Effects of intonational patterns on processing of relative clauses in Japanese

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Outline

- Background
- Intonational Pattern
- Processing of Relative Clause

Experiment
- Procedure
- Result

Discussion
- General Discussion
- Further Issue

Background

Intonational pattern

1. Japanese intonation is formed by
   a. Initial Lowering
   b. Downstep
   c. Lexical pitch accent

Initial Lowering

2. Initial Lowering
   a. A Low-High rise at left edge of a Minor Phrase (MiP)
   b. Regardless of its specification of accentedness
      Yamámori-ga       Naomi-o       (yonda)

   \begin{align}
   \text{Accented} & \quad \text{Unaccented} \\
   \end{align}

   \begin{align}
   \text{Accented} & \quad \text{Accented} \\
   \text{Accented} & \quad \text{Unaccented}
   \end{align}

   \begin{align}
   \text{Two MiPs} & \quad \text{Two MiPs}
   \end{align}

3. Factors on MiP formation 1: Accentedness
   a. Accented PW forms a PW which is independent from the following PW.
      \begin{align}
      ( \text{Aomori-no} ) & \quad ( \text{obasan} ) \\
      \text{Accented} & \quad \text{Accented} \\
      \text{Accented} & \quad \text{Unaccented}
      \end{align}

   \begin{align}
   \text{Two MiPs} & \quad \text{Two MiPs}
   \end{align}
b. Unaccented PW forms one MiP with the following PW.
(Oomori-no obáasan) Unaccented
(Oomori-no obasan) Accented

Unaccented  Accented

Oomori-no  obáasan

50 250 100 150 200
Pitch (Hz)
Time (s)

One MiP

(4) Factors on MiP formation 2: Syntax
Left edge of XP = MiP boundary. (Selkirk and Tateishi 1988, Kubozono 1993 others)

a. (Naomi-ga[NOM]) (America-de[LOC]) (obasan-ni[DAT])(tegami-o[ACC] okutta)
‘Naomi sent a letter to her aunt at USA.’

b. (Naomi-NOM) (America-GEN obasan-DAT)(tegami-ACC okutta)
‘Naomi sent a letter to her aunt in USA.’

Downstep
(5) Downstep (or Catathesis)
Pitch lowering triggered by lexical accent (HL fall)
Náoya-no obáasan
Naomi-no obáasan
Accented  Accented
Unacented  Accented

Intonational patterns and processing of RC in Japanese (Matsuura et.al.) p.2
(6) Syntactic factor on Downstep
At the left edge of XP, Downstep is weakened/blocked (Selkirk and Tateishi 1991, Kubozono 1993, Ishihara 2008 etc.)

‘(I) sent a letter to Naoya’s aunt at Morioka.’

‘Naoya sent a letter to his aunt at Morioka.’

(7) Summary
a. Japanese Intonation
   Initial Lowering
   Downstep
b. A prosodic marker of the left edge of XP
   Obligatory LH-rise
   Pitch range reset

Processing of relative clause
(8) What is the following word?
   a. Yamada-ga Naomi-o ________
      Yamada-NOM Naomi-ACC
   b. Yamada-ga Naomi-ni ________
      Yamada-NOM Naomi-DAT

(9) Narrowing down of subsequent elements
   a. The parser (reader/listener) narrows down subsequent elements before they appear.
   b. In narrowing down, case markers, animacy, negative concordance etc. function as factors.
      (see Muraoka 2008 for review)
(10) Reanalysis
a. Does the sentence end?
Yamada-ga Naomi-o yonda syoonen-ni
Yamada-NOM Naomi-ACC called boy-DAT
b. Reanalysis
simple sentence $\rightarrow$ complex sentence

(11) Second-pass ambiguity
Yamada-ga Naomi-o yonda syoonen-ni ______

(12) Early Opening type sentence
Yamada-NOM Naomi-ACC called boy-DAT consulted
Main predicate = 2-place
N2 = Relative clause

(13) Late Opening type sentence
Yamada-NOM Naomi-ACC called boy-DAT introduced
Main predicate = 3-place
N2 = Main clause (or Relative clause)

(14) Detection of Opening point
a. In visual presentations (silent reading), there is no difference other than the main predicate between EO and LO.
EO: Yamada-ga Naomi-o yonda syoonen-ni ootaisita.
LO: Yamada-ga Naomi-o yonda syoonen-ni syookaisita.
$\rightarrow$ You cannot detect the opening point before the main verb (ootaisita/syookaisita) appears.
b. In auditory presentations (oral reading), intonational patterns are different between EO and LO.

(15) Syntax – intonation matching (Unaccented)
a. EO:

[–Initial Lowering]

b. LO:

[+Initial Lowering]
(16) Sample F0 of Complex sentences (N2&V1=Unaccented)
   a. Early Opening: Yamada-ga Naomi-o yonda syoonen-ni ootaisita.
   b. Late Opening: Yamada-ga Naomi-o yonda syoonen-ni syookaisita.

(17) Syntax – intonation matching (Accented)
   a. EO:
      N1-NOM  N2-ACC  V1  N3-DAT  V2
   b. LO:
      N1-NOM  N2-ACC  V1  N3-DAT  V2

(18) Sample F0 of Complex sentences (N2-acc&V1=Accented)
   b. Late Opening: Yamada-ga Náoya-o manéita syoonen-ni syookaisita.

(19) Summary
   a. Two types of complex sentences
      EO-type   N1-ga [N2-o V1] N3-ni V2
      LO-type   N1-ga N2-o [V1] N3-ni V2
   b. Initial Lowering on V1
      No – EO (solid)
      Yes – LO (dot)
   c. Downstep on V1
      Yes – EO (solid)
      No – LO (dot)

Intonational patterns and processing of RC in Japanese (Matsuura et.al.) p.5
d. Question
Are these prosodic differences used as a cue for detecting the opening point of relative clauses?

Experiment

Procedure
(20) Issues
a. Does prosody affect increment sentence processing?
   → prosody – syntax matching issue
b. If Yes, is there a difference between accented words and unaccented words in sentence processing?
   → Accentedness issue

(21) Global ambiguity in LO-type sentences
Main verb (syookaisita) = 3-place, Relative verb (maneita) = 2-place
Apparent Noun = 3 (Yamada, Naoya, syoonen) → Empty categories = 2 (e1, e2)
Too many possible interpretations!! (There are, of course, other possibilities)
b. Yamada- NOM Naoya- ACC [e1- NOM e2- ACC maneita] syoonen- DAT syookaisita
c. Yamada- NOM Naoya- ACC [e1- NOM e2- ACC maneita] syoonen- DAT syookaisita
d. Yamada- NOM Naoya- ACC [e1- NOM e2- ACC maneita] syoonen- DAT syookaisita
e. Yamada- NOM e1- ACC [e2- NOM Naoya- ACC maneita] syoonen- DAT syookaisita
eetc...

(22) Sample F0 of unaccented conditions
Huzítani-san-ga  Hirayama-san-o  tuihoosita  katyoo-ni  mikatasita
Huzitani-Mr.-NOM Hirayama-Mr.-ACC banished chief-DAT stood:up:for
a. EO prosody – Unaccented (EU) condition

b. LO prosody – Unaccented (LU) condition

(23) Sample F0 of accented conditions
Huzítani-san-ga  Nisízaki-san-o  oidásita  katyoo-ni  mikatasita
Huzitani-Mr.-NOM Nisizaki-Mr.-ACC banished chief-DAT stood:up:for
a. EO prosody – Accented (EA) condition

b. LO prosody – Accented (LA) condition

(24) Control of stimuli
a. Lexical property of N2 and V1
   Mora length
   Word frequency
b. Naturalness of matrix VP

(25) Control of stimuli 1: Lexical property
a. Mora length and frequency of a word affect its recognition.

(26) Control of stimuli 2: Naturalness of matrix VP
a. Materials: 32 pairs of sentences
   Accented condition
   Ando-Mr.-acc invited OL-dat was:jealous

Intonation patterns and processing of RC in Japanese (Matsuura et.al.) p.7
Unaccented condition
Yamanaka-san-o sasotta oocru-ni sittosita.
Yamanaka-Mr.-acc invited OL-dat was:jaeious

b. Participants:
34 undergraduate students in Kumamoto area
c. Procedure:
Marking an appropriate point for each sentence from "very natural" (5) to "extremely unnatural" (1)
d. Result

→Both the lexical property of N2 and V1 and naturalness of matrix VP were appropriately controlled between Accented conditions and Unaccented conditions.

(27) Stimuli recording
a. Male speaker of Tokyo Japanese
b. 28 years 3 months
c. Mean F0 of initial valley and peak

(28) Procedure of main experiment
a. Number of sentences:
   32 sets of 'yes'-response sentences containing four conditions
   32 sets of 'no'-response sentences
   28 filler sentences.
   Sets of 'yes'-response sentences are distributed in a Latin Square.
b. Participants: 28 undergraduate students at Kyushu University
c. Presentation: an auditory stimulus from a headphone.
d. Instruction: After listening to the stimuli, decide whether or not the sentence makes sense.
Results

(29) Reaction time
   a. EO-prosody (Matched) < LO-prosody (Mismatched) [F₁ *** , F₂ **]
   b. No significant difference for accentedness
   c. No significant difference for interaction

(30) Error rate
   a. EO-prosody (Matched) < LO-prosody (Mismatched)
   b. No significant difference for accentedness
   c. No significant difference for interaction

Discussion

General Discussion

(31) Finding 1: Prosody – syntax matching
   a. Significant differences on reaction time and error rate are found in prosody – syntax matching.
   b. The result denotes that intonational pattern helps to detect the opening point of relative clauses.
   c. There is a longer reaction time and higher error rate as a result of the reanalysis process.

(32) Preference for 2-place predicates
   a. Yamada-NOM Naomi-ACC yonda syoonen-DAT
   b. The parser tends to fill a 2-place predicate in the blank. (Mazuka and Itoh 1995)
      →Preference: 2-place predicate > 3-place predicate
   c. The parser posits a phonologically null predicate (pred). (Muraoka 2008)
      Yamada-NOM Naomi-ACC yonda syoonen-DAT pred

(33) Relative clause processing with auditory presentation
   EO prosody [reanalysis = 1]
   LO prosody [reanalysis = 2]
      Yamada-ga [Naomi-0 [yonda] syoonen-ni ootaisita.

(34) Finding 2: Accented – unaccented contrast
   a. No significant difference is found in accentedness.
   b. The result implies that incremental processing is independent from lexical phonological information (=accentedness).

Intonational patterns and processing of RC in Japanese (Matsuura et.al.) p.9
This study conducted a decision-making experiment to investigate whether or not the parser uses prosodic cue in order to detect a left-clause boundary in Japanese.

**Findings**

a. Both Initial Lowering and Downstep work as a cue for detecting the opening point of relative clauses.

b. Contrast of accentedness does not make a significant difference for biasing the opening point of relative clauses.

**Further issue**

(36) Degree of F0-rise at the relative verb

- LO-prosody > EO-prosody

(37) Factors on Minor Phrase formation (Selkirk and Tateishi 1988, Kubozono 1993, among others)

a. Syntax: The left edge of XP = the left edge of MiP

b. Rhythm: (i) Four PWs → two MiPs
   (ii) Four MiPs → two superiordinate MiPs

c. Phonology: Accented PW = rightmost PW of MiP

(38) Realization of Minor Phrase (F0-rise)

a. Selkirk et al.'s study
   syntax-driven F0-rise > phonology-driven F0-rise

b. Shinya et al.'s study
   syntax-driven F0-rise > rhythm-driven F0-rise

(39) Accented – Unaccented

Yonémura-NOM Náoya-ACC yonda syoonen-DAT ootaisita

(40) Remaining question

How do interpretations of a listener change depending on the degree of F0-rise?

**References**


Appendix: summary of statistical results

Table 1. Mean F0 bottom and peak (in Hz) in the initial three Prosodic Words

<table>
<thead>
<tr>
<th></th>
<th>N1-nom</th>
<th></th>
<th>N2-acc</th>
<th></th>
<th>V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>valley</td>
<td>peak</td>
<td>valley</td>
<td>peak</td>
<td>valley</td>
</tr>
<tr>
<td>EO-A</td>
<td>Mean</td>
<td>126.1</td>
<td>199.8</td>
<td>103.5</td>
<td>189.9</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>15.7</td>
<td>1.3</td>
<td>10.0</td>
<td>1.2</td>
</tr>
<tr>
<td>LO-A</td>
<td>Mean</td>
<td>127.0</td>
<td>199.8</td>
<td>101.0</td>
<td>190.1</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>17.3</td>
<td>1.4</td>
<td>7.5</td>
<td>0.9</td>
</tr>
<tr>
<td>EO-U</td>
<td>Mean</td>
<td>122.3</td>
<td>199.8</td>
<td>104.9</td>
<td>160.1</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>9.1</td>
<td>1.7</td>
<td>9.1</td>
<td>2.3</td>
</tr>
<tr>
<td>LO-U</td>
<td>Mean</td>
<td>122.3</td>
<td>199.6</td>
<td>104.7</td>
<td>158.8</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>9.1</td>
<td>1.7</td>
<td>8.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Table 2. Means of number of morae of N2-acc and V1.

<table>
<thead>
<tr>
<th></th>
<th>N2-acc</th>
<th>V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accented condition</td>
<td>4.00 (SD=0.00)</td>
<td>5.16 (SD=0.88)</td>
</tr>
<tr>
<td>Unaccented condition</td>
<td>4.00 (SD=0.00)</td>
<td>4.94 (SD=0.72)</td>
</tr>
</tbody>
</table>

Δ 0.00<sup>a</sup>  Δ 0.22<sup>b</sup>

<sup>a</sup>No difference [t(31) = 0.00, p = 1.00]

<sup>b</sup>Not significant difference [t(31) = 1.23, p = .23]

Table 3. Means of frequency of NP<sub>2-o(ACC)</sub> and V1.

<table>
<thead>
<tr>
<th></th>
<th>N2-acc</th>
<th>V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accented condition</td>
<td>2210 (SD=1564)</td>
<td>8285 (SD=13043)</td>
</tr>
<tr>
<td>Unaccented condition</td>
<td>2299 (SD=3825)</td>
<td>5847 (SD=8291)</td>
</tr>
</tbody>
</table>

Δ 89<sup>a</sup>  Δ 22411<sup>b</sup>

<sup>a</sup>Not significant difference [t(31) = 1.23, p = .23]

<sup>b</sup>Not significant difference [t(31) = 0.81, p = .43]

Note: Data is based on Amano and Kondo (2000).

Table 4. Means of Naturalness of matrix VP.

<table>
<thead>
<tr>
<th></th>
<th>Naturalness-rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accented condition</td>
<td>4.09 (SD=0.65)</td>
</tr>
<tr>
<td>Unaccented condition</td>
<td>4.08 (SD=0.57)</td>
</tr>
</tbody>
</table>

Δ 0.01<sup>a</sup>

<sup>a</sup>Not significant difference [t<sub>1</sub>(33) = 0.25, p = .80, t<sub>2</sub>(31) = 0.15, p = .88]
Table 5. Means of reaction times (ms)

<table>
<thead>
<tr>
<th>Condition</th>
<th>EO-prosody cond.</th>
<th>LO-prosody cond.</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accented condition</td>
<td>668 (SD=372)</td>
<td>852 (SD=517)</td>
<td>184</td>
</tr>
<tr>
<td>Unaccented condition</td>
<td>703 (SD=371)</td>
<td>795 (SD=441)</td>
<td>92</td>
</tr>
</tbody>
</table>

The statistical test for reaction times (An ANOVA analysis)

a. Main effects of accentedness: Not significant [Fs < 1].

b. Main effects of syntax-prosody matching: Significant \(F_1(1, 27) = 10.09, p< .005, F_2(1,31) = 8.30, p < .01\]

c. Interaction: Not significant [Fs < 1].

Table 6. Means of error rates (%)

<table>
<thead>
<tr>
<th>Condition</th>
<th>EO-prosody cond.</th>
<th>LO-prosody cond.</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accented condition</td>
<td>4.46 (SD=6.86)</td>
<td>8.04 (SD=12.14)</td>
<td>3.58</td>
</tr>
<tr>
<td>Unaccented condition</td>
<td>4.46 (SD=11.68)</td>
<td>11.61 (SD=12.91)</td>
<td>7.15</td>
</tr>
</tbody>
</table>

The statistical test for error rates

a. Main effects of accentedness: Not significant \(F_1 < 1, F_2(1,31) = 1.01 , p = .32\]

b. Main effects of syntax-prosody alignment: Significant \(F_1(1, 27) = 9.47, p< .005, F_2(1,31) = 7.11 , p < .05\]

c. Interaction: Not significant \(F_1(1, 27) = 2.75, p= .11, F_2(1,31) = 2.12 , p = .16\]