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SYNTACTIC STRUCTURES AND PROSODY IN JAPANESE: A STUDY ON PITCH CONTOURS AND THE PAUSES AT PHRASE BOUNDARIES*

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Abstract

Fifteen types of utterances spoken by a professional male announcer, consisting of noun phrases and declarative sentences in Japanese, were analysed and examined to elucidate the relationships between syntactic constructions and the prosody, focusing on the pauses at phrase boundaries. The result revealed that the use of different length reflected the hierarchical relationships in the surface structure of a given utterance, such as the relationship of main sentence to subordinate clause. In addition, the result suggests that the pauses share this role with the pitch contours, which likewise contribute to the identification of the clause initial boundaries in a given phonological sequence.

1. Introduction

Semantic content is conveyed in speech not only by means of the syntactic configurations of phrases and clauses but also by the use of prosodic components such as intonation contours and pauses. Moreover, whether or not a sentence sounds natural and is intelligible aurally depends greatly on the appropriate use of prosodic features.

In our previous studies (Uyeno et al. 1979 and 1980), intonation contours used in complex declarative sentences in Japanese were examined from the point of view of comprehension and production. In these studies, it was shown that the pitch contour assigned to a relative clause differs significantly depending on

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whether that clause is located at the sentence initial position or it is center-embedded in a matrix sentence. When a relative clause is center-embedded, and the surface matrix sentence is potentially ambiguous, the intonation was shown to be fully responsible for disambiguation.

In these previous studies, we confined ourselves to the study of pitch contours, and left the issue of pauses untouched. The purpose of the present study, therefore, is to clarify the actual use of pauses in different syntactic structures, and to see if there is any relationship between the use of pauses and intonation contours.

As is well known (Greenberg, 1963), Japanese is an SOV language. The basic surface word order locates predicates at a clause-final position, post-positions after noun phrases, and subordinate phrases and clauses directly before the elements they modify. We may, therefore, regard a phrase or a clause in Japanese as syntactically marked at the end but not at the beginning. In a relative clause, for instance, a relative pronoun does not occur, and the structure can be interpreted only when the head noun immediately after the clause final predicate in a tensed form has been identified.[1]

It is assumed to be essential in comprehension of sentences to identify clause boundaries in the given phonological sequence and to reconstruct the hierarchical relationships among them in order to grasp the semantic content of the sentence. The predicate should play an important role in identification of a clause by indicating the clause final boundary. Intonation contours, on the other hand, should mark the clause initial boundary by a high rise in pitch. Then, one may delve into the question of how the pauses contribute to this issue.

In the present study, when pauses were examined, only pause length was measured and other factors such as pre-pause vowel lengthening or the shift in the quality of pre-pause vowels were neglected.

2. Materials and Methods

Recorded Material

Japanese phrases and sentences read in a natural speech style

by a professional male announcer who is speaker of the Tokyo dialect were recorded in a sound-proof room. Items recorded were the following (1) through (15) in Table 1.[2] Each of them was uttered separately three times at normal speed.

Table 1 Table 1 Items recorded and examined

(1)
A Z B C D
Akira to [Eizi no imooto no] Hanako
a b c
and sister of
'Akira and Hanako, Eizi's sister'

(2)
A Z B C D
[Akira to Eizi no imooto no] Hanako
a b c
and of sister of
'Hanako who is the sister of Akira and Eizi'

(3)
A Z B C
Emerarudo to [daiya o tiribameta] ookan o nusunda
a b c d
emerald and diamond set crown stole
'(He) stole an emerald and a crown set with diamonds.'

(4)
A Z B C
[Emerarudo to daiya o tiribameta] ookan o nusunda
a b c d
emerald and diamond set crown stole
'(He) stole a crown set with emeralds and diamonds.'

(5)
A Y B Z C
Yamada wa kaisan ni hantai-si [senkyo-ku ni kaetta]
a b c
dissolution oppose voting district to returned
D
Suzuki o kainin-sita
d
dismissed
'Yamada opposed the dissolution and dismissed Suzuki who returned to the voting district.'

(6)
A Y B Z C
Yamada wa [kaisan ni hantai-si senkyo-ku ni kaetta]
a b c
dissolution oppose voting district returned
D
Suzuki o kainin-sita
d
dismissed

'Yamada dismissed Suzuki who opposed the dissolution and returned to his voting district.'

(7)
A Y B Z C D
Oo wa utagai-bukaku [kenseeyoku no tuyoi] oohi o osorete-ita
a b c d
king suspicious lust for power strong queen was afraid
'The kind was suspicious and afraid of the queen who had a strong lust for power.'

(8)
A Y B C D
Oo wa [utagai-bukaku kenseeyoku no tuyoi] oohi o osorete-ita
a b c d
king suspicious lust for power strong queen was afraid
'The kind was afraid of the queen who was suspicious and had a strong lust for power.'

(9)
A Y B Z C D
Ototoi Oosaka de [nusumi o hataraita] otoko
a b c
day before yesterday in Osaka stealing dis man
ga tukamatta
d
was caught
'A man who did some stealing was caught in Osaka the day before yesterday.'

(10)
A Y B Z C D
Ototoi [Oosaka de nusumi o hataraita] otoko
a b c
day before yesterday in Osaka stealing did man
ga tukamatta
d
was caught
'A man who did some stealing in Osaka was caught the day before yesterday.'

(11)
A Y B Z C D
[Ototoi Oosaka de nusumi o hataraita] otoko
a b c
day before yesterday in Osaka stealing did man
ga tukamatta
d
'A man who did some stealing in Osaka the day before yesterday was caught.'

(12)
A Z B
Ano ko ga aruite ano ko ga koronda.
a b c
that child walk that child fell
'That child walked and that child fell.'

(13)
A Z B
Ano ko ga aruita. Ano ko ga koronda.
a b c
that child walked that child fell
'That child walked. That child fell.'

(14)
A Y B Z C
Ototoi [aruita] ano ko ga koronda.
a b c
day before yesterday walked that child fell
'That child who walked fell the day before yesterday.'

(15)
A Y B Z C
[Ototoi aruita] ano ko ga koronda
a b c
day before yesterday walked that child fell
'That child who walked the day before yesterday fell.'

(1) through (15) above have the following syntactic characteristics which are of interest in this study.

Noun phrases (1) and (2) contain the same chain of words, and each contains a subordinate phrase enclosed in the square brackets, which modifies the immediately following noun, Hanako. The scope of subordinate phrases differs in each case as the square brackets indicate. The subordinate phrase is located in between the two main noun phrases in (1), that is, it is center-embedded; conversely, the subordinate phrase of (2) occupies phrase-initial position and is simply left-branching.

Sentences (3) contains the same chain of words as sentence (4), and each contains a relative clause enclosed in the square brackets, which modifies the immediately following noun, ookan 'crown.' In (3), the relative clause is center-embedded in the matrix sentence, while it is simply left-branching in (4).

Again, sentences (5) contains the same chain of words as sentence (6), and each contains a center-embedded relative clause enclosed in the square brackets, which modifies the immediately following noun, Suzuki. In (5), the matrix sentence is constructed

of two clauses coordinately conjoined, and the second clause contains the relative clause. In (6), on the other hand, the relative clause contains two coordinately conjoined clauses.

Once more, sentences (7) contains the same chain of words as (8), and each contains a center-embedded relative clause enclosed in the square brackets, which modifies the immediately following noun, oohi 'queen.' In (7), two coordinately conjoined clauses constitute the matrix sentence, and the relative clause belongs to the second clause as is the case in (5). In (8), on the other hand, the relative clause is composed of two coordinately conjoined clauses, which, as a unit, modify the object noun phrase of the matrix sentence, as is also the case in (6).

Sentences (9), (10) and (11) contain the same word sequence, in which the first two phrases in each case are a time adverbial and a locative adverbial, respectively. The relative clauses enclosed in the square brackets modify the immediately following noun otoko 'man.' In (9), the relative clause is center-embedded and preceded by the two adverbial phrases of the matrix sentence. In (10), the relative clause is also center-embedded, but it includes in addition the locative phrase within its domain; thus, it is preceded only by the time adverbial phrase of the matrix sentence. In (11), the relative clause includes both the time adverbial and the locative phrase, and is simply left-branching.

Items (12) and (13) contain a sequence of words which is identical in each case except for the verb forms of the first verb phrase. Sentence (12) is a coordinately conjoined construction, and the verb form aruite 'walk (and)' is a conjunctive verb form. By contrast, in (13), two separate sentences occur. The verb form aruita 'walked', therefore, simply functions as the main verb of the first sentence.

Sentences (14) and (15) each contain the same chain of words, including in each case a relative clause enclosed in the square brackets, which modifies the immediately following noun ano ko 'that child'. The adverbial phrase ototoi 'the day before yesterday', which occurs at the beginning of each sentence, is a constituent of the matrix sentence in (14) and of the relative clause in (15). The relative clause, therefore, is center-embedded in (14), while it is simply left-branching in (15).

Analysis of the Fundamental Frequency

Using the recorded matrials described above, the fundamental frequency of the speech signal for each example was analysed. The speech signals were lowpass-filtered to 5 kHz, sampled at 1 kHz and digitized in 10 bits. PARCOR analysis was made every 6.4 msec. for Hamming-windowed speech of 19.2 msec. The order of the analysis was 12. Voiced/unvoiced judgment was performed based on the values of the maximum peak in the autocorrelation function of the residual wave for a period of 38.4 msec. In the case where it was judged 'voiced', the pitch period was determined by detecting the location of the maximum peak in a range of 2.5 msec to 16 msec, in the autocorrelation function of the residual wave.

Methods

For all the tape-recorded materials of items (1) - (15), speech envelopes were obtained from ocillograms, as exemplified in Fig. 1, and the pitch contours were extracted by the analysis of the fundamental frequency, as shown in Fig. 2. Ocillographic data were used to measure the pauses, while the extracted pitch contours were used to measure the fundamental frequency.

The letters marking items (1) - (15) indicate the places where the fundamental frequency and the pauses were measured. To be precise, the upper-case letters A, B, C and D indicate where the highest pitch frequency was found within the corresponding phrases, and the letters Z and Y indicate the phrase final portions where the lowest frequency was observed within the corresponding phrases. The lower-case letters, mark the phrase boundaries where pauses were measured. When pauses are followed by voiceless consonants, pauses are measured to include the voiceless portion of those consonants.

Fig. 1 shows a portion of an occillogram. The lower-case letter a indicates the point of pause measurement.

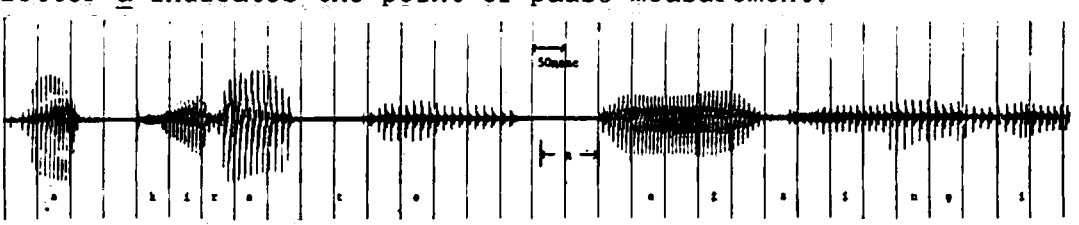


Fig. 1 Occilogram used for the measurement of pauses

Fig. 2 exemplifies the extracted pitch curves where the letters A, B, C, D and Z indicate the points of pitch measurement.

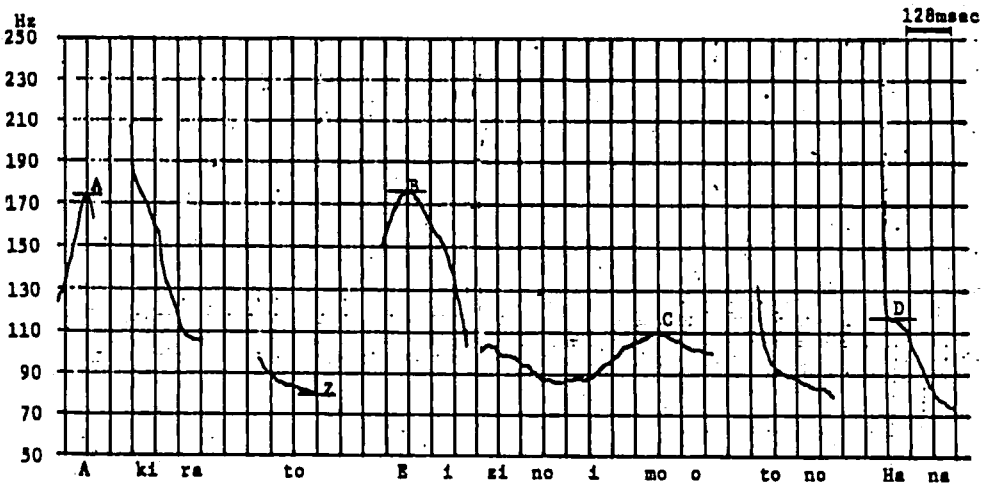


Fig. 2 Extracted pitch curves for the measurement of fundamental frequency

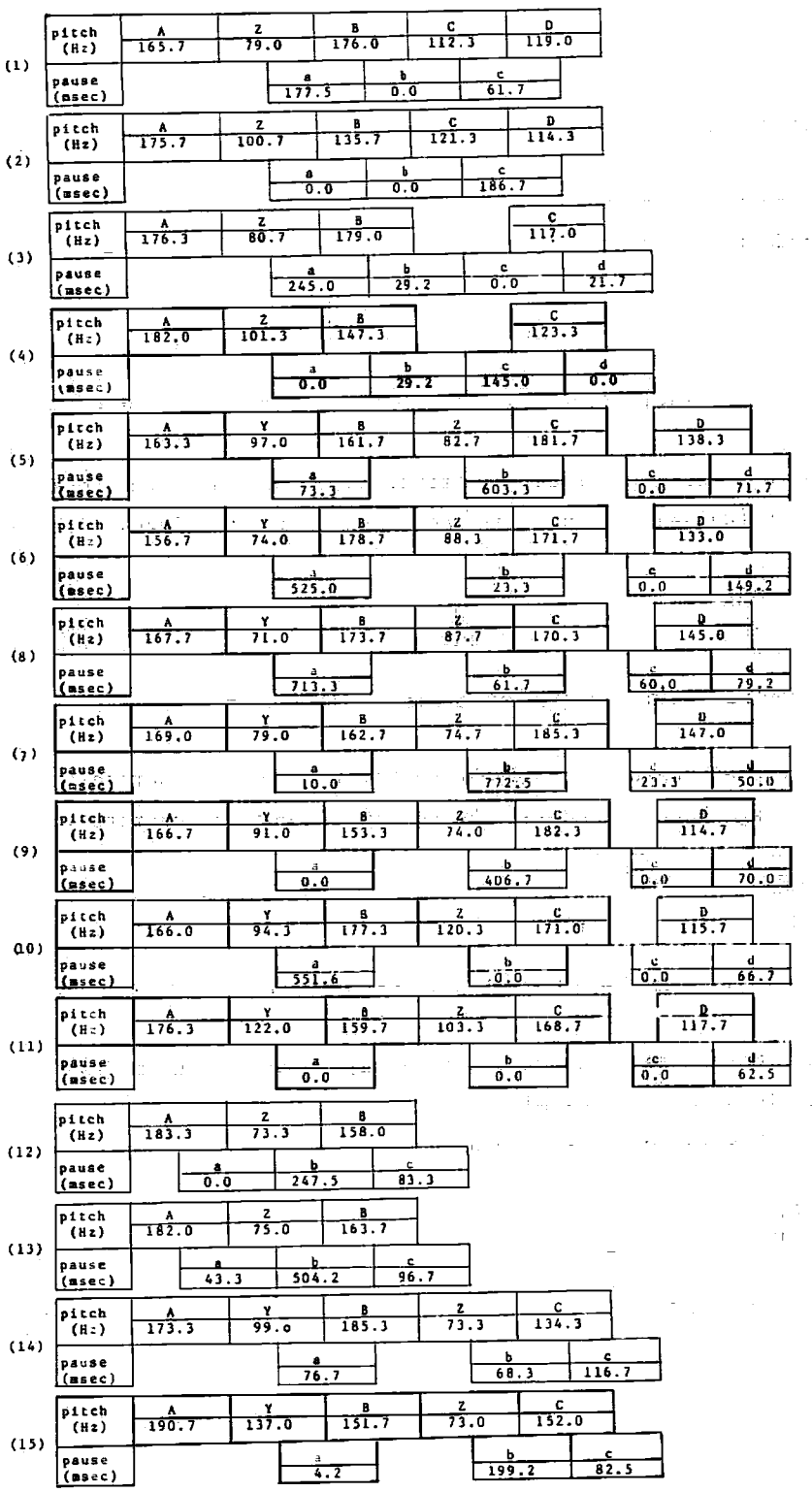
3. Results and Discussion

Table 2 shows the mean values for pitch and pauses obtained from the three separate occurrences of each of the items (1) - (15) in the recorded data. The upper-case and lower-case letters correspond to those appearing in (1) - (15) in Table 1.

In figures 3 - 9 below, items (1) - (15) are written in segments showing the location of pauses that were observed to occur. Below each space between the segments a bar graph indicates the length of the pause. The white bars refer to the length of pauses in the first item of each pair or group, the bars with slanted lines refer to the second item, and those with dots refer to the third item, for cases where a third item is given. The longest bars represent a maximum of 100 msec., so values in msec which are larger than 100 are given by more than one bar. When a zero-line lacking bars is given in the figure this is meant to indicate that no pause occurred in any of the examples for that figure.

We can see in Figures 3 - 9 that pauses occur 1 to 4 times within a phrase or a sentence. The length of pauses varies from shorter ones of less than 100 msec to longer ones of over 700 msec. If one compares those items which share the same chain of words, the constructions that contain a center-embedded phrase or clause

Table 2 Mean values of pitch and pauses in items (1) - (15)



(1) Akira to [Eizi no imooto no] Hanako

(2) [Akira to Eizi no imooto no] Hanako

Fig. 3 Location and length of pauses in items (1) and (2)

(3) Emerarudo to [daiya o tiribameta] ookan o nusunda

(4) [Emerarudo to daiya o tiribameta] ookan o nusunda

Fig. 4 Location and length of pauses in items (3) and (4)

(5) Yamada wa kaisan ni hantai-si [senkyoku ni kaetta] Suzuki o kainin-sita

(6) Yamada wa [kaisan ni hantai-si senkyoku ni kaetta] Suzuki o kainin-sita

Fig. 5 Location and length of pauses in items (5) and (6)

(7) Oo wa utagaibukaku [kenseiyoku no tuyoi] oohi o osorete-ita

(8) Oo wa [utagaibukaku kenseiyoku no tuyoi] oohi o osorete-ita

Fig. 6 Location and length of pauses in items (7) and (8)

(9) Ototoi Oosaka de [nusumi o hataraita] otoko ga tukamatta

(10) Ototoi [Oosaka de nusumi o hataraita] otoko ga tukamatta

(11) [Ototoi Oosaka de nusumi o hataraita] otoko ga tukamatta

Fig. 7 Location and length of pauses in items (9), (10) and (11)

(12) Ano ko ga aruite ano ko ga koronda
(13) Ano ko ga aruita. Ano ko ga koronda

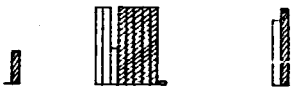


Fig. 8 Location and length of pauses in items (12) and (13)

(14) Ototoi [aruita] ano ko ga koronda
(15) [Ototoi aruita] ano ko ga koronda

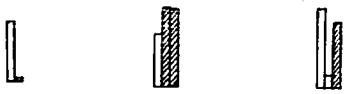


Fig. 9 Location and length of pauses in items (14) and (15)

show a tendency also to contain a pause immediately preceding those center-embedded portions. Within matrix sentences, long pauses are observed at clause boundaries followed by embedded subordinate clauses (see (5) in Fig. 5, and (7) in Fig. 6). Likewise, long pauses are found after a sentence-initial noun phrase marked by the particle wa, when that phrase is a constituent of the matrix sentence and is followed by an embedded subordinate clause (see (6) in Fig. 5, and (8) in Fig. 6). Pauses may or may not occur right after a subordinate clause. A short pause is, however, frequently found after a subordinate clause (see (4) in Fig. 4) when that clause is located in sentence-initial position.

Figures 10 - 16 show in line graphs the fundamental frequency obtained at points A, B, C, D, Y and Z for each item (1) - (15). The numbering of the solid, dotted, and broken lines given in parentheses in each figure corresponds to the numbering of the individual items (1) - (15) as given in Table 1. Each Figure 10 - 16 presents a pair or triad of items. As explained earlier, each pair or triad represents, respectively, two or three different structural bracketings of the same word chain (or nearly the same word chain, in the case of items (12) and (13) given in Figure 15).

The pitch information given in Figures 10 - 16 shows that there are high rises at the beginning of a subordinate clause (or phrase) which is center-embedded, and also that there is a tendency to decline in pitch rather sharply just before the high rise.

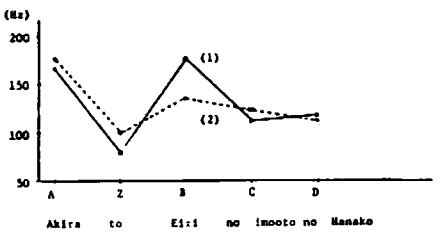


Fig. 10 Pitch information obtained from items (1) and (2)

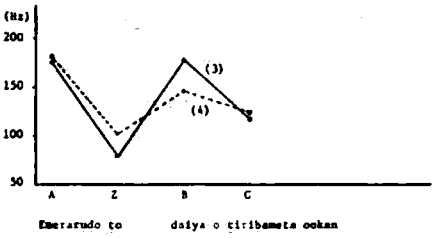


Fig. 11 Pitch information obtained from items (3) and (4)

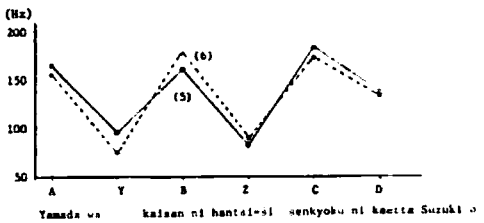


Fig. 12 Pitch information obtained from items (5) and (6)

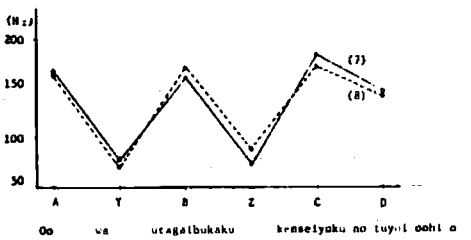


Fig. 13 Pitch information obtained from items (7) and (8)

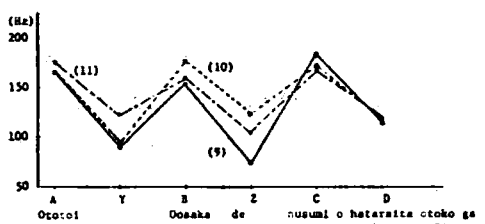


Fig. 14 Pitch information obtained from items (9), (10) and (11)

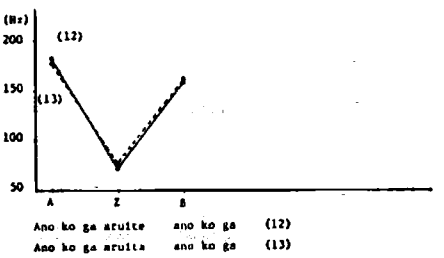


Fig. 15 Pitch information obtained from items (12) and (13)

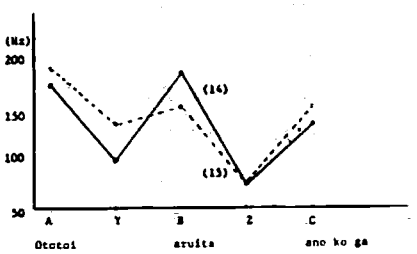


Fig. 16 Pitch information obtained from items (14) and (15)

When we have precise data on the length of pauses, it becomes clear that the length varies to some extent even if the pauses occur at phrase or clause boundaries in structures having the same type of surface configuration. Therefore, the question arises as

to whether or not the length of a pause is partially dependent upon the length of the utterance in which it occurs. In order to answer to this question, the longest pauses (P) of (1) - (15) were selected and arranged in Table 3 from the shortest to the longest, with indications as to the length of the utterances (T) in which they occurred (given in msec). The numbers in the parentheses in Table 3 correspond to those of the items in Table 1. The ratio P/T indicates what percent the longest pause is of the entire time of the utterance in which it occurred. The data in Table 3 allow us to conclude that, in general, the longer the sentences are, the longer the pauses are. the correspondence, however, is not linear, nor is the rank correlation perfect.

Next, we will examine the relationship between pitch patterns and pauses. Uyeno et al. (1980) reported that a high rise in the pitch pattern can serve to mark clause-initial boundaries in a surface structure. The results obtained in the present study suggest that pauses also mark clause-initial boundaries. At this point, there are three possible relationships between pitch pattern and pause. Firstly, they could be completely independent. Secondly, it could be the case that the extent of either is dependent on the importance of a boundary. If this were the case, the more important a boundary were, the higher the pitch would rise and the longer the pause would become. The information conveyed by the pitch pattern and the pause would then turn out to be redundant. Finally, it is possible that pitch height and pause length are inversely proportional; that is, we could expect that the shorter the pause, the higher the pitch would rise, and inversely, the longer the pause, the less the pitch would rise.

We will now examine the data in an attempt to determine which of these three possibilities does in fact occur. Relevent data are arranged in Table 4. A comparison is made between a chain of words having a certain grammatical boundary and the same chain lacking such a boundary. Thus, we have selected points where such contrasts occur in the pairs of examples originally given in Table 1. The numbering in parentheses in Table 4 corresponds to the numbering of the original items in Table 1. Sometimes more than one point of contrast occurs in a pair of items, so that pair may appear in Table 4 more than once (note for example the pair (5)/(6)). The upper-case letters A, B, C, D, Y and Z correspond to the

Table 3 Length of the recorded items (T), length of the longest pause (P), and the ratio P/T (%)

	(14)	(2)	(15)	(12)	(1)	(13)	(4)	(11)	(3)	(10)	(9)	(7)	(8)	(5)	(6)
T	2746.7	2818.3	2850.8	2950.0	2969.2	3255.8	3652.6	3800.0	3960.0	4393.3	4405.0	5171.7	5190.9	5770.0	5816.7
P	116.7	186.7	199.2	247.5	177.5	504.2	145.0	62.5	245.0	551.6	406.7	713.3	772.5	603.3	525.0
P/T	4.2	6.6	7.0	8.4	6.0	15.5	4.0	1.6	6.2	12.6	9.2	13.8	14.9	10.5	9.0

Table 4 Pitch and pauses in pairs of items with boundary contrast

		(5)ZC	(8)YB	(10)YB	(7)ZC	(6)YB	(3)ZB	(9)ZC	(1)ZB	(14)YB
boundary	pitch (p)	99.0	102.7	83.0	110.6	104.7	98.3	108.3	97.0	86.3
	pause (q)	603.3	713.3	551.6	772.5	525.0	245.0	406.7	103.8	76.7
		(6)ZC	(7)YB	(9)YB	(8)ZC	(5)YB	(4)ZB	(10)ZC	(2)ZB	(15)YB
no boundary	pitch (r)	83.4	83.7	62.3	82.6	64.7	46.0	50.7	35.0	14.7
	pause (s)	23.3	10.0	0	61.7	73.3	0	0	0	4.2
	p-r	15.6	19.0	20.7	28.0	40.0	52.3	57.6	62.0	71.6
	q-s	580.0	703.3	551.6	710.8	451.7	245.0	406.7	103.8	72.5

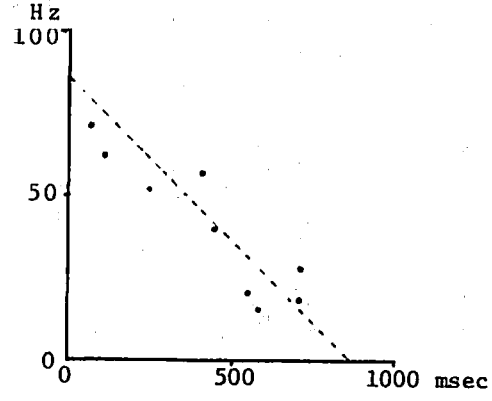


Fig. 17 Distribution of pitch and pause values obtained in Table 4

lettered marking of the items in Table 1 and represent the points in the items at which measurements were taken. The first horizontal row of squares in Table 4 gives pitch and pause readings for items having certain grammatical boundaries, while the second horizontal row of squares gives the readings for that item's paired counterpart which lacks that same grammatical boundary. The third horizontal row of squares shows (a) the difference in pitch (p-r) between the item having a grammatical boundary and the one lacking it and (b) the difference in pause length (q-s) between the same two items. Table 4 is arranged in vertical rows so that the smallest value for (p-r) is at the far left and the largest is at the far right.

The same information is given again in Figure 17, where the horizontal axis represents pause length differences (q-s) in msec, and the vertical axis represents pitch height differences (p-r) in Hz. All points are near the tentative regression line (Pitch = - 1/10 Pause + 85). This suggests that pitch height is generally in iverse proportion to pause length. That is, pause length and pitch height function complementarily in marking syntactic boundaries, such as the clause-initial ones referred to in this study.

4. Concluding Remarks

The present study aimed at specifying the function of pauses and intonation contours by examining in detail complex syntactic structures of Japanese uttered by a professional male announcer. The findings are summarized as follows:

(1) High rises are characteristic of clause-initial pitch contours, particularly, in the case of subordinate clauses center-embedded in a matrix sentence.

(2) Major pauses are located at the beginning of a clause in a sentence or between two sentences.

(3) Both the degree of pitch rise and the length of the pauses examined vary to some extent; it was suggested that they play complementary roles in signaling clause-initial boundaries in a given phonological sequence.

On the basis of these findings, we may conclude that intonation contours and pauses in Japanese have, among other functions, the crucial function of identifying clause-initial (or, in certain

cases, phrase-initial) boundaries, which are unlikely to be otherwise marked.

Notes

1. In such a case a tensed verb form (non-past or past) may end the sentence, whereas certain non-tensed verb forms (-te-forms or stem forms) combine with the following clause to form a coordinately conjoined sentence as shown in (12) in Table 1.
2. Two additional sentences, referred to here as (16) and (17), are given below. These, which differ from items (1) through (15) in terms of their length as well as the depth of embedding involved, were also recorded and examined by the procedures used for the other items.

Item (16) contains a center-embedded complex clause which is composed of five coordinately conjoined clauses. Item (17) contains left-branching relative clauses with seven layers of embedding as the square brackets indicate.

(16)

watasi no otooto wa [Monariza no sakusya de ari ketueki-
a b
my brother Mona Lisa of painter blood-
zyunkan no genri o kenkyuusi sugureta kaiboozu o nokosi
c d
circulation of principles study fine anatomical chart leave behind
hikooki no senku-teki kenkyuu o okonai kindai-kagaku no
e
airplane pioneering study carry out pre-modern science
so to iwarete-iru] Dabinti o sonkee-site-iru
f g
of founder is called Leonardo da Vinci respect

'My brother respects (Leonardo) da Vinci, who is the painter of the Mona Lisa, who studied the principles of blood circulation and left behind a fine anatomical chart (for the successors), who carried out a pioneering study of the airplane and who has been called the founder of the pre-modern science.

(17)

[[[[[[[Komori no Oman ga kobosita] issyoo no abura o
baby-sitter spilt one shō[a] (=0.477 U.S. gallon) of oil

mina namete-simatta] inu ni[b] kamikorosareta] neko no kawa o
all licked up dog by was bit and killed cat of skin

hatta] syamisen o hiita] geesya o hikasita] danna ni[c]
covered three string instrument played geisha redeemed patron

gakusi o dasite moratte[d] gakusya ni natta] hito ga ita.
from school expenses to be offered scholar became man existed

'There was a man who became a scholar having been offered school expenses by the patron who redeemed the geisha who played shamisen covered with the skin of the cat which was bit and killed by the dog which licked one sho of oil which the baby-sitter Oman spilt.'

Pauses observed in items (16) and (17) are shown in Table 5, where the lower-case letters correspond to those given in (16) and (17) to indicate the phrase boundaries where pauses occurred.

Table 5 Pauses in items (16) and (17)

	Length of item (msec)	a	b	c	d	e	f	g
(16)	16,130	780.0	230.8	363.3	436.7	354.2	314.2	50.8
(17)	14,612.5	413.3	19.2	504.2	238.3			

The following pitch patterns were observed in (16) and (17). In (16), high points of pitch, each of the order of 165 - 175 Hz, occurred within the first phrase of the matrix sentence, watasi no otooto wa 'as for my brother', and at the beginning of each clause in the complex, center-embedded relative clause. The point of highest pitch (180.7 Hz) occurred on the noun Dabinti 'da Vinci', which is located near the end of the sentence.

The point of the lowest pitch (72 Hz) occurred at the end of the noun phrase watasi no otooto wa 'as for my brother'. Other lows in pitch, ranging from 72 to 78 Hz occurred at the end of each coordinately conjoined, subordinate clause, and a low of

74.3 Hz occurred at the end of the matrix sentence.

In (17), the pitch at the beginning of the sentence reached a high of 185.3 Hz, and then gradually declined in the overall pattern until it rose sharply again to 175 Hz at the beginning of the phrase gakusi o dasite moratte 'having been offered school expenses'. This high point of 175 Hz, it should be noted, occurred within the first relative that directly modifies a noun in the matrix sentence. The pitch then fell to its lowest point (74.3 Hz) at the end of the sentence. Between the initial high point of 185.3 Hz and the final one of 175 Hz, other relatively high pitch points of about 150 Hz were observed to occur on some head nouns modified by relative clauses, but much lower (110 - 135 Hz) peaks occurred on other head nouns. No principle was found to account for these differing patterns with respect to head nouns. Before pauses, low pitch points of 77 - 80 Hz were observed, but these were not as low as the sentence final low (74.8 Hz).

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