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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

<table>
<thead>
<tr>
<th>Segments</th>
<th>Alternating pairs</th>
<th>Exceptional fricatives</th>
<th>Exceptional stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>/x/ or /ks/</td>
<td>kibes levatels</td>
<td>zibex lezajem</td>
<td>kijem lekajem</td>
</tr>
<tr>
<td>/v/ or /bs/</td>
<td>betel levatels</td>
<td>vetel levatel</td>
<td>kibel lekabel</td>
</tr>
<tr>
<td>/p/ or /ps/</td>
<td>piter lefaters</td>
<td>pipel lefajel</td>
<td>siper lepater</td>
</tr>
</tbody>
</table>

- Additionally, variation in alternating segments has been reported:

(2) Variation in alternating pairs

<table>
<thead>
<tr>
<th>Expected</th>
<th>Possible variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>kibes</td>
<td>zibes</td>
</tr>
<tr>
<td>betel</td>
<td>vetel</td>
</tr>
<tr>
<td>piter</td>
<td>piper</td>
</tr>
</tbody>
</table>

- 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 [z], respectively. Fricatives occur in post-vocalic position whereas stops occur elsewhere.

(3) Spirantization distribution in Modern Hebrew

- 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

<table>
<thead>
<tr>
<th>Binyan</th>
<th>Past</th>
<th>Future</th>
<th>C₁</th>
<th>C₂</th>
<th>Alternation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pa’al</td>
<td>āC₁ āC₂ ac</td>
<td>jāC₁ jāC₂ jāC₃</td>
<td>yes</td>
<td>yes</td>
<td>pa’al [kav] [jikbor]</td>
</tr>
<tr>
<td>Nif’al</td>
<td>niC₁ niC₂ aC</td>
<td>jīC₁ jīC₂ jīC₃</td>
<td>yes</td>
<td>yes</td>
<td>nif’al [jīta] [jītah]</td>
</tr>
<tr>
<td>Hiṭ’al</td>
<td>hīC₁ hīC₂ ic</td>
<td>jēC₁ jēC₂ jēC₃</td>
<td>no</td>
<td>no</td>
<td>hil’al [ja’l]</td>
</tr>
<tr>
<td>Pi’el</td>
<td>īC₁ īC₂ eC</td>
<td>jēC₁ jēC₂ jēC₃</td>
<td>yes</td>
<td>no</td>
<td>sip’al [jē]</td>
</tr>
<tr>
<td>Hitpa’el</td>
<td>hitC₁ hitC₂ eC</td>
<td>jēC₁ jēC₂ jēC₃</td>
<td>no</td>
<td>no</td>
<td>hitpa’el [jē]</td>
</tr>
<tr>
<td>Huṭ’al</td>
<td>huC₁ huC₂ aC</td>
<td>jēC₁ jēC₂ jēC₃</td>
<td>no</td>
<td>no</td>
<td>huṭ’al [jē]</td>
</tr>
<tr>
<td>Pu’al</td>
<td>āC₁ āC₂ aC</td>
<td>jēC₁ jēC₂ jēC₃</td>
<td>no</td>
<td>no</td>
<td>pu’al [jē]</td>
</tr>
</tbody>
</table>

C. Exceptionality

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

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

- /b/ (< *q) /bq/ [kara] [jikro] ‘to read’
- /v/ (< *w) /vṭr/ [levacter] ‘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

<table>
<thead>
<tr>
<th>Expected</th>
<th>Acceptable Variant</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>pagaʃ</td>
<td>fagaʃ</td>
<td>‘met’</td>
</tr>
<tr>
<td>jikbor</td>
<td>jikvor</td>
<td>‘will bury’</td>
</tr>
<tr>
<td>jekase</td>
<td>jekase</td>
<td>‘will cover’</td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>Pair</th>
<th>Root</th>
<th>3rd Person Sg. Past</th>
<th>Infinitive</th>
<th>Expected (word-initial stop)</th>
<th>Variant (word-initial fricative)</th>
<th>Expected (post-vocalic fricative)</th>
<th>Variant (post-vocalic stop)</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p/</td>
<td>/pr/</td>
<td>[paras]</td>
<td>[lifros]</td>
<td>‘to spread’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/b/</td>
<td>/bh/</td>
<td>[bana]</td>
<td>[libnot]</td>
<td>‘to build’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/k/</td>
<td>/kh/</td>
<td>[katav]</td>
<td>[liktov]</td>
<td>‘to write’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 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] jedan[le] (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 hol[le] (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] jedan[le] (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.
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.

1. Alternating segments

- Both position and allophone contributed to the acceptability of variation in alternating segments.
  - Main effect of type \( F(1, 73) = 80.073, p < .001 \)
  - Interaction between type and allophone \( F(1, 73) = 18.707, p < .001 \)
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


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
  - 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

<table>
<thead>
<tr>
<th>Word-Initial</th>
<th>Post-Consonantal</th>
<th>Post-Vocalic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>Variant</td>
<td></td>
</tr>
</tbody>
</table>

(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

- Gradienct 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/ (alternating /b/, exceptional /k/) using the combined model

<table>
<thead>
<tr>
<th>/bk/</th>
<th>+ sg.m.pres 'asks for'</th>
</tr>
</thead>
<tbody>
<tr>
<td>* a. mevak</td>
<td>Generated (57.4%)</td>
</tr>
<tr>
<td>b. mevak</td>
<td>Generated (39.3%)</td>
</tr>
<tr>
<td>c. mevak</td>
<td>Generated (23.9%)</td>
</tr>
<tr>
<td>d. mevk</td>
<td>Generated (3.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>+ sg.m.pres 'asks for'</th>
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