

2-14-2010

An Experimental Investigation of Variation in Modern Hebrew

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I. Introduction

- In Modern Hebrew, there are several acoustically identical segments that behave differently phonologically, with some undergoing spirantization and others not doing so.

(1) Alternating pairs and exceptional segments in Modern Hebrew spirantization

| Segments | Alternating pairs | Exceptional fricatives | Exceptional stops |
|------------|-------------------|------------------------|-------------------|
| /χ/ or /k/ | kibes lexabes | χijex lexajeχ | kijem lekajem |
| /v/ or /b/ | bitel levatel | vitel levatel | kibel lekabel |
| /f/ or /p/ | piter lefater | fifel lefafel | siper lesaper |

- Additionally, variation in alternating segments has been reported:

(2) Variation in alternating pairs

| Expected | Possible variant |
|----------|------------------|
| kibes | χibes |
| bitel | vitel |
| piter | fiter |

- Variation is a consequence of exceptional segments and alternating segments influencing each other.
- This presentation reports the results of a rating experiment testing the acceptability of variation in alternating and exceptional segments with relation to Modern Hebrew spirantization.
- Outline of the talk:**
 - Overview of Modern Hebrew Spirantization
 - Alternation
 - Exceptionality and non-alternation
 - Variation
 - Rating Experiment
 - Hypotheses
 - Methods
 - Results
 - Conclusions

II. Overview of Modern Hebrew Spirantization

A. Regular alternation

- Spirantization in Modern Hebrew verbal paradigms is loosely characterized by the alternation of [p], [b], and [k] with their fricative counterparts [f], [v], and [χ], respectively. Fricatives occur in post-vocalic position whereas stops occur elsewhere.

(3) Spirantization distribution in Modern Hebrew

| | Root | Infinitive | 3rd Person Sg. Past.m. | Gloss |
|-----------|-------|------------|------------------------|-------------|
| /p/ → [f] | /pɔj/ | [lifɔj] | [pagaʃ] | 'to meet' |
| /b/ → [v] | /bɔd/ | [livɔd] | [bagad] | 'to betray' |
| /k/ → [χ] | /ktb/ | [liχtov] | [katav] | 'to write' |

B. Non-alternation

- Of the seven binyanim in Modern Hebrew, only two allow for the consonants to be in the environment required for alternation.

(4) Non-alternating paradigms in Modern Hebrew

| Binyan | Past | Future | Alternation? | |
|----------|--|--|---------------------------|----------------------------|
| | | | C ₁ | C ₂ |
| Pa'al | C _{1a} .C _{2a} C | ji.C ₁ .C _{2o} /aC | yes [kanas] [jiχnos] | yes [kavar] [jikbor] |
| Nif'al | ni.C ₁ .C _{2a} C | ji.C _{1a} .C _{2e} C | yes [niftax] [jipataχ] | yes [ni]bar] [ji]faber] |
| Hif'il | hi.C ₁ .C _{2i} C | ja.C ₁ .C _{2i} C | no [hiflig] [jaflig] | no [hilbi] [jalbi] |
| Pi'el | C _{1i} .C _{2e} C | je.C _{1a} .C _{2e} C | yes [biter] [jevate] | no [siper] [jesaper] |
| Hitpa'el | hit.C _{1a} .C _{2e} C | je.C _{1a} .C _{2e} C | no [hitbaje] [jitbaje] | no [hitlabe] [jitlabe] |
| Huf'al | hu.C ₁ .C _{2a} C | Ju.C ₁ .C _{2a} C | no [huxpal] [juxpal] | no [huxpal] [juxpal] |
| Pu'al | C _{1u} .C _{2a} C | je.C _{1u} .C _{2a} C | no [putar] [jeputar] | no [χupar] [jeχupar] |

C. Exceptionality

- Exceptions to spirantization are non-alternating [p], [b], [k], [f], [v], and [χ], which may surface as stops in post-vocalic position or as fricatives elsewhere.

(5) Exceptions to spirantization in Modern Hebrew (underlined>

| | | | | |
|---------------|-------|---------|-----------|--------------|
| a. /k/ (< *q) | /krʔ/ | [kara] | [likro] | 'to read' |
| b. /v/ (< *w) | /vtr/ | [viter] | [levater] | 'to give up' |

D. Variation

- Variation has been reported in Modern Hebrew spirantization (Adam 2000) and involves segments that normally conform to the spirantization distribution surfacing as stops where fricatives are expected or as fricatives where stops are predicted.

(6) Variation in Modern Hebrew spirantization

| Expected | Acceptable Variant | Gloss |
|---------------------|--------------------|--------------|
| paga ^j | faga ^j | 'met' |
| jikbor | jikvor | 'will bury' |
| je ^χ ase | jekase | 'will cover' |

- Adam (2002) claims that this variation is driven by non-alternation and exceptionality.
 - Variation in alternating forms is seen as a "conflict [which] entails a competition between two grammars: one which allows alternation and one which blocks it."
- No documentation of variation in exceptional and non-alternating forms.
- This rating experiment was designed to examine the nature and acceptability of variation in alternating *and* exceptional segments.

III. Rating Experiment

- Based on a pilot study, the following were the hypotheses for the rating experiment:

(7) Hypotheses

Alternating Segments

- 1a. Variation is acceptable
- 1b. Not free variation: variation is biased to expected form
- 1c. Positional effects

Exceptional Segments

- 2a. If any variation, then less than variation in alternating segments
- 2b. Positional effects

A. Stimuli

- A total of 42 roots were used in the experiment:
 - 24 with alternating segments
 - 12 with exceptional segments
 - 6 containing two target segments
- Each root was conjugated and recorded in the expected and variant form for each conjugation, resulting in 204 target words.

(8) Expected and variant forms in the spirantization distribution

| Pair | Root | 3 rd Person Sg. Past | | Infinitive | | Gloss |
|-----------|-------|---------------------------------|----------------------------------|-----------------------------------|-----------------------------|-------------|
| | | Expected (word-initial stop) | Variant (word-initial fricative) | Expected (post-vocalic fricative) | Variant (post-vocalic stop) | |
| /p/ → [f] | /prs/ | [paras] | [faras] | [lifros] | [lipros] | 'to spread' |
| /b/ → [v] | /bnh/ | [bana] | [vana] | [livnot] | [libnot] | 'to build' |
| /k/ → [χ] | /ktb/ | [katav] | [χatav] | [lixtov] | [liktov] | 'to write' |

- Target words were inserted into carrier sentences. Following each of the verbs was a semantically plausible four-syllable sentence ending (e.g. the verb 'to wash' could be followed by 'in the bathroom').

(9) Sample carrier sentences for target words

Past

[amru li jedaniel (target verb) le/be/me/et _____]
 told to me that Daniel (target verb) to/in/from/the _____
 "I've been told that Daniel (target verb) to/in/from/the _____"
 e.g. "I've been told that Daniel *built* the *hut*."

Infinitive

[amru li jedan holeχ (target verb) le/be/me/et _____]
 told to me that Dan is going (target verb) to/in/from _____
 "I've been told that Dan will (target verb) to/in/from _____"
 e.g. "I've been told that Dan will *build* the *hut*."

Present

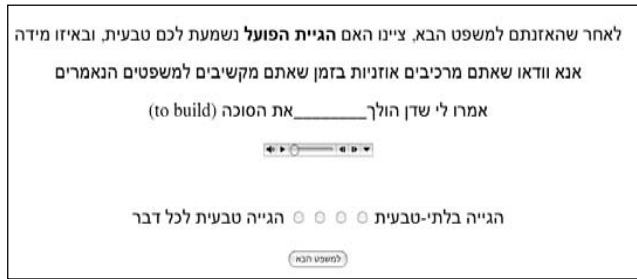
[amru li jedani (target verb) le/be/me/et _____]
 told to me that Danny (target verb) to/in/from _____
 "I've been told that Danny (target verb) to/in/from _____"
 e.g. "I've been told that Danny is *building* the *hut*."

B. Participants and Procedure

- 74 native speakers of Hebrew (34 male, 40 female) ages 19-40 residing in Israel participated in the online experiment.
- Participants were instructed (in writing) to listen carefully to each of the sentences using headphones and to pay special attention to the target verb.
 - Participants were asked to rate the target verbs in the sentences as to their **naturalness**.
 - A **natural** pronunciation was described as one that could possibly be uttered by their peers.
 - An **unnatural** pronunciation was described as one that a native speaker would never utter.

- Participants had to select one of four radio buttons on the screen with 'very natural pronunciation' on the left side of the button set and 'unnatural pronunciation' on the right.

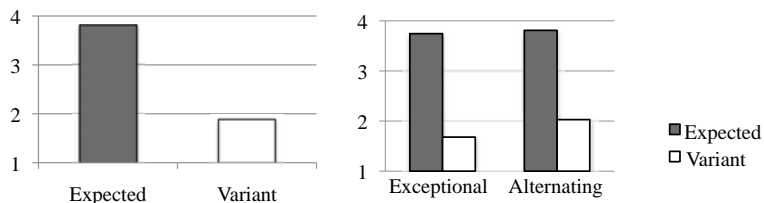
(10) Screen shot of experiment



C. Results

- Participants' responses to the rating task were translated to a four-point scale:
 - Very natural pronunciation = 4 points
 - Unnatural pronunciation = 1 point
- There was a preference for the expected form across all positions.
 - Main effect of *allophone* ($F(1, 73) = 886.521, p < .001$)
 - Tokens with the target segment in the expected form were rated more natural than tokens with the target segment in the variant form.

(11) Ratings of expected vs. variant forms



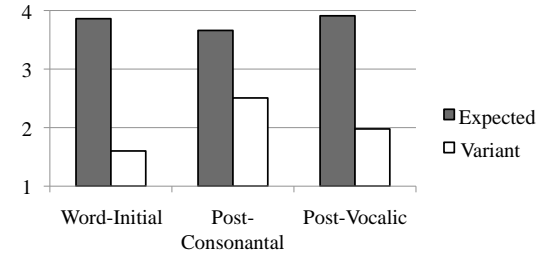
- Variation in exceptional segments was rated less natural than variation in alternating segments.
 - Main effect of *type* ($F(1, 73) = 80.073, p < .001$)
 - Interaction between *type* and *allophone* ($F(1, 73) = 18.707, p < .001$)

1. Alternating segments

- Both *position* and *allophone* contributed to the acceptability of variation in alternating segments.

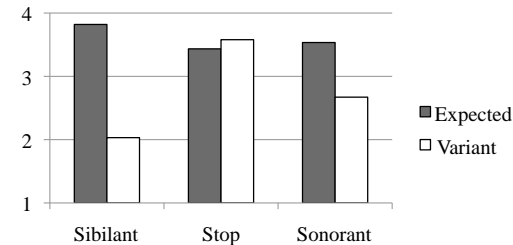
- Main effect of *position* ($F(2, 72) = 36.963, p < .001$)
- Main effect of *allophone* ($F(1, 73) = 890.882, p < .001$)
- Interaction between *position* and *allophone* ($F(2, 72) = 89.036, p < .001$)
 - Tokens with the target segment post-consonantal drove the main effect of *position* and the interaction of *position* and *allophone*.

(12) Acceptability of variation in alternating segments



- Main effect of the segment preceding the alternating segment within a given token ($F(1, 36) = 32.869, p < .001$)
- Interaction of *consonant type* and *allophone* ($F(1, 36) = 38.346, p < .001$)
 - Driven by the higher rating of acceptability of the variant form (a fricative) when following a stop.

(13) Acceptability of variation within post-consonantal position (alternating segments)

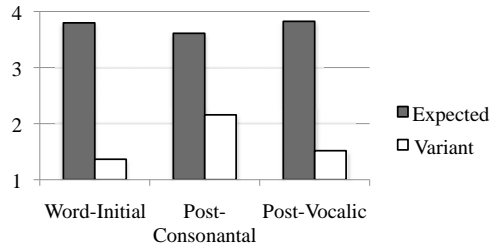


2. Exceptional segments

- Variation is somewhat acceptable in exceptional segments.
 - Significant difference between the acceptability of variants of exceptional segments vs. baseline ($t(73) = 10.718, p < .001$)
- Both Position and Allophone contributed to the acceptability of variation in exceptional segments.

- Main effect of *position* ($F(2, 72) = 40.481, p < .001$)
- Main effect of *allophone* ($F(1, 73) = 767.518, p < .001$)
- Interaction between the *position* and *allophone* ($F(2, 72) = 57.094, p < .001$)
 - Words containing the target segment in post-consonantal position drove the main effect of *position* and the interaction of *position* and *allophone*.

(14) Acceptability of variation in exceptional segments



V. Conclusions, Implications, Further Directions

- Variation is acceptable not only in alternating segments, but also in exceptional segments.
 - Variation is less acceptable in exceptional segments.
 - Not free variation in either case – gradient (based on position, preceding segment, etc.)

Future directions:

- Further analysis of experiment data – look at paradigmatic trends within participants.
- Diacronic data – examine directionality of variation
- Production experiments in Hebrew with pre-literate children and non-literate adults.
- Corpus study (CoSIH) to determine occurrences of variation in natural speech.
- Other languages and other phenomena where there is alternation and exceptionality (and, hopefully, variation as a consequence).

Selected Reference

Adam, Galit. 2002. From Variable to Optimal Grammar: Evidence from Language Acquisition and Language Change. Ph.D. Dissertation. Tel-Aviv University.

Many of my talk handouts (and my dissertation) are available on my Selected Works webpage:

http://works.bepress.com/michal_martinez/

Appendix: Optimality Theoretic analysis

- **Alternating segments** are in complementary distribution – allophony
 - Markedness constraints » Faithfulness constraints

(15) Constraints for the analysis of alternation

- *V-STOP Post-vocalic stops are prohibited.
- *[+cont, -sib] Non-sibilant fricatives are prohibited.
- *STOP Stops are prohibited.
- IDENT-IO[cont] Input-output correspondents are identical in [±cont].
 - *V-STOP » *[+cont, -sib] » IDENT-IO[cont], *STOP

- **Exceptionality** (non-alternation) is captured through set-indexation (Pater 2000)
 - Cloning of the faithfulness constraint, IDENT-IO[cont], and placement of cloned (indexed) constraint above the relevant markedness constraints.
 - Indexed Faithfulness » Markedness » General Faithfulness
- **Gradience in variation** is accounted for by implementing Stochastic OT
 - Algorithm cycles through the grammar (input/output pairs, candidate frequencies, constraint violations)
 - Constraints are assigned ranking values
 - Ranking values and constraint distributions determine amount of overlap between constraints
 - Overlap in distribution determines level of variation
 - Selection points determine whether one constraint outranks another.

(16) Analysis of /bk_l/ (alternating /b/, exceptional /k/) using the combined model

| /bk _l / + sg.m.pres 'asks for' | IDENT-IO[cont] _l (.723) | *V-STOP (.637) | *[+cont, -sib] (.592) | *StopStop (.717) | *STOP (1) | IDENT-IO[cont] _l |
|--|---------------------------------------|-------------------|--------------------------|---------------------|--------------|-----------------------------|
| a. mevak _l e _l Input (57.4%) Generated (42.3%) | | * | * | | * | * |
| b. mebak _l e _l Input (39.3%) Generated (33.8%) | | **! | | | ** | |
| c. mevaχ _l e _l Input (0%) Generated (23.9%) | *! | | ** | | | ** |
| d. mebaχ _l e _l Input (3.3%) Generated (0%) | *! | * | * | | * | * |