Research Paper

Prosodic Phrasing in Bangla: The Effect of Phrase Length and Speech Rate

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ABSTRACT: *The present study focuses on the effect of speech rate and the interaction of speech rate and phrase length on the prosodic organisation of utterances in Bangla. Drawing upon the idea of Prosodic Domains in languages and default phonological patterning of prosodic segmentation of utterances into rhythmic groups, the paper tries to shed light on the overriding factors such as syntactic phrase length and rate of speech on Prosodic phrasing. Declarative sentences of varied length, transitive and intransitive, have been examined and the observations denote the fact that with more casual and faster rate of speech syntactic boundaries does not correspond to prosodic boundary in Bangla. It also appears that the minimum requirement of words per P-phrase motivates the P-phrasing in Bangla rather than syntactic boundaries in few cases. Adjunct phrases, however constitute separate P-phrase and articles are phonologically null, therefore is always included in the preceding P-phrase.*
Keywords: Prosodic domain hierarchy, Prosodic Phrasing or P-phrasing, Speech rate, Syntactic phrase length

I.   INTRODUCTION

Prosodic phrasing has been known to be influenced by several factors such as syntax, focus, new information, phrase length and speech rate (Jun 1993, Ferreira 1993, Selkirk 1984). A prosodic phrase has been claimed to be predicted by the alignment of the left or right edge of a syntactic constituent with the edge of a prosodic unit, by the head-complement relation and the domain of a maximal projection, or by the branchingness of the constituents (Selkirk 1986, Nespor and Vogel 1986, Truckenbrodt 1999). However, faster speech rate and longer sequence of words in a phrase intervene into the default prosodic structure of the utterance. Studies on speech production and sentence processing have shown that prosodic phrasing determined by syntax is often overridden by the length of a phrase and speech rate. Hirose (1999) presents data from Japanese, sentences consisting of five or six words (i.e., single or double subject NP + object NP + adverb + verb + dative NP), where a major prosodic boundary occurs after a double subject NP, thus matching a syntactic boundary. But when the subject is a single NP, it comes after the object NP, mismatching a syntactic grouping. Moreover, the effect of length on phrasing would not be the same if the sentences were uttered fast or slow. It is known that a prosodic phrase tends to include more syllables at a fast rate and fewer syllables at a slower rate compared to those at a normal rate.

II.   THE PRESENT STUDY

The present study examines sentences of varied length and syntactic structure and tries to capture the systematic grouping of constituents into prosodic phrases in Bangla, an Indo-Aryan language. The paper also captures the effect of speech rate on the prosodic boundaries in the sentences and presents the interaction of syntactic phrase length and speech rate in determining the prosodic structure of the utterance.

Experiment conducted on the native speakers of Bangla with a three way distinction in speech rate; namely deliberate, near spontaneous and casual fast, clearly points out the effect of speech rate on the grouping of syntactic constituents into p-phrases. In deliberate speech, the phonological grouping of syntactic constituents strictly follows syntactic phrase boundaries. However in spontaneous and fast speech scenario rhythmic grouping does not follow syntactic boundary, instead, is presumably driven by the number of words that constitutes a sentence. It has been observed in the present experiment that the number of words that constitute a p-phrase is preferably two and maximum three. When the subject is monosyllabic or a single word, the tendency is to include the immediately following functional word within the p-phrase.

III.   THEORIES PROPOSED

Different models of syntax-phonology interface have been proposed to map phonological phenomena from its syntactic constituent structure. Chomsky and Halle 1968 proposes that there is some kind of rebracketing between Syntax and Phonology, which is the central hypothesis of the Prosodic Hierarchy Theory (Selkirk 1984), where syntactic component output constitutes the input to phonological constituent with the possible intervention of readjustment rules. Deriving from prosodic hierarchy and the strict layer hypothesis, the edge based theory (Chen 1987, Selkirk 1986, Truckenbrodt 1995), formulated within the framework of Generalized Alignment (McCarthy and Prince 1993), proposes alignment of syntactic categories to the left or right edge of the prosodic category. More recent works in the syntax-phonology mapping introduces the notion of phase and multiple spell out to argue for the default stress pattern observed in phrases resulting from prosodic spell out (Chomsky 2001, Dobashi 2003, Kratzer and Selkirk 2007, Kahnemuyipour 2009).

Two major theories of phonological phrasing are Relation-based theory (Nespor and Vogel 1986) and Edge based theory (Selkirk 1986).

The principles proposed for defining phonological phrase in the relation-based theory are as follows

Phonological Phrase Formation (Nespor and Vogel 1986:168)

a. φ *domain*

The domain of φ consists of a *C* which contains a lexical head (X) and all *C*s on its nonrecursive side up to the *C* that contains another head outside of the maximal projection of X.

b. φ construction

Join into an n-ary branching φ all Cs included in a string delimited by the definition of the domain of φ.

a.   φ relative prominence

In languages whose syntactic trees are right branching, the rightmost node of φ is labelled s; in languages whose syntactic trees are left branching, the leftmost node of φ is labelled s. All sister nodes of s are labelled w.

Here φ is a p-phrase and C is a clitic group.

For the syntactic structure: $[_{IP}NP_{Subj}Infl [_{VP}V NP_{Obj}]]$, we get the following p-phrases

$(NP_{Subj})φ (Infl V)φ (NP_{Obj})φ$

According to the optional restructuring rule proposed by Nespor and Vogel 1986,

φrestructuring(optional) (Nespor and Vogel 1986:173)

A nonbranching φ which is the first complement of X on its recursive side is joined into the φ that contains X.

Thus, $(NP_{Obj})φ$ may be restructured into the preceding p-phrase if it is nonbranching since it is the first complement of V on its recursive side:

$(NP_{Subj})φ (Infl V NP_{Obj})φ$

Selkirk (1986) proposes the Edge-based theory of syntax-phonology mapping (Selkirk 1995 and Truckenbrodt 1995, 1999 for the formulation of this theory within the framework of *GeneralizedAlignment*(McCarthy and Prince 1993). According to this theory, the right or left edge of a syntactic category is mapped to the right or left edge of a prosodic category. The following formulation is adopted from Truckenbrodt 1999:223, where φ is a p-phrase and XP is a maximal projection of a lexical category:

a. Align-XP, R: Align (XP, R; φ, R)

"For each XP there is a φ such that the right edge of XP coincides with the right edge of φ."

b. Align-XP, L: Align (XP, L; φ, L)

"For each XP there is a φ such that the left edge of XP coincides with the left edge of φ."

If we suppose that Align-XP, R is chosen in this language, the right edges of syntactic categories are mapped to the right edges of phonological phrases. Thus, the right edge of NP_{Subj} corresponds to the right edge of a p-phrase, and the right edge of VP, as well as that of NP_{Obj}, corresponds to the right edge of a p-phrase:

$(NP_{Subj})φ (Infl V NP_{Obj})φ$

Dobashi 2003 proposes a theory of syntax-phonology mapping within the framework of the Minimalist program claiming that a phonological string mapped to the phonological component by Spell-out corresponds to a phonological phrase. Unlike previous accounts Dobashi's hypothesis does not require particular mapping algorithm that creates a phonological phrase by referring to syntactic information such as maximal projection.

Studies on syntax-phonology mapping presuppose the fact that languages have prosodic constituents which can be derived and defined syntactically. Thus both edge based theory and relation based theory consider the subject noun phrase to constitute separate p-phrase. While this is reported to be true in languages if we assume there is a standard default pattern of phrasing, we cannot be sure whether the same pattern follows if we examine longer subject NPs. The present study looks at subject NPs which constitute four words and in that case the subject NP is not a single p-phrase and head of the NP has been observed to be phrased with the following VP.

IV.   PROSODIC PHRASING IN BANGLA

Hayes and Lahiri (1991) paper titled 'BengaliIntonational Phonology' is the first comprehensive work done on the BanglaIntonational System (Bangla spoken in Kolkata and its vicinity) using a descriptive framework developed by Pierrehumbert (1980) and others. The paper incorporates Beckman &Pierrehumbert's (1986) fundamental distinction between two types of tone: pitch accents and boundary tones. While pitch accents align to prominent syllables, boundary tones associate to the edges of prosodic, and by extension, phonological domains. Hayes &Lahiri's (1991) view of prosodic phrasing draws upon the theory of the Prosodic Hierarchy (Selkirk 1980, Nespor& Vogel 1986, Hayes 1989), which distinguishes several levels of prosodic structure both within individual words and groups of words.

Default P-phrasing(Hayes and Lahiri 1991)
a.   Every phonological word may be a P-phrase
b.   For two consecutive constituents X, Y: if
I.   X forms a legal P-phrase
II.   Y is a head c-commanding X
III. $Y \neq V$
Then [XY] may form a P-phrase.
P-phrasing is recursive: in a string of heads when each of which c-commands a maximal projection on its left, the whole string forms a single P-phrase.
For example,
$[[[[tɔk]_A [gur-er]_N]_{NP} [ǰonno]_P]_{PP} [durgɔndʰo]_N]_{NP}$
Sour   molasses   for   bad-smell
 'The bad smell of sour molasses'
P-phrase formation is optional at every stage, so the possibilities of forming P-phrases are as follows:
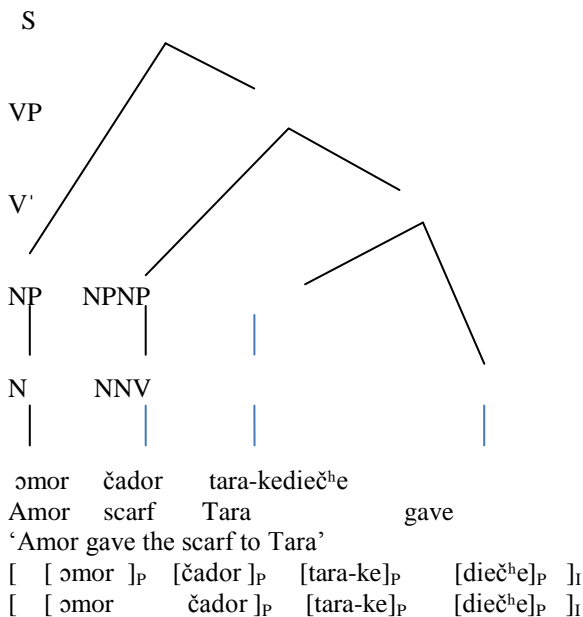**a.** $[tɔk]_P [gur-er]_P [ǰonno]_p [durgɔndʰo]_P$
b .$[tɔkgur-er]   [ǰonno]_P[durgɔndʰo]_P$
c. $[tɔkgur-erǰonno]_P [durgɔndʰo]_P$
d. $[tɔkgur-erǰonnodurgɔndʰo]_P$
To account for the variation in the structure of the above sentence from its syntactic structure depending on speech rate, Hayes and Lahiri proposes the rule of P-phrase restructuring.

P-phrase Restructuring
Where X and Y are consecutive permissible P-phrases, [XY] may form a P-phrase, provided the following conditions are met:
a.   X c-commands Y
b.   One of the following:
i.   Rapid speaking rate
ii.   X or Y is a non-initial constituent constituting old information in the discourse.

S

VP

V'

NP   NPNP

N   NNV

ɔmor   čador   tara-kediečʰe
Amor   scarf   Tara   gave
'Amor gave the scarf to Tara'
$[[ɔmor]_P [čador]_P [tara-ke]_P [diečʰe]_P]_I$
$[[ɔmor   čador]_P [tara-ke]_P [diečʰe]_P]_I$

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[[ɔmor]$_P$ [čador   tara-ke]$_P$ [dieč^{h}e]$_P$]$_I$
[[ɔmorčadortara-ke]$_P$ [dieč^{h}e]$_P$]$_I$

In the above example, if we take X to be *ɔmor* and Y to be *čador*, then in fast speech *ɔmorčador* may construct a P-phrase according to the rules of P-phrase restructuring.

Bruce and Lahiri (1991) have also argued in this paper that Bangla has true phonological rule of phrasal stress assignment applying in neutral focus contexts which is contrary to the view of Bolinger (1972) that says all phrasal stress assignment is non-phonological in nature, reflecting only semantic factors. In other words, Intonation in Bangla is phonological, not syntactic and the boundary tones link to purely phonological boundaries like]$_p$ and]$_I$, not syntactic boundaries like]$_{NP}$ or]$_S$. The evidences for this claim are given from two segmental rules in Bangla, namely /r/ assimilation and voicing assimilation. Hayes and Lahiri adopts the following stress rules which assign initial prominence to phonological phrases (P-phrase) and final prominence to intonational phrases (I-phrase).

I-phrase stress rule:
b. A P-phrase bearing narrow focus receives the strongest stress of its I-phrase.
c. Under neutral focus, the rightmost P-phrase within the I-phrase is the strongest.

P-phrase stress rule
Within the P-phrase the leftmost non-clitic word is the strongest.
Word stress rule
Stress the initial syllable of a word.

The study of Kawasaki & Shattuck-Hufnagel (1988) finds that high F0 and intensity do not serve as reliable cues to stress in Bangla. Two additional studies (Chatterji 1921, Anderson 1962) make a claim about phonetic correlates of Bangla stress, both stating that stress is often phonetically realized in conjunction with vowel lengthening. Although stress in Bangla appears to be phonetically weak, it is nevertheless phonologically salient. Bangla clearly does assign a special status to particular syllables, the initial syllable of native monomorphemic words, and normally also on borrowings and complex words. Even though the phonetic evidence for word stress is inconclusive, phonological evidence supports the word-initial stress analysis, as word-initial syllables have a special status in their ability to host a greater range of phonemic distinctions, and in their ability to resist alternations undergone by unstressed syllables (e.g. syncope, metathesis, diphthongization). In addition to this phonological evidence, the power of stressed syllables to attract postlexical tones away from prosodic edges confirms that Bangla words bear phonological stress, and the tones associated to phonologically stressed syllables are indeed pitch accents (Lahiri and Fitzpatrick 1999).

V.   HYPOTHESIS

Previous works on phonological phrasing have looked at mostly small (approx. 3 content words) sentences and have concluded that constituents within a p-phrase should be in a c-commanding relation. However, when length of the syntactic phrase and speech rate interact with the default pattern of phonological phrasing, the prosodic organization of the constituents do not follow syntactic structure. Phonological phrasing, in that case, is motivated by the number of content words within a p-phrase.

VI.   EXPERIMENT

In this paper we have designed an experiment to check the interaction of phrase length and speech rate in effect on phonological phrasing. We have examined altogether 17 declarative sentences, 4 intransitive sentences and 10 mono-transitive and 4 di-transitive sentences. The intransitive SV sentences with the verb 'come', ranges from the shortest 2 words to the longest 5 words in order to test the effect of the length of Subject NP. The transitives are divided into mono-transitive and di-transitive, monotransitive without adjuncts are small sentences(3 words) and monotransitive with adjuncts are examined to test the effect of the length of Object NP within VP and the effect of adjunction in a sentence. Sentences with the di-transitive verb 'give' show the pattern of p-phrasing in sentences with two internal arguments. A little variation in the length of Subject NP has been brought in to see the interaction of the Subject phrase with the verb phrase.

The 17 declarative sentences have been recorded in three different rate of speech. The slowest is deliberate speech which sounds close to reading out from a script, near spontaneous speech which is close to natural speech and Casual Fast speech is hurried, faster than the natural way of speaking.

a. Speakers

Three Standard Kolkata Bangla speakers have been recorded for the 17 sentences, 3 times for each trial, deliberate, near spontaneous and casual fast. The recordings are been judged by few other native speakers

of the language to confirm the naturalness of the recording. We have provided the speakers with different contexts for producing three different speech rate.

b. Data Set

Intransitive	Transitive		
	Mono-transitive		Di-transitive
	Without Adjunct	With Adjunct	
Singers have come	John ate apple	Ram saw a few students	The king gave a coin to Gopal
Famous singers have come	Mohima went home	Ram saw a few students with the professor	The king gave a gold coin to Gopal
Very famous singers have come	Roma called Romen	Ram saw a few students with the professor in canteen	The king gave gold coin to gopal
Very famous big singers have come		Ram's brother saw a few students	The king of Chittor gave a gold coin to Gopal
		Ram's brother saw a few students with the professor	
		Ram's brother saw a few students with the professor in canteen	

Table [1]

Sentences provided in the above set have been recorded in Bangla with the help of a microphone attached to the laptop and the analysis of the data is being done using PRAAT.

c. Data Analysis

In this section I have provided with bracketings the P-phrasing observed in the sentences systematically. Table [2] shows the P-phrase pattern in Intransitive sentences as observed in three different speech rate. Table [3] and [4] shows the Phrasing in Monotransitives and Di-transitives respectively.

Intransitive		
Deliberate speech	Spontaneous speech	Casual fast speech
ubN] [V]	[SubN V]	[SubN V]
[AdjSubN] [V]	[Adj] [SubN V]	[AdjSubN V]
[IntAdj] [SubN] [V]	[Int] [AdjSubN V]	[IntAdj] [SubN V]
[IntAdj] [AdjSubN] [V]	[IntAdj][AdjSubN V]	[IntAdj] [AdjSubN V]

Table [2]

Monotransitives		
Without Adjuncts		
Deliberate speech	Spontaneous speech	Casual Fast speech
[SubN] [ObjN] [V]	[SubN] [ObjN V]	[SubNObj N V]
With Adjuncts		
Deliberate speech	Spontaneous speech	Casual Fast speech
[Sub N][Adj][ObjN][V]	[SubN][Adj][ObjN V]	[SubN][AdjObjN V]
[SubN][AdjObjN][PP][V]	[SubN][AdjObjN][PP V]	[SubNAdjObjN][PP] [PP V]
[SubN][AdjObjN][PP][PP][V]	[SubN][AdjObjN][PP][PP V]	[SubNAdjObjN][PP][PP V]
[SubGen N][AdjObjN][V]	[SubGenN][Adj][ObjN V]	[SubGenN][AdjObjN V]
[SubGenN][AdjObjN][PP][V]	[SubGenN][AdjObjN][PP V]	[SubGenN][AdjObjN][PP V]
[SubGenN][Adj][ObjN][PP][PP][V]	[SubGenN][AdjObjN][PP][PP V]	[SubGenN][AdjObjN][PP][PP V]

Table[3]

Di-transitives		
Deliberate speech	Spontaneous speech	Casual Fast speech
SubN][ObjN Art][ObjN][V]	SubN][ObjN Art][ObjN V]	SubNObjN Art][ObjN V]
SubN][ObjN Art][AdjObjN][V]	SubN][ObjN Art][AdjObjN V]	SubNObjN Art] [AdjObjN V]
SubN][ObjN][AdjObjN][V]	SubN] [ObjN][AdjObjN V]	SubNObjN] [AdjObjN V]
SubGenN][ObjN Art][AdjObjN][V]	SubGenN][ObjN Art][AdjObjN V]	SubGenN][ObjN Art][AdjObjN V]

Table[4]

VII.   Observations

Below are listed the observations in three sections according to rate of speech. Each section talks about how syntactic phrases namely, Subject Noun phrase, object noun phrase, Verb phrase, Postpositional phrases are being treated prosodically with the variation in speech rate. As it has been reported in earlier studies on Japanese and Korean that the number of p-phrases per utterance reduces with the increase of speech rate, the present experiment supports the result and also shows the maximum number of content words per p-phrase is three. If

there are four content words in the sentence, the phonological phrasing maintains symmetry and forms two p-phrases out of four content words.

1. Deliberate speech
- In deliberate speech phonological phrasing strictly follows syntactic phrase boundaries. All XPs constitute separate p-phrase.
- Verb almost always form separate P-phrase in deliberate speech, which sounds somewhat like news reading.
- Other constitutents e.g. subject Noun or adjective or quantifier can form separate p-phrases when the sentence is short; in longer sentences, however, they can be put together to make a single p-phrase.
- Adjuncts form separate P-phrase; I have tested only PPs in adjuncts (Noun followed by a postposition). The post-position sounds cliticized with the preceding Noun.

2. Spontaneous speech
- In spontaneous speech phonological phrasing does not strictly follow syntactic phrase boundaries, instead can be driven by purely phonological reasons.
- Number of words within a p-phrase is maintained; two to maximum three words constitute a p-phrase; more than three words are not allowed.
- Adjuncts always form separate p-phrases. But if it is immediately preceding the verb, it includes the verb as well. e.g. [ram][a few students][Prof. with saw]
- Articles are phonetically reduced forms and are included with the preceding p-phrase.
 e.g. [king][Gopal-Infl Art][gold coin gave] vs. [King][Gopal-Infl][gold coin gave] .
- The subject NP tends to remain separate unless it's an article following,
 e.g. [Ram a] [spider saw] vs. [ram][a few][students saw]

3. Fast speech
- In fast speech phonological phrase boundaries do not match with syntactic phrase boundaries at all, it can be said to depend totally on the number of words within a p-phrase.
- Subject noun can be phrased together with the following constituents namely NPs which are part of VP, e.g. [ram a few students][professor with saw]
- In fast speech when the subject NP is big enough, e.g. [Ram's brother] is kept always together and separate. As the minimum requirement of words per p-phrase is fulfilled by the Subject NP.
- Adjuncts constitute separate p-phrase.
- When the number of words per phrase is not more than three, phrasing is somewhat similar as spontaneous speech, just the words are uttered faster and articles and postpositions are cliticized.
- So, probably we can conclude that in fast speech it seems important to maintain the minimum two words per phrase rule, three words will be preferred. If the NP has two constituent words make a separate p-phrase, if not then attach it with the following.

VIII.   DISCUSSION AND CONCLUSION

We hypothesized that in spontaneous and fast speech scenario syntax dependency of phonological phrasing radically reduces and it appears to be motivated by the number of words per phrase than the syntactic phrase boundary. A few examples can be sited to support the claim that in near spontaneous and casual fast speech syntactic bracketing is either partially maintained or not at all.

Mono-transitive (Bangla)
[rɑm]$_P$ [koekdzontʃʰɑtro-ke]$_P$ [prɔfesɑr-ersa̪tʰe]$_P$ [dekʰlo]$_P$ Deliberate
[rɑm]$_P$ [koekdzontʃʰɑtro-ke]$_P$ [prɔfesɑr-ersa̪tʰedekʰlo]$_P$ Spontaneous
[rɑmkoekdzontʃʰɑtro-ke]$_P$ [prɔfesɑr-ersa̪tʰedekʰlo]$_P$ Fast
Ram   a few   students   professor   with   see
'Ram saw a few students with the professor'

Ditransitive (Bangla)
[radʒa]$_P$ [gopal-keekta]$_P$ [ɕonɑrmohor]$_P$ [dilo]$_P$ Deliberate
[radʒa]$_P$ [gopal-keekta]$_P$ [ɕonɑrmohordilo]$_P$ Spontaneous
[radʒagopal-keekta]$_P$ [ɕonɑrmohordilo]$_P$ Fast
 King   Gopalagold coin   give
'King gave a gold coin to Gopal'

From the examples cited above it can be said that in deliberate speech the phonological phrase boundary can be mapped from the syntactic phrase boundary. If we compare the spontaneous and fast speech data we get that syntactic boundary is not maintained and the number of p-phrases is reduced with the increase of speech rate. In spontaneous speech even though the subject is small it is kept separate, so the requirement for minimum two words per p-phrase can be violated in spontaneous speech. But in case of fast speech, Subject noun can be phrased together with the VP. What shows more clearly the minimum requirement of words per phrase as two in fast speech is the following.

If we compare the two sentences in fast speech

1. [radʒagopal-keekta]ₚ [ɕonɑrmohordilo]ₚ   Fast
 King   Gopala gold   coin give
        'The King gave a gold coin to Gopal.'
2. [tʃitor-erradʒa]ₚ [gopal-keekta]ₚ [ɕonɑrmohordilo]ₚ   Fast
Chittor's king   Gopal   a   gold coin give
        'The king of Chittor gave a gold coin to Gopal.'

In sentence (1), the subject NP is small, thus constitutes a single p-phrase with the following Object Noun. Sentence (2), the subject NP fulfils the minimum requirement of words in a p-phrase, thus qualifies to constitute a p-phrase on its own.

Similarly,

1. [ramkoekdzontʃʰatro-ke]ₚ [prɔfesɑr-ersaʈʰedekʰlo]ₚ
    Ram a few   students   professor with see
    'Ram saw a few students with the professor.'
2. [ram-erbʰɑɪ]ₚ [koekdzontʃʰatro-ke]ₚ [prɔfesɑr-ersaʈʰedekʰlo]ₚ
    Ram's brother a few   students   professor   with see
    'Ram's brother saw a few students with the professor.'

Other longer sentences recorded in the present experiment with two adjuncts show that adjunct phrases, which are PPs in our case, are treated differently. Adjunct phrases constitute separate p-phrase. However, if an adjunct phrase is immediately followed by a verb, the p-phrase can include the verb as well.

[ram-erbʰɑɪ]ₚ [koekdzontʃʰatro-ke]ₚ [prɔfesɑr-ersaʈʰe]ₚ [kæntɪn-e dekʰlo]ₚ
Ram's brother a few   students   professor with   canteen   see
'Ram saw a few students with the professor in Canteen'

Thus summarises the findings of the present study. However, to get a more generalised and detailed picture of the effect of speech rate on prosodic phrasing, we need to examine more data considering various aspects of syntactic structure and speech prosody.

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