THE DISTRIBUTION PATTERN OF PAUSES IN LECTURE-STYLE SPEECH

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1 Introduction

Spontaneous spoken discourse seems often formless when it is written, even if the original speech was quite sensible to the participants. This is mainly because such speech was not meant to be written, it was meant to be heard. Spoken discourse is understood by hearing, which includes hearing of both segmental and prosodic features. Investigating these prosodic features in natural speech is of great interest, because comparatively little is known about their characteristics. In this paper, we use pause phenomena as a basis for building an analysis of chunking in spoken discourse and investigate the incidence of pauses at different syntactic boundaries in order to find some regular pattern of distribution.

2 Material and Method of Measurement

The speech material was a recording of a videotaped lecture of about 280 seconds duration (T.I.T. 1987).
The material was computer-analyzed on a High-Speed Speech Analysis System (Imagawa 1989). Measuring the duration of pauses, silences longer than 0.15 seconds were identified as unfilled pauses. In the case of filled pauses, we simply measured the duration of the sound.

We found three types of hesitation in the material.
(1) unfilled pauses: silence
(2) filled pauses: speakers uttered conventional 'planning markers' at the end / beginning of an utterance.
(3) combinations of the above : filled pauses occurred adjacent to unfilled pauses.
We treated these three types of hesitation as pauses in our analysis.

3 Statistical Characteristics of Pauses

Table 1. Number of Occurrences of Pauses

	<0.4sec	<1.0sec	<1.1sec<	total	min.	max.
unfilled pauses	27	21	0	48	0.15sec	1.7sec
filled pauses	12	4	0	16	0.1sec	0.9sec
combination type	7	31	23	61	0.3sec	3.9sec
	46	56	23	125		

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Table 1 shows the number of occurrences of the three types of pauses. Filled pauses were few in number and comparatively short. Unfilled pauses were relatively shorter than the combination type.

We may divide the varieties of spoken language into two groups.
(1) loud-reading: a speaker reads aloud a written text
(2) spontaneous speech:
    (a) conversation: participants talk in turn
    (b) lecture-style speech: a speaker makes a spontaneous speech before a group of hearers

Sugito (1987,1989) reported on the characteristics of pauses in two different styles of spoken discourse: part of a TV newscast (70 seconds) and a monologue from a natural conversation (77 seconds). Sugito's materials and our material can be considered as examples of (1), (2)(a) and (2)(b), respectively. To discern the different characteristics among these speech styles, we made comparison of the data.

Table 2. Speaking / Reading Rate (morae / sec.)

The figures in the top line indicate the sentence number of the lecture and the newscast, or the paragraph number of the conversation. The data from the newscast and the conversation are cited from Sugito(1989), except for the average rate.

	1	2	3	4	Avg.
lecture	8.6	7.5	8.6	9.1	8.5
conversation	8.3	8.8	8.0		8.4
newscast	8.8	9.0	8.6		8.8

Table 3. Proportion Pauses to Utterances in Speech

U:utterance, P:pause

	U :	P	(unfilled p.:	filled p.)
lecture	63%	37%	26%	11%
conversation	68%	32%	25%	7%
newscast	77%	23%	23%	0%

Table 4. Average Duration of Utterances and Pauses

	utterance	pause
lecture	1.37sec	0.78sec
conversation	1.08sec	0.51sec
newscast	0.96sec	0.28sec

Sugito originally classified unfilled pauses as utterances
instead of pauses. We recalculated Sugito's data so that we could
make a direct comparison among the speech styles. These data are
given in Table 3 and Table 4 .

The average reading rate of the newscast was faster than
the average speaking rate. The proportion of pauses was greater
in spontaneous speech than in reading aloud. This difference was
due to the high degree of filled pauses in spontaneous speech,
especially in the lecture, where the speaker could / had to speak
alone. The average duration of the utterances and pauses were
shortest in the newscast. In spontaneous speech styles, both the
pause intervals and the duration of pauses were longer in the
lecture.
We can summarize the differences among the speech styles
as below. In the newscast, the speaker read the text without
filled pauses, pausing at relatively short intervals. However, in
the spontaneous speech, filled pauses occurred frequently, and
the pause intervals were longer. The proportion of filled pauses
was greater in the lecture than in the conversation.

4 Syntactic Boundaries and Pauses

4.1 Definition of 'Build-up' Phrases

In order to make a constituent-based syntactic analysis, we
defined 'build-up' phrases ('bunsetu', the smallest constituent
unit of a clause) in the following manner.

(1) ordinary build-up phrases: a free form, or a free
    form   and   one or more bound forms.

We regarded the following compound forms as bound forms.
(2) postpositions: ni-tuite, ni-yotte, ni-totte, ni-sitemo,
                          to-yuu
(3) bound auxiliaries: de-aru, wake-da, noda

We treated the following compound forms as build-up
phrases.
(4) verbal compounds: site-iru, site-iku, site-kuru, site-
                      aru, site-miru, site-simau, sureba
                      ii, siyoo to suru, sitai to omou
(5) phrasal verb: ki ga tuku

To apply the above definition, we used the criteria given
in "Hanashikotoba no Bunkei"(1964).

4.2 Varieties of Syntactic Boundaries

We examined the incidence of pauses at the following syn-
tactic boundaries.

(1) sentence boundary

(2) clause boundaries
We treat following as clauses.
  (a) subordinate clauses: Minami(1974)'s ' third
     level' clauses.*
  (b) adnominal clauses ('rentai setu')
  (c) quasi-quotative clauses preceding the particle 'to-
     yuu': e.g., the underlined part of 'natu <u>ga</u> <u>kuru</u>
     to-yuu koto'
  (d) quotative clauses preceding the particle 'to' or 'to-
     yuuhuuni' before quotational verbs.
  (e) thematized clauses preceding the demonstratives
     'kono, sono, kooyuu etc.': e.g., the underlined part
     of '<u>natu</u> <u>ga</u> <u>kuru</u>, sooyuu kehai ga'(not found in the
     material)

Numbers (3) to (6) below were phrase boundaries within clauses.

(3) after sentence openers:
  (a) after conjunctives
  (b) after some adverbs ('tumari' and 'tatoeba' in the
     material)
(4) after independent words ('dokuritugo'):
  (a) after interjectives ('nanda' and 'kimi' in the mate-
     rial)
  (b) after thematized unmarked noun phrases: e.g., the
     underlined part of '<u>tuyu</u>, kono uttoosii kisetu'
(5) right-branching phrase boundaries: the phrase before the
    boundary did not modify the phrase that came directly
    after it
(6) left-branching phrase boundaries: phrases before a
    boundary which modified the phrases following
    directly

Since we found some pauses occurring inside build-up phrases, where we do not expect pauses normally, we settle (7).
(7) inside build-up phrases
  (a) between nouns and postpositions
  (b) between verbs and bound auxiliaries

NOTE * Minami identified four levels in the generative process of a sentence. He defined subordinate clauses morphologically and classified them into three groups from the modal and syntactic points of view: first , second and third level. Roughly speaking, first level subordinate clauses are structurally the least free and the most dependent, whereas third level subordinate clauses are the most free and independent. Third level clauses are clauses with infinitive predicates ('rennyo-okei') or conjunctive particles ('te', 'ga', 'keredomo' in the material).

5 Results

5.1 Syntactic Boundaries and Pauses

We examined the pause phenomena from a probabilistic point of view. Table 5 shows the number of syntactic boundaries found to be followed by pauses, and the incidence of pauses at each boundary type. The table does not contain the following cases.

(1) Phrases before a boundary which was eventually not followed by a clause containing a modified element.
(2) Phrases before a boundary where there were two apposi-tional phrases which followed immediately and modified by the preceding phrase.
(3) When the speaker corrected one or more elements of the preceding phrase immediately after a boundary. e.g., 'eigo wo # de kuroosite-korareta kata'('#' indicates the boundary)
(4) When the phrase preceded a filled pause which was obvi-ously an expression indicating the subject was search-ing words.

Table 5. Syntactic Boundaries and Post-boundary Pauses

syntactic boundaries	no. of pause occurrences	no. of cases	incidence
sentence	20	22	90.9%
subordinate cl.	13	19	68.4%
adnominal cl.	3	7	42.8%
quasi-quotative cl.	0	5	0.0%
quotative cl.	5	12	41.6% *
conjunctives	1	8	12.5%
'tumari,tatoeba'	3	5	60.0%
interjectives	0	2	0.0%
thematized unmarked NP	0	1	0.0%
right-branching ph.	32	76	42.1%
left-branching ph.	22	131	16.0%
inside ph.			
(a) noun / post.			
N / no	3	44	6.8%
N / ni	1	14	7.1%
(b) verb / bound aux.			
V / noda	3	6	50.0%

NOTE * In the case of quotative clauses, we included pauses after the case marker 'to' in 'post-boundary pauses'.

Pauses most regularly occurred following sentence bound-aries. Other syntactic boundaries which gave about a fifty per-cent probability of post-boundary pauses were: subordinate clause boundaries, adnominal clause boundaries, quotative clause bound-aries and right-branching phrase boundaries. We will investigate

the conditions which controlled the occurrence of pauses at these boundaries in the following sections.

5.2 Morphological Conditions

Was the incidence of pauses related to the differences of word forms? Table 6 shows some morphological conditions of clause boundaries. As to subordinate clauses, we could not find any relevant morphological conditions; pause phenomena therefore do not seem related to differences in conjunctive particles.

Table 6.   Morphological Conditions of Clauses

syntactic boundaries	incidence of pauses	morphological conditions	no. of p. occ. /no.of cases
subordinate cl.	68.4%	no relation	
adnominal cl.	42.8%	before nouns	3/3*
		before postadnominals	0/4
quotative cl.	41.6%	before case marker 'to'	2/9**
		ellipsis of 'to'	3/3

NOTE *postadnominals ('keisiki meisi'): 'toki' 0/1, 'tokoro' 0/1, 'kata' 0/2
   **with case marker: 'to' 1/8, 'to-yuuhuuni' 1/1.
   ellipsis of 'to': '0' 1/1, 'yuuhuuni'   2/2.

5.2.1 Adnominal Clauses

When the head nouns were postadnominals, no pauses appeared after the clauses, and when the head nouns were ordinary nouns pauses occurred after the clauses. The difference between postadnominals and ordinary nouns is that, not having much lexical meaning, postadnominals need some adnominal modification in sentences, while ordinary nouns can be used without modification.

An adnominal clause modifies the head noun and the whole noun phrase becomes a constituent of a clause. We do not usually expect a post-boundary pause between adnominal modification and its head noun, whether the head noun is a postadnominal or an ordinary noun. To know whether this phenomenon was characteristic of the lecture style of speech or not, further study will be needed.

5.2.2. Quotative Clauses

Quotative clauses occur under different kinds of conditions. The speaker may pause after the clause when he does not say the case marker 'to'. In some Japanese dialects, this ellipsis of 'to' is popular. However, our subject speaker belonged to a dialect which does not have 'to' ellipsis, and his ellipsis

occurred only when a pause followed the clause. We can conclude that such pauses appeared as compensation for the ellipsis of the case marker and represented the termination of the quotative clause in the flow of speech. This coincidence of ellipsis and pauses should be examined across speakers of other lecture materials we have collected.

5.3 Length of Clauses

In this section, we examine 'length' factors. One kind of length is the length of a clause. Another kind of length is the length of a string of speech segmented by pauses.

Six out of nineteen subordinate clauses were not followed by post-boundary pauses. We compared the average length of
    (1) subordinate clauses without post-boundary pauses,
    (2) subordinate clauses which had only post-boundary pauses,
    (3) subordinate clauses which contained and followed by
       pauses.

Two of the six subordinate clauses without post-boundary pauses had pauses within themselves. To make the comparison clearer, we excluded these two cases.

Table 7.   Length of Subordinate Clauses   (morae)

	subord. clause	resultant sentence	segmented string
sub.cl. without pauses	14.7	34.7	18.8
sub.cl. with post-b. pauses	31.0	100.2	31.0
sub.cl. with pauses	55.5	133.7	9.9
Average	39.5	102.2	12.9

Subordinate clauses without post-boundary pauses were significantly shorter than other subordinate clauses. In these cases, the resultant complex sentences were also short and had only post-boundary pauses. Despite the comparative briefness of the subordinate clauses with only post-boundary pauses, the total length of the complex sentences was about average . From these facts, we can say that if a sentence was short, the whole sentence could be uttered as a string, and pauses did not occur after subordinate clauses. Otherwise, if there were pauses in complex sentences, most normally pauses occurred following subordinate clause boundaries.

As to the length of a segmented string, we could not observe a general tendency. The average length of a segmented string was 12.9 morae. However, pauses do not seem to occur at regular intervals in natural speech.

5.4. Right-Branching Phrase Boundaries

Table 8 shows the varieties of right-branching phrase boundaries and the incidence of pauses at each boundary. The boundaries at which pauses occurred with more than a fifty percent probability were: appositional phrase boundaries, second level clause boundaries and the noun-phrase boundaries of 'NP wa', 'NP ga', 'NP ni'. We investigated the conditions of appositional phrases and 'NP wa' for this paper and will not discuss here conditions regarding other boundaries.

Table 8. Pauses at Right-Branching Boundaries

syntactic boundaries	no.of pause occurrences	no. of cases	incidence
appositional ph.	5	9	55.5%*
first level cl.	0	1	0.0%**
second level cl.	6	11	54.5%***
NP wa	8	16	50.0%
NP ga	3	4	75.0%
NP wo	1	4	25.0%
NP ni	4	8	50.0%
NP no	0	1	0.0%****
NP + other postpositions	1	3	33.3%
unmarked NP	2	3	66.6%
adverbs	2	12	16.6%
conjunctions	0	2	0.0%
adnouns('rentaisi')	0	2	0.0%
	32	76	42.1%

NOTE * 'Appositional phrase boundary' indicates the boundary between appositional phrases.
** In Minami's classification.
*** In Minami's classification.
**** 'NP no' Nominative

Table 9. Appositional Phrases

(no. of occurrences of pauses/number of cases)
J: Japanese, E:English

	J-E	J-J	total
with modification	3/3	1/2	4/5
without modification	1/1	0/3	1/4
total	4/4	1/5	5/9

5.4.1 Appositional Phrases

Here, we observed two conditions. When one of the apposi-

tional phrases was Japanese and the other was its' English equiv-
alent, pauses always occurred between the phrases. When there
was a preceding phrase that modified both of the appositional
phrases, four out of five cases had pauses between the phrases
(see Table 9).

5.4.2. NP wa

'NP wa' represents the theme of a clause and appeared syn-
tactically in sentences, subordinate clauses and quotative
clauses in the material. Table 10 shows the distribution pattern
of the pauses after 'NP wa'. We excluded one case from the table
that did not have a corresponding predicate at all because of
the speaker's reformation of the sentence.

We employed two factors to clarify the distribution of
pauses:
    (1) Whether the 'NP wa' had a predicate only in the same
        clause or not.
    (2) Whether the 'NP wa' had a negative predicate or not.

Table 10. NP wa

(no. of occurrences of pauses/number of cases)

	pred. not in the cl.	pred. in the cl.	total
affirmative pred.	2/2	3/10	5/12
negative pred.	1/1	2/2	3/3
total	3/3	5/12	8/15

Pauses always occurred after the phrase boundary under two
conditions.
    (1) When the 'NP wa' had a predicate (also) in a different
        clause.
    (2) When the 'NP wa' had a negative predicate in the clause.

When 'NP wa' was the theme of an affirmative clause, the
incidence of pauses became low. These 'NP wa's' with pauses
appeared in clauses where nearly every NP or VP group had a
following pause (three cases).
 case 1: the clause consisted of two NPs and a VP
       with three pauses
 case 2: the clause consisted of three NPs and a VP
       with four pauses
 case 3: the clause consisted of two NPs and a Vp
       with four pauses
    We can assume that if there are pauses in clauses with an
affirmative predicate, one of them is likely to occur after 'NP
wa'.

Pauses did not occur after 'NP wa' in seven cases, which should be divided into two groups.

(1) The whole clause was uttered as a string and did not have pauses (four cases). These clauses were shorter than clauses which had pauses in . (Avg. 25.2 morae vs. 44.2 morae)

(2) Pauses occurred following other phrasal boundaries in the sentences (two cases).

case 1: a pause occurred after a first-level clause boundary which followed an 'NP wa'.

case 2: a pause occurred after an 'NP ga' which followed an 'NP wa'.

These two cases violated the regular distribution pattern of pauses. When there were pauses in eight out of eleven clauses, a pause occurred after 'NP wa'. We do not have an explanation for this finding now, since ' speaker's intention' is not within the scope of this paper.

We had one more case without post-phrasal pauses. This case was in a particularly disfluent sentence and we can hardly discern any regularity in it.

6 Discussion

Investigating the incidence of pauses at several syntactic boundaries, we observed some regularities in the distribution of pauses. From a probabilistic approach, pauses occurred regularly at the following boundaries.

1. sentence boundaries
2. subordinate clause boundaries
3. after 'NP wa', when its predicate was not in the same clause
4. after 'NP wa', when it had a negative predicate in the same clause

As to adnominal clauses and quotative clauses, we observed some morphological conditions controlling pause occurrences. A comparison across speakers will be needed to see whether these conditions are idiosyncratic or not.

Length factors are not clear yet. We observe that clauses are relatively short when pauses do not occur after the syntactic boundaries at which they are likely to occur. Even though these clauses are short, as clauses, they are often longer than the average length of a speech segment. Pauses do not seem to occur at regular intervals in spontaneous speech.

If there was some distribution pattern in lecture-style speech, was there some rank among syntactic boundaries?

When complex sentences had pauses in them, 13/15 cases had pauses after their subordinate clauses.

When clauses had pauses, 8/11 cases had pauses after 'NP wa'.

There was a case in which the only pause in the clause occurred after the 'NP wa', but, there are not cases found in the material in which the only pause occurs after 'NP ga', 'NP wo' or 'NP ni'.

These facts suggest that there was a rank among syntactic
boundaries after which pauses may occur. We are going to examine
other syntactic boundaries we have not yet discussed in this
paper to clarify the 'default' distribution pattern of pauses
and ranks among syntactic boundaries.

Acknowledgements

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