

## Temporal Information and Pitch Contour Information in Processing Relative Clauses in Japanese

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## The ambiguity in relative clauses

(1) Furuhasi-san-ga Takasima-san-o tasuketa seinen-ni .....  
Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT

↓ **ambiguous !**

(2) Early Opening:

Furuhasi-san-ga [ec<sub>i</sub><sup>SUBJ</sup> Takasima-san-o tasuketa]  
Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped  
seinen-ni sigamituita.  
the young man-DAT clung-to  
"Mr.Furuhasi clung to the young man who helped Mr. Takasima."

(3) Late Opening:

Furuhasi-san-ga Takasima-san-o [ec<sub>i</sub><sup>SUBJ</sup> ec<sub>j</sub><sup>OBJ</sup> tasuketa]  
Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped  
seinen-ni syookaisita.  
the young man-DAT introduced  
"Mr.Furuhasi, introduced Mr. Takasima to the young man whom he, helped."

## Sentence processing

What is the Parser?

The parser is the human cognitive-mechanism responsible for computing of syntactic structure.

Sentence Processing

Phonological processing

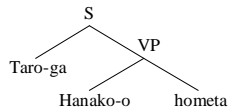
↓  
Lexical processing

Syntactic processing  
(=parsing)

↓  
Semantic processing  
(Sakamoto 1998: p.5)

Syntactic processing  
(=parsing)

Taro-ga Hanako-o hometa  
Taro-NOM Hanako-ACC praised



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## Resolution of ambiguity

The structural ambiguity is resolved when a matrix predicate (i.e. verb) is received.

i) 2-place predicate (i.e. sigamituita) => EO sentence

The parser recognizes that the accusative marked NP (i.e. Takasima-san-o) occupies the object position in a **relative** clause.

ii) 3-place predicate (i.e. syookaisita) => LO sentence

The parser recognizes that the accusative marked NP (i.e. Takasima-san-o) occupies the object position in a **matrix** clause.

Before a matrix predicate is inputted, only prosodic information may be available in resolving the ambiguity.

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## Delayed parsing or incremental parsing

**Delayed Parsing:**

Only when a head of sentence is received, the parser starts to integrating NPs and verb to a parsing tree. (Pritchett 1992)

**Incremental Parsing:**

The parser integrates NPs to parsing tree before a head of sentence is received. (Kamide & Mitchell 1999, Miyamoto 2002, and others)

→ We accept the hypothesis that the parser builds a parsing tree **incrementally**.

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## MajP boundary and syntactic structure

**Major phrase** (McCawley 1968): The domain of downstep.

**Downstep:** Lowering of pitch range after an accented syllable.

(4) Effects of downstep

YUmi-no Ani-ga KiIta  
Yumi-GEN elder brother-NOM came  
"Yumi's elder brother came."

**Syntactic condition on Downstep (or Major Phrasing):**

- If there is a left-boundary of a phrase, then the effect of the downstep becomes weak (or is blocked). (Selkirk and Tateishi 1991, Kubozono 1988, and others)
- Major Phrase: {Left, XP} (Selkirk & Tateishi 1991: p.529)

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## Syntactic structure of EO sentence and LO sentence

### (5) Early Opening:

Furuhasi-san-ga [CP ec<sub>i</sub><sup>SUBJ</sup> Takasima-san-o tasuketa]  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped  
 seinen<sub>i</sub>-ni sigamituita.  
 the young man-DAT clung-to  
 "Mr.Furuhasi clung to the young man who helped Mr. Takasima."

### (6) Late Opening:

Furuhasi-san-ga [VP Takasima-san-o [CP ec<sub>i</sub><sup>SUBJ</sup> ec<sub>j</sub><sup>OBJ</sup> tasuketa]  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped  
 seinen<sub>i</sub>-ni syookaisita.  
 the young man-DAT introduced  
 "Mr.Furuhasi<sub>i</sub> introduced Mr. Takasima to the young man whom he<sub>j</sub> helped."

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## Previous study (Cont.)

Azuma's conclusion :

- Pitch contour information is most important prosodic information which denotes a syntactic boundary.
- Temporal information (i.e. pause) does not contribute much to denoting a syntactic boundary as pitch contour information does.

Remaining problem:

- The stimulus employed in his experiment does not invoke reanalysis process. He investigated only first-pass analysis process, and it is not clear whether his conclusion can apply to reanalysis process.

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## Where are MajP boundaries?

Predictions from Selkirk & Tateishi

### (7) Early Opening:

Furuhasi-san-ga # Takasima-san-o tasuketa seinen-ni  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT  
 sigamituita.  
 clung-to  
 "Mr.Furuhasi clung to the young man who helped Mr. Takasima."

### (8) Late Opening:

Furuhasi-san-ga # Takasima-san-o # tasuketa seinen<sub>i</sub>-ni  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT  
 syookaisita.  
 introduced  
 "Mr.Furuhasi<sub>i</sub> introduced Mr. Takasima to the young man whom he<sub>j</sub> helped."

"#" denotes MajP boundary.

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## Aim of this study

Prosodic information is sensitive to syntactic structures.



Does prosodic information affect on reanalysis process?

- With employing auditory stimulus, we investigate the effects of pitch contour information and temporal information (i.e. pause) in reanalysis process.
- Is there any difference between first-pass analysis and reanalysis processes?

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## Previous study

Azuma (1997)

Nara-de taoreta kodomo-o hakonda  
 at-Nara fell child-ACC carried

**Globally ambiguous**

- 1) [Nara-de taoreta kodomo-o] hakonda  
 at-Nara fell child-ACC carried  
 "(Someone) carried the child who fell at Nara"
- 2) Nara-de [taoreta kodomo-o] hakonda  
 at-Nara fell child-ACC carried  
 "At Nara (Someone) carried the child who fell"

- He manipulated both the pitch contour and the length of pause at "Nara-de" and "taoreta", and asked the subjects to choose the preferred interpretation.

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## Experiment

Furuhasi-san-ga [CP ec<sub>i</sub><sup>SUBJ</sup> Takasima-san-o tasuketa]  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped

seinen<sub>i</sub>-ni sigamituita.  
 the young man-DAT clung-to  
 "Mr.Furuhasi clung to the young man who helped Mr.Takasima."

Factor I: Position of prosodic information (**ProInfo**)

- i) Matched Condition:  
 NP<sub>NOM</sub> **ProInfo** [NP<sub>ACC</sub> V<sub>RC</sub>] NP<sub>DAT</sub> V<sub>matrix</sub>
- ii) Mismatch Condition:  
 NP<sub>NOM</sub> **ProInfo** [NP<sub>ACC</sub> **ProInfo** V<sub>RC</sub>] NP<sub>DAT</sub> V<sub>matrix</sub>

Factor II: Types of prosodic information

- i) Only pitch counter resetting (pitch contour information) => %
- ii) Pitch counter resetting + pause (temporal information) => %+P

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## Conditions

### Condition I: Matched – Only %

Furuhasi-san-ga % Takasima-san-o tasuketa seinen-ni sigamituita.  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT clung-to

### Condition II: Mismatch – Only %

Furuhasi-san-ga % Takasima-san-o % tasuketa seinen-ni sigamituita.  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT clung-to

### Condition III: Matched – % +P

Furuhasi-san-ga % +P Takasima-san-o tasuketa seinen-ni sigamituita.  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT clung-to

### Condition IV: Mismatch – % +P

Furuhasi-san-ga % +P Takasima-san-o % +P tasuketa seinen-ni sigamituita.  
 Furuhasi-Mr.-NOM Takasima-Mr.-ACC helped the young man-DAT clung-to  
 "Mr.Furuhasi clung to the young man who helped Mr.Takasima."

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### • Participants:

29 native speakers of Japanese. They were graduate and undergraduate students of Kyushu University. One of them were omitted because his error rate was over 20%.

### • Procedure:

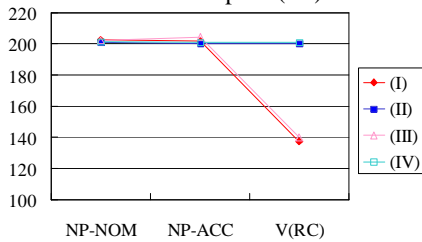
Participants listened to the stimulus sentences and answered correctness of the stimulus sentence with buttons.

### • Materials:

36 sets of sentence pairs as (I)-(IV) above.

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Mean of F0 peak (Hz)

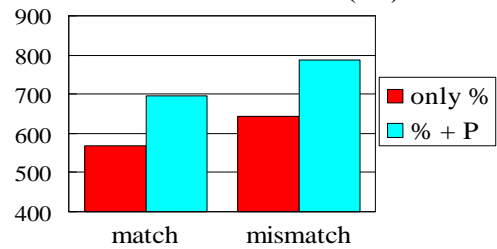


	NP-NOM		NP-ACC		V(RC)
Condition I	202.6	%	201.7		134.3
Condition II	200.9	%	200.0	%	200.1
Condition III	202.2	%+P	204.5		139.9
Condition IV	201.4	%+P	201.0	%+P	201.1

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## Result (1)

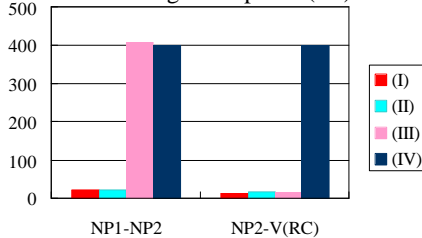
Mean Reaction Time (ms)



only %	569	644
% + P	696	787

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Mean length of pause (ms)



	NP1-NP2	NP2-V(RC)
Condition I	21.4	12.0
Condition II	21.9	16.8
Condition III	407.3	13.3
Condition IV	400.2	400.1

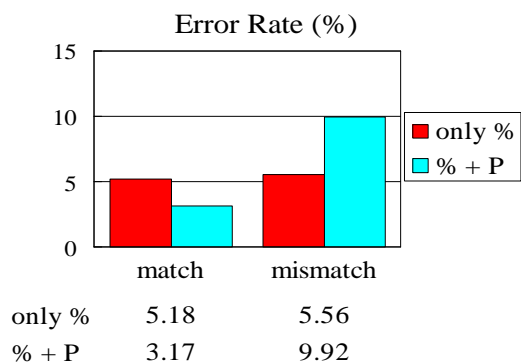
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## Statistical analysis (RT)

- Main effect of position of prosodic information:  
 $F_1(1, 27) = 6.91, p < .05, F_2(1, 35) = 9.10, p < .005$   
**"Mismatch condition" > "Match condition"**
- Main effect of types of prosodic information :  
 $F_1(1, 27) = 19.46, p < .001, F_2(1, 35) = 6.02, p < .05$   
**"% +P" > "Only %"**
- Interaction (position x type):  
 $F_1 < 1, F_2 < 1.$

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## Result (2)



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## Pause and informational structure

- In speech production process, discourse information (e.g. focus) has great influence on the pause length.
- Existence of a salient pause induces the language processor to start processing discourse information.



- Simultaneous processing of both syntactic information and discourse one invokes more processing difficulty.
- This processing difficulty results in longer reaction time in %+P (Con III & IV).

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## Statistical analysis (ER)

- Main effect of position of prosodic information:  
 $F_1(1, 27) = 5.44, p < .05, F_2(1, 35) = 4.29, p < .05.$   
**"Mismatch condition" > "Match condition"**
- Main effect of types of prosodic information :  
 $F_1 < 1, F_2 < 1.$
- Interaction (position x type):  
 $F_1(1, 27) = 2.76, p = .11, F_2(1, 35) = 5.53, p < .05.$

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## Thank you!

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## Conclusion

### Similarity between first-pass and reanalysis

- Pitch contour information affects not only on first-pass but also on reanalysis processes.

### Difference between first-pass and reanalysis

- In first-pass process, temporal information (i.e. pause) also contributes to denoting a syntactic boundary.
- In reanalysis process, temporal information increases processing difficulty.

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