green)(was
transferred to a low lead area) (Phonological Phrase partition).

RESULTS

PBs PRED. CORR.	PBs PRED. INCOR.	PBs NOT PRED.
489	89	323

Evaluation of Steedman's theory for 167 sentences

Too many non predicted phrase breaks reflecting the contrast between a simple, binary IS organisation and a complex PP partition. For example:

in a context of *Marshall saying things*)

(Marshall says) θ (it would take about ten million dollars to equip the building for glass making with six furnaces operating round the clock to melt down truckloads of asbestos waste each day) ρ
(IS partition)

(Marshall says)(it would take about ten million dollars) (to equip the building)(for glass making)(with six furnaces)(operating round the clock)(to melt down)(truckloads of asbestos waste)(each day) (PP partition)

PITCH ACCENT DISTRIBUTION

- no obvious correspondence between pitch accent distribution and their proposed discourse marking function.

The policy also is humiliating says Joanne Leard

H* L*+!H L+H* L_L% H* L+H* L_L%

a union health and safety monitor who's worked at Johnson Controls for sixteen years

And Virginia Green says in her case the policy is infuriating

L+H* !H* L_ H* L_L% H* L+H* L_L%

- adjacent-discontinuous themes and rhemes

(Marcel gave) (a book) (to Fred)

L+H*LH% H*L L+H*LH%

(she lost) (incentive pay)

H*H_ H* L_L%

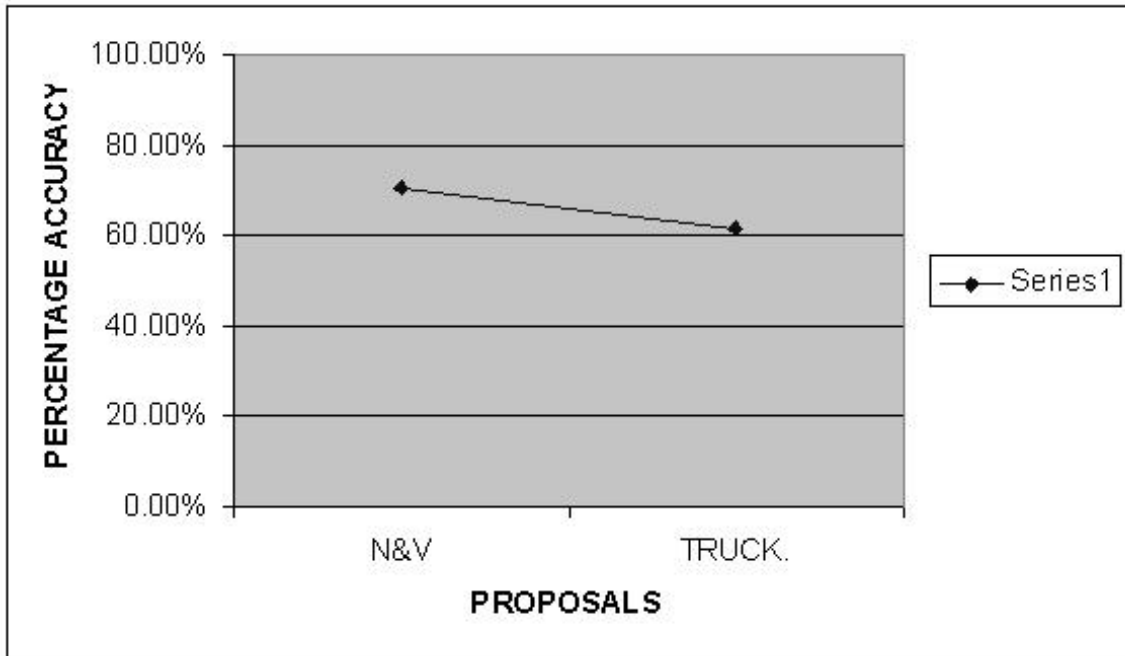
CONCLUSIONS

Information Structure Hard to evaluate its effect. There was, however, a significant mismatch between IS and PP partition.

Syntax The *phrase head* parameter was found to be the most important. Other distinctions such as the complement-adjunct distinction, which formed an important part of Truckenbrodt's proposal, did not seem to have a corresponding effect on Prosody

Length It was shown to influence Prosody, at least in the cases of SV structures and restructuring.

Nespor & Vogel's proposal It was shown to be the one that better predicts the phonological partition in the test corpus.



Percentage accuracy = $\frac{N-D-I}{N} 100\%$,
 where N is the number of phrase breaks in the corpus, D is the number of phrase breaks not predicted and I is the number of phrase breaks predicted incorrectly

FUTURE DIRECTIONS

- Test M.Steedman's proposal on less complex and dialogic texts
- Examine the role of length in more depth, especially in relation to balance. That is, the effect of length should be assessed on a syntagmatic level as well.
- Explore the possibility of adopting recursive structures, to account for cases where Truckenbrodt's proposal failed, e.g.
(The device)(is attached to a plastic wristband)
(The device)(is attached (to a plastic wristband)
- Examine the effect of different speech rate, speech style and different speakers.

TO SUM UP...AGAIN

For cases in which there is no clear effect of discourse structure (more like the default cases):

- Each clause is processed separately.
- The clause is then divided into Phonological Phrases according to Nespor & Vogel's definition of the PP domain. This definition should be stated in terms of an *extended projection* as far as noun projections are concerned.
- Restructuring of the Phonological Phrase may occur with respect to:
 - the length of the following Phonological Phrase
 - the lexical properties of the head (e.g. restructuring should occur *semantically light* verbs such as link verbs).