

ERP RESPONSES TO VIOLATIONS IN JAPANESE VERB CONJUGATION PATTERNS

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What'd be the past-tense form?

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□ English nonce verbs

skum → skummed [d]

slade → sladed [ɪd]

□ Japanese nonce verbs

すまぐ (sumagu) → すまいだ (sumai-da)

すぬう (sunuu) → すぬった (sunut-ta)

Onbin (音便)

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- Simple phonologically-conditioned “rule”: Onbin forms are determined by the root-final consonant

$/k, g/ \rightarrow /i/$; $/m, n, b/ \rightarrow /N/$; $/r, t, w/ \rightarrow /ʔ/$

$/ʔ/ =$ glottal stop 「っ」

Experiment by Vance (1991)

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□ Past tense form of *hoku*

hota 18%

hokutta 38%

hoita 44%

→ Is the past-tense formation involving “onbin” change a rule in the same sense as English regular inflection (-ed suffixation as in *walk/walked*) IS a rule?

Introduction

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- Issue: more than one mechanism in the processing of inflection?
- Dual Mechanism Model: Two qualitatively different mechanisms involved in word-level processing (Pinker 1999)
 - Rule-based computation and associative memory
 - Regular (walk/walked) vs. Irregular (sing/sang)
 - What about Japanese verb conjugation?

Roadmap

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- Introduction
- ERP components relevant to language processing
- Conjugation of Japanese verbs
- Experiment
 - Method
 - Stimuli & Predictions
 - Results
- Discussion & Conclusion

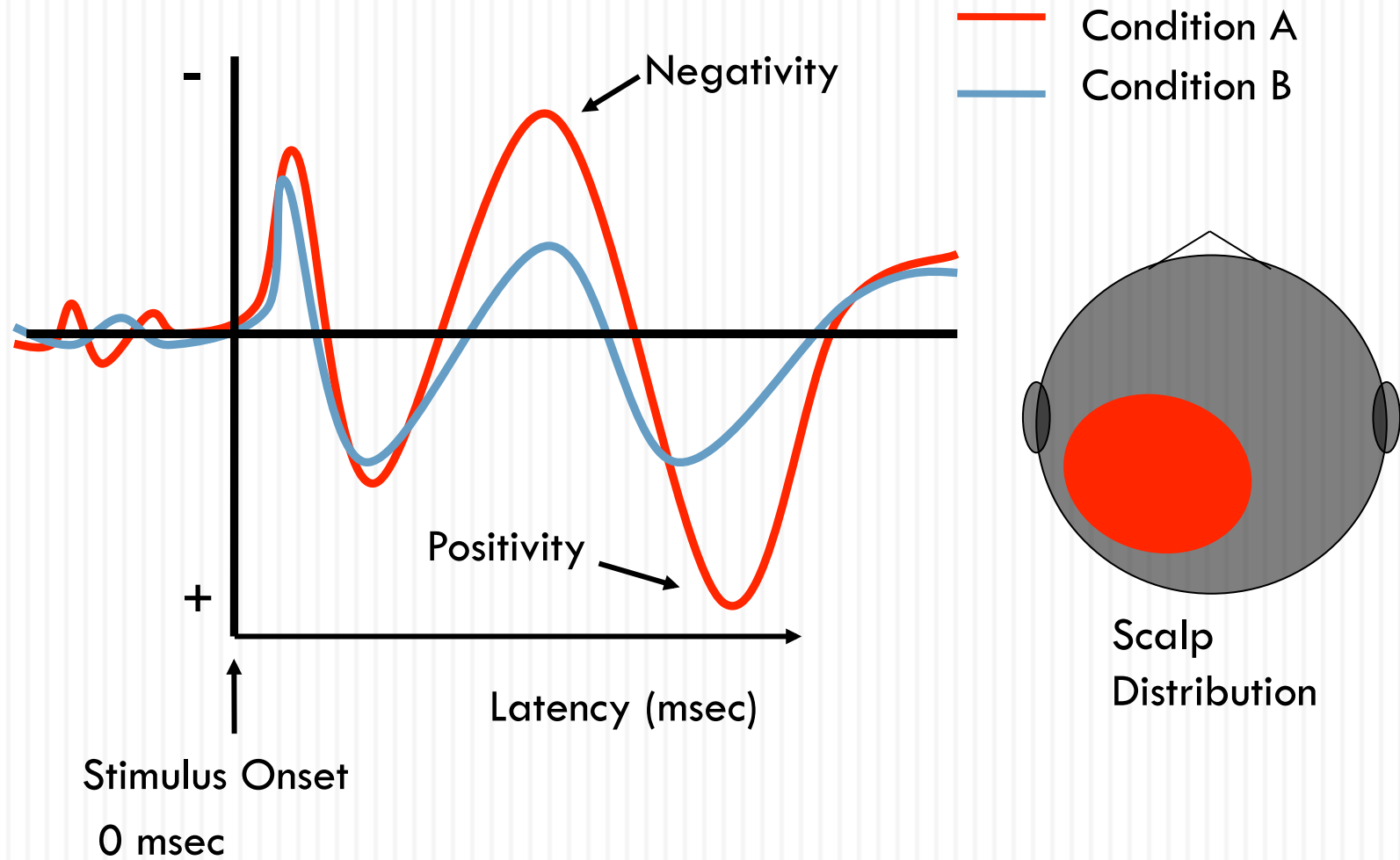
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ERP (Event-Related Potential)

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ERP Components Related to Language Processing

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- N400
 - Negativity
 - Peaks at around 400 ms after the stimulus onset
 - Wide distribution, often posterior-centered
 - Reflects semantic or pragmatic anomaly, costs related to lexical search
- LAN (Left Anterior Negativity)
 - Negativity
 - Observed around 300-500 ms after the stimulus onset
 - Distribution limited to the left anterior region
 - Reflects morpho-syntactic anomalies like agreement errors.

ERP Components Related to Language Processing

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□ P600

Positivity

Observed at around **600 ms** after the stimulus onset

Both **anterior & posterior distribution** observed

Reflects the process of reanalysis or repair in face of **morpho-syntactic or syntactic violations of various types**

ERP Studies on Regular and Irregular Inflection

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- Inappropriately attached or omitted regular inflectional affixes tend to elicit **a LAN**.
e.g. *bringed*, *wip* in the past context
- Modifications of irregular inflection tend to yield **an N400-like component**.
e.g. *pept* as the past form of *peep*

Newman et al. (2007)

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Conjugation of Japanese Verbs

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- Two different types of verb roots in terms of their conjugation patterns:
 - Vowel-ending roots (1-dan katsuyo)
 - Consonant-ending roots (5-dan katsuyo)

- Phonological changes in inflection with consonant-ending roots:
 - (a) various vowels (-a-, -i-, -u-) are inserted according to the following inflectional endings
 - (b) the final consonant undergoes morpho-phonological changes ("onbin")

Phonological Changes in Japanese Verb Conjugation

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□ Consonant-ending root: shaber 'chat'

<Vowel Insertion>

- a. non-past shaber-**u** (root + TENSE)
- b. negation shaber-**a**-nai (root + stem vowel+ NEG)
- c. infinitive shaber-**i** (root + stem vowel, e.g. -tai 'want to')

<Onbin Change>

- d. past shabe**ʔ**-ta
- e. continuative shabe**ʔ**-te

ʔ: glottal stop (「っ」)

Rule vs Memory in Verb Conjugation?

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- Vowel Insertion (-a) before NEG

Applies to all consonant-ending verb roots with no exception → rule-governed?

- Onbin change

Phonologically conditioned by root-final consonant

$/k, g/ \rightarrow /i/$; $/m, n, b/ \rightarrow /N/$; $/r, t, w/ \rightarrow /?/$

Some exceptions: ik 'go' → i?-ta, tow 'ask' → tow-ta

→ Lexically memorized? (Vance 1991)

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Stimuli and Predictions 1

(Vowel Insertion (-a) before NEG)

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- a. shaber-**a**-nai (Neg-form + -nai)
- b. *shaber-**i**-nai (infinitive form + -nai)
- c. *shaber-**u**-nai (non-past form + -nai)

(b) Involves a purely morpho-phonological rule violation (i.e., insertion of a wrong vowel)

(c) involves a phrase-structure violation (-u: non-past tense form)

[[[shaber]_V -u]_T -nai]_{NEG}

(the correct configuration would be: [[[]_V]_{NEG}]_T)

→ Both (b, c) will elicit computation-related components, with (c) exhibiting a more complicated response

Stimuli and Predictions 2

(Onbin Form before Past *-ta*)

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d. shabe[?]-ta / ka-i-ta / ton-da ('chat' / 'write' / 'fly')

e. *shaber-i-ta / *kak-i-ta / *tob-i-ta

(infinitive form + PAST)

“Onbin” forms are likely to be lexically memorized

→ The illicit forms (e) can be predicted to elicit a memory-related ERP component N400.

Stimuli (Negation Conjugation Errors)

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Negation conjugation errors

Zyuumin-wa danti-de otiba-o
residents-TOP housing.complex-in fallen.leaves-ACC

- | | | | |
|---|------------------|-----------------------|---|
| { | (a) moyas-a-nai | (Neg-form+nai) | } |
| | burn-NEG | | |
| | (b) *moyas-i-nai | (infinitive form+nai) | |
| | (c) *moyas-u-nai | (non-past form+nai) | } |

kisoku-da.

rule-COP

'Residents are not allowed to burn fallen leaves in the site of the housing complex'

Stimuli (Onbin Errors)

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Onbin errors in the past-tense form

Kazoku-wa ima-de syasin-o

family-TOP living.room-in pictures-ACC

{ (d) to^o-ta (onbin form +past)
take-PAST
(e) *tor-i-ta (infinitive form+past) }

rasii.

seem

‘It seems that the family took pictures in the living room.’

Method

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Participants

21 Japanese right-handed undergraduate students
(15 males and 6 females)

Stimulus Sentences

- Negative conjugation error
 - 30 sentences with Neg-form+ nai
 - 30 sentences with infinitive form+nai
 - 30 sentences with non-past form+nai
 - Onbin form error
 - 36 sentences with onbin form +past
 - 36 sentences with infinitive form+past
- 162 target + 90
filler sentences

Method

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□ Procedure

- Each phrase appeared on the screen for 600 ms with a 200 ms blank between each phrase.
- Participants were instructed to make a grammaticality judgment (yes/no decision) by clicking a computer mouse.

□ ERP Recording

64 Ag/AgCl electrodes Impedance: $\leq 10\text{k}\Omega$

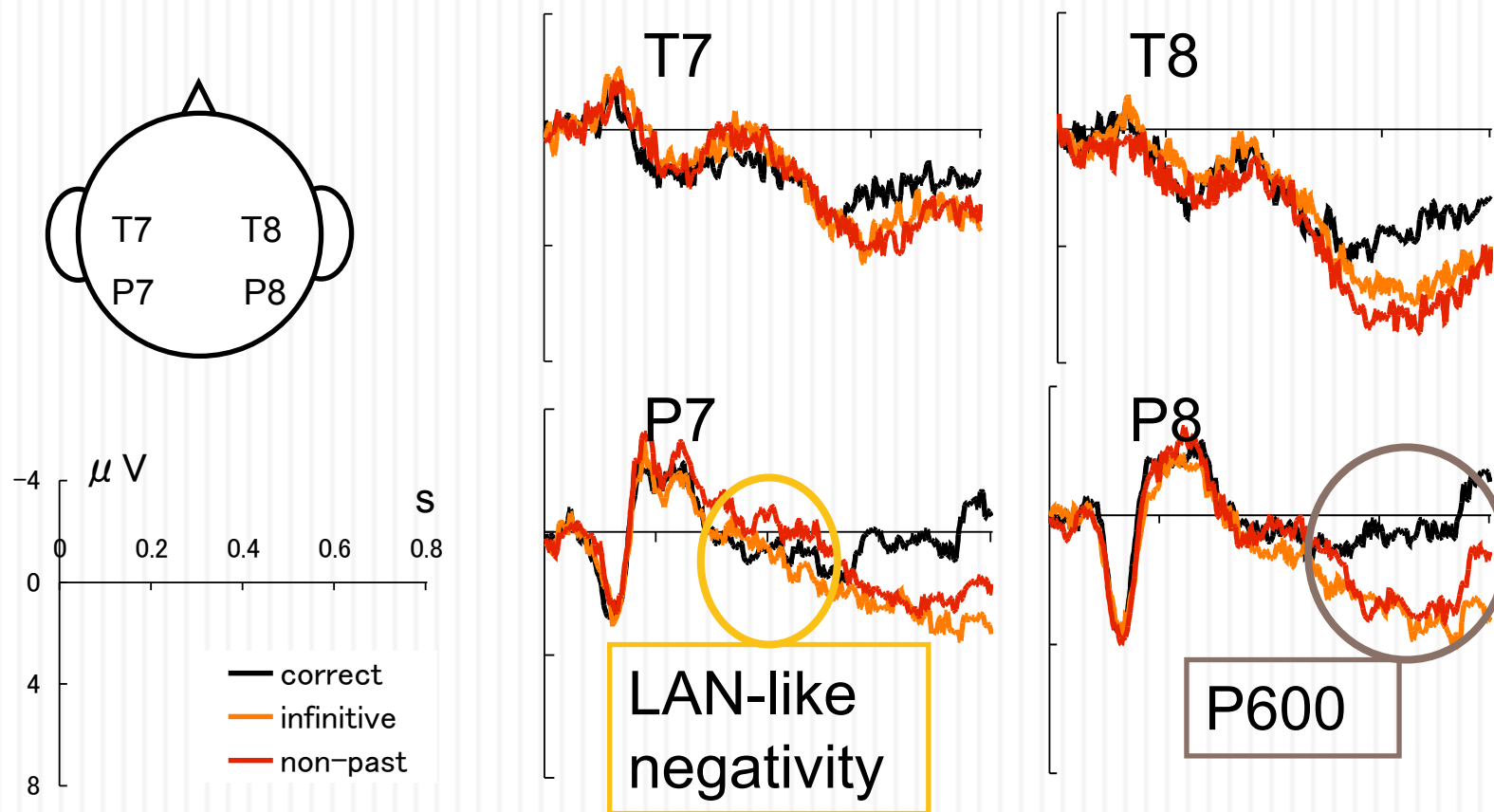
Sampling rate: 250Hz Baseline: -100-0ms

Bandpass: DC-70Hz Artifact rejection criterion: $\pm 70 \mu\text{V}$

Results

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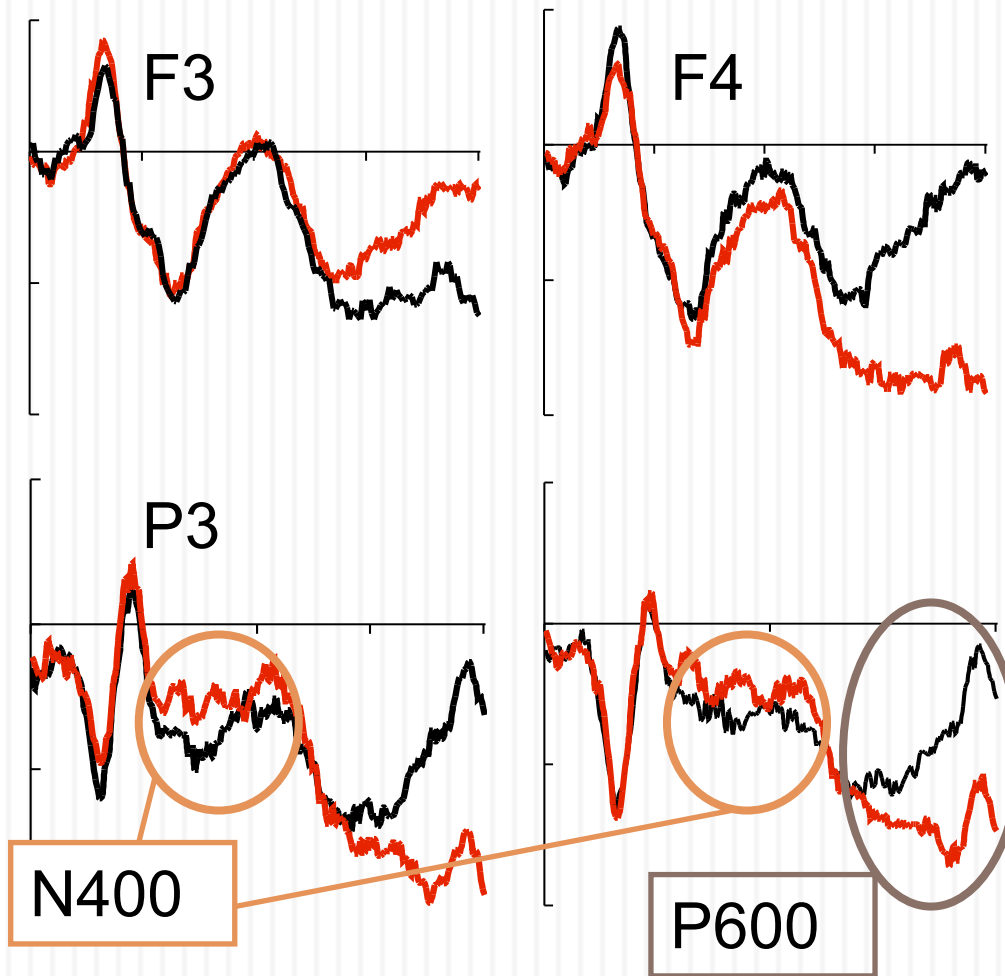
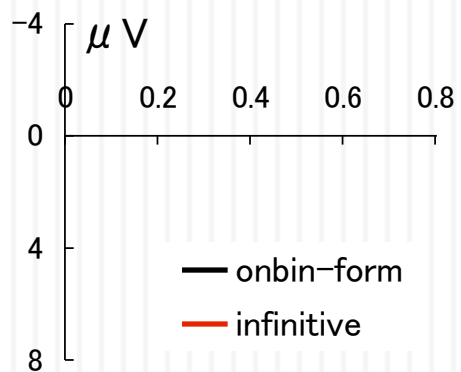
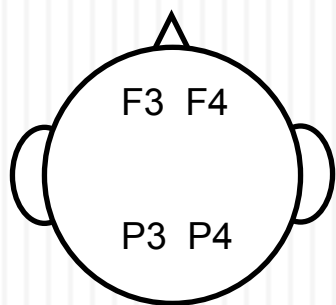
➤ Negation conjugation errors



Results

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➤ Onbin-errors



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Discussion: N400

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- The negativity elicited by the illicit infinitive form without onbin (*tori-ta* compared to *to^ɔ-ta*): N400

N400: known to be related to lexical search

→ Onbin does not involve computation by rule;
The onbin form for each verb root is memorized
in the lexicon.

Discussion: LAN-like Component

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- The negativity elicited by the non-past illicit forms (*moyasu-nai* compared to *moyasa-nai*) : a LAN-like component.

→ can be interpreted as reflecting the parser's detection of a phrase-structure violation (i.e., NEG outside the TP).

Discussion:

the Distribution of LAN-like Component

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- Different from a typical LAN in distribution (temporal, not anterior)
- A similar component observed in Catalan stem formation: overapplication of rule-based stem formation (root+ -a-) to a root which requires an irregular form (root+ -i-/-u-)

Rodriguez-Fornells et al. (2001)

Discussion: Lack of the Lan-Like Component

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- Negation Conjugation Errors:

- (b) Infinitive form + nai (*moyasi-nai*): P600

- (c) Non-past form + nai (*moyasu-nai*): LAN-like component+P600

- WHY the difference?

- (b): violation of a simple morpho-phonological rule (vowel insertion)

- (c): phrase-structure violation (NEG outside TP)

→ Both are computation-related violation, but differ in complexity

Discussion: P600

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- P600: Observed in all the error types
 - Reflects the cost of dealing with conjugation errors, irrespective of its nature (rule-based or memory-based).

Concluding Remarks

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- Conjugation of Japanese roots with a specific vowel for each ending involves rule-based computation.
- The morpho-phonological change (onbin) requires lexical memory.
 - support for the Dual Mechanism Model

For Future Study

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- Rule-based phonological change (vowel insertion) and memory-based phonological change (onbin) in the inflection of one and the same verb
→ different from well-studied regular/irregular dichotomy in inflectional patterns in English, German, etc.
- What about the conjugation of verbs with vowel-ending roots?
- Or of adjectives?

Selected References

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THANK YOU

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