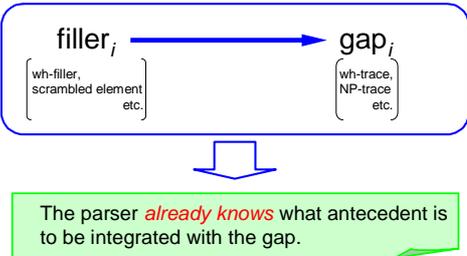


Backward-Integration in Japanese Parsing: Evidence from Event-Related Brain Potentials

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Forward-Integration Processes



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wh-question in English
a. John bought a book.
b. **What**, did John buy **gap**,

scrambling in Japanese
a. Taroo-ga hon-o katta.
Taro-NOM book-ACC bought.
'Taro bought a book.'
b. **Hon-o**, Taroo-ga **gap**, katta.
book-ACC Taro-NOM bought.
'Taro bought a book.'

☀ **filler** : a moved element which is co-indexed with its gap
gap : abstract element which is phonologically null
i : index (co-index)

filler-gap dependency 2

ERP Reflecting Forward-Integration

Fiebach et al. 2001

sustained-LAN

the cost for the storage of the filler in working memory

P600

the cost for the establishment of the syntactic dependency



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Fiebach et al. 2001

Fiebach et al. (2001) investigated ERPs elicited during the processing of indirect German wh-questions with either a subject or an object moved to the clause-initial position.

a. subject wh- question
Thomas fragt sich, **wer**, **gap**, am Dienstag nachmittag nach dem Unfall den Doktor verständigt hat.

b. object wh- question
Thomas fragt sich, **wen**, am Dienstag nachmittag nach dem Unfall der Doktor **gap**, verständigt hat.

☀ P600 ☀ sustained-LAN

Previous Studies 4

Backward-Integration Processes

The quantified elements (host-NP) can precede the numeral quantifiers(NQ) in Japanese.

e.g. *gakusei-ga kinoo kombini-de zasshi-o san-satsu katta.*
student-NOM yesterday store-at magazine-ACC three-volumes bought
'Three students came yesterday.'

host-NP ← NQ (FQ)

↓

The parser recognizes the triggering element for integration *at a later* point in the string of elements.

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Present Study

In on-line sentence processing, *when* and *how* are the backward-integration processes performed?



Event-Related Brain Potentials (ERPs) are ideal tools!

↑

ERPs provide a continuous, on-line record of the brain's electrical activity that occurs during the process under study.

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Experimental Sentences

a. Short-distance Condition (SC)

gakusei-ga kinoo kombini-de zasshi-o san-satsu katta.
student-NOM yesterday store-at magazine-ACC three-volumes bought
'Yesterday, a student bought three magazines at the store.'

b. Long-distance Condition (LC)

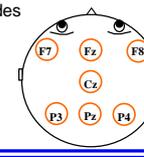
gakusei-ga kinoo kombini-de zasshi-o san-nin katta.
student-NOM yesterday store-at magazine-ACC three-persons bought
'Yesterday, three students bought a magazine at the store.'

c. Adverb Condition (AC)

gakusei-ga kinoo kombini-de zasshi-o san-kai katta.
student-NOM yesterday store-at magazine-ACC three times bought
'Yesterday, a student bought a magazine three times at the store.'

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Electrodes



Presentation of Stimuli

- *bunsetsu* by *bunsetsu* presentation on a TFT screen.
- SOA; 700msec ISI; 100msec

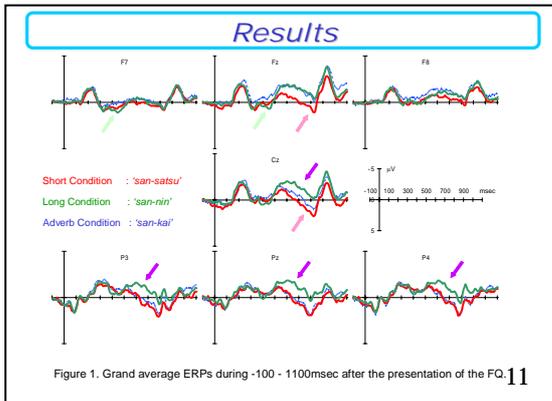
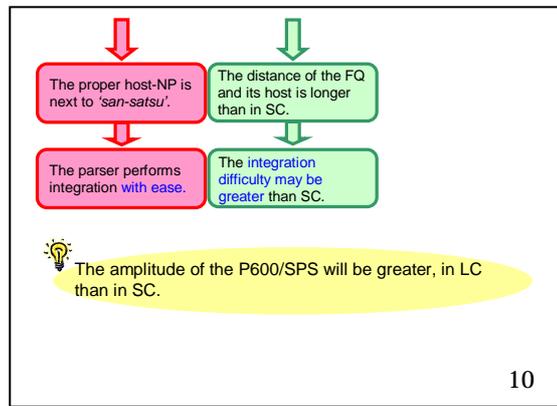
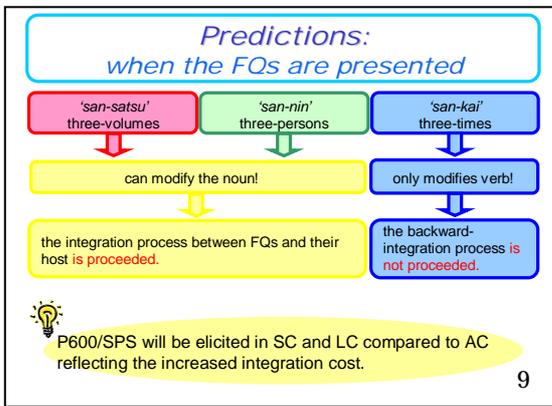
List of stimuli

- Ninety experimental sentences (30 sentences in each conditions), and 150 filler sentences.
- An acceptability judgment was imposed to all sentences.

Participants

- Eighteen Japanese native speakers (mean age=21.9)
- All were right handed, and had correct or corrected-to-normal vision.

Procedure 8



350 - 550 msec

SC and LC elicited **positivity** compared to AC at sites Fz and F7

Go to "Discussion 1"

550 - 950 msec

SC elicited **positivity** compared to AC and LC at sites Fz and Cz

Go to "Discussion 2"

LC elicited **negativity** compared to SC and AC at sites Cz, Pz, P3 and P4

Go to "Discussion 3"

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Discussion 1

positivity in 350 - 550 msec

the processing cost of recognizing 'san-satsu' and 'san-nin' as FQs, and beginning to search for their host-NPs.

One possible account:

The integration processes consist of two processes.

a. **Judgment Process**, examines whether the input element needs to be integrated with another element.

b. **Actual Integration Operation**, associates two syntactic elements.

↓ ↓

The judgment process may have elicited the positivity in this epoch.

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Discussion 2

positivity in 550 - 950 msec

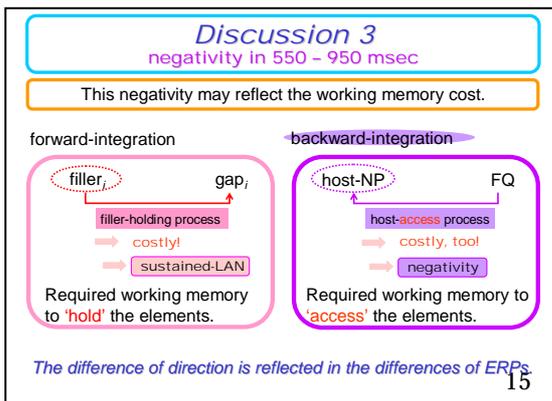
This positivity may be P600/SPS judging from its polarity and latency.

Q. What cognitive process does elicit this P600/SPS?

A. The actual integration operation, which mentioned above may have elicited P600/SPS.

P600/SPS is elicited not only in forward-integration but also in backward-integration!

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ERP Reflecting Memory Search Process

Memory search negativity

It has been proposed that **the negativity** is elicited reflecting the search process to the memory in **300 - 700 msec** latencies. The scalp distribution of such negativity has been observed at **central, posterior, parietal sites**. This component has also been observed in letter search tasks using visual stimuli and in phoneme search tasks using acoustic stimuli.

(Miyatani 2000, for review)

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Summary

three ERP components are elicited when the FQ is presented.

- a. **Judgment Positivity**;
recognizing a numeral quantifier as the FQ and starting to search for its host-NP
- b. **P600/SPS**;
integrating the FQ with its host-NP
- c. **Memory Search Negativity**;
accessing working memory to search for the possible host-NP of the FQ

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Conclusion

Incrementality of integration

The backward-integration proceeds incrementally as well as the forward-integration.

Judgment Positivity and P600/SPS

Cost for working memory

The difference of direction is reflected in the differences of ERPs.

Memory Search Negativity

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