DURATION OF VOWELS IN THE CONSTRUCT STATE IN HEBRE

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Introduction

Every noun of the Hebrew language appears in one of three states: absolute, construct and with pronominal suffixes. Nouns in the construct state and with pronominal suffixes usually change their forms and vowel systems. The vowel sign מ- (one of the vowel signs of 'segol malé') in the word-final position of masculine, singular nouns in the absolute state changes to מ- (one of the vowel signs of 'sere malé') for the singular form and •- (one of the vowel signs of 'sere malé') for the plural of the construct state, respectively.

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The vowel sign ֦, whose phoneme is /e/, consists of the vowel sign 'segol' and the consonant letter of "hei" following the 'segol' as a quasi-vowel. The vowel sign ֦, whose phoneme is /e/, consists of the vowel sign 'sere' and "hei", a consonant letter of Hebrew, following 'sere' as a quasi-vowel. The vowel sign of ֦, whose phoneme is /e/, consists of the vowel sign 'sere' and the consonant letter "yod" following the 'sere' as a quasi-vowel.

This study discusses the differences in the duration of word-final vowels between the singular and plural forms of the construct state for certain nouns in actual speech.

### 1. Experiments

#### 1.1 Preparation of test words

Three different words as governing nouns (ie, ‘nismáx’ in Hebrew) and one word as a governed noun (ie, ‘soméx’ in Hebrew) were used for the test words. The governing nouns (in the construct state), the governed noun (in the absolute state) and their combined form (ie, ‘smixút’ in Hebrew) are listed, using phonemic transcription* in Table I. Phonetically

<table>
<thead>
<tr>
<th>Word</th>
<th>s/pl</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mumhé/</td>
<td>s</td>
<td>expert</td>
</tr>
<tr>
<td>/mumhé/</td>
<td>pl</td>
<td>experts</td>
</tr>
<tr>
<td>/ma’asé/</td>
<td>s</td>
<td>deed</td>
</tr>
<tr>
<td>/ma’asé/</td>
<td>pl</td>
<td>deeds</td>
</tr>
<tr>
<td>/mexabé/</td>
<td>s</td>
<td>extinguisher</td>
</tr>
<tr>
<td>/mexabé/</td>
<td>pl</td>
<td>extinguishers</td>
</tr>
<tr>
<td>/pát/</td>
<td>s</td>
<td>a piece of bread</td>
</tr>
</tbody>
</table>

**Governed noun in the absolute state**

<table>
<thead>
<tr>
<th>Word</th>
<th>s/pl</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mumhèpát/</td>
<td>s</td>
<td>expert of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
<tr>
<td>/mumhèpát/</td>
<td>pl</td>
<td>experts of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
<tr>
<td>/ma’asepát/</td>
<td>s</td>
<td>deed of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
<tr>
<td>/ma’asepát/</td>
<td>pl</td>
<td>deeds of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
<tr>
<td>/mexabèpát/</td>
<td>s</td>
<td>extinguisher of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
<tr>
<td>/mexabèpát/</td>
<td>pl</td>
<td>extinguishers of (or ‘for’, ‘in’) a piece of bread</td>
</tr>
</tbody>
</table>

* The transcription /h/ was used for the voiceless, fricative, pharyngeal consonant.

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the nouns in the combined form are considered as one word where the governing noun loses its main stress, which now falls on the governed noun. (1)

1. 2 Procedures and method

The subject was a female, native speaker of Israeli Hebrew who was twenty-five years old. The test words were presented to her to read separately at a normal tempo in terms of her own speech more than three times. The recording was performed in an anechoic studio, and the speech sounds were then analyzed with an LPC analysis program. (9) The results were then processed by a SPSS program on the VAX-11/780 System.

1. 3 Duration of vowels

Speech signals low pass-filtered with 4.5 kHz cut-off frequency were passed through A/D converters on a computer system and then displayed on a graphic display screen. Observing the speech signals there and listening to the speech sounds, the duration of the vowels in question was determined.

The onset of the wave form of each test word in combined form was at the beginning of the speech signal for consonant /m/. The offset of the wave form was at the end of the duration of the aspiration following the closure for the stop consonant /t/. The duration of the word-final vowel of a governing noun was defined as below (Fig. 1).

1. 3. 1 /mumhepat/

The onset of vowel of /e/ was at the beginning of the periodical wave form for /e/, which followed the fricating wave form for the preceding consonant /h/. The end of the wave form for /e/ was defined as the boundary, which the closure for the consonant /p/ followed.

1. 3. 2 /ma'asepat/

The onset of the vowel /e/ was at the beginning of the periodical wave form for /e/, which followed the fricating wave form for the preceding consonant /s/. The end of the wave for /e/ was defined as the boundary just before the onset of the closure for the consonant /p/ which followed the vowel /e/.

1. 3. 3 /mexabepat/

A periodical wave form, of small intensity, for the consonant /b/ changed
to show a small amount of frication caused by the burst, which occurred after
the closure of /b/ for the vowel of /e/. The onset of the vowel /e/ was at the
beginning of the periodical wave form with strong intensity for /e/ which
followed the wave form for the preceding consonant /b/. The end of the wave
form for /e/ was defined as the boundary just before the onset of the closure
for the consonant /p/ which followed the vowel /e/.

Fig. 1 Wave form for /mumḥepāt/ (/mumḥe/: singular)
2. Results and comments

The duration of the word-final vowel of governing nouns with a governed noun in the combined form was measured for both the singular and plural forms.

Duration of noun in combined form: \( W \) (msec)
Duration of governing noun: \( Y \) (msec)
Duration of governed noun: \( I \) (msec)
Duration of vowel /e/: \( X \) (msec)
Duration of vowel /a/: \( H \) (msec)
Duration of /h/, /s/ or /x/: \( Z \) (msec)
Duration of consonant /p/: \( J \) (msec)
Duration of consonant /t/: \( K \) (msec)

Normalized value of \( Y \) to \( W \): \( R = (Y/W) \times 100(\%) \)
Normalized value of \( Z \) to \( W \): \( T = (Z/W) \times 100(\%) \)
Normalized value of \( X \) to \( W \): \( P = (X/W) \times 100(\%) \)
Normalized value of \( J \) to \( W \): \( N = (J/W) \times 100(\%) \)
Normalized value of \( H \) to \( W \): \( L = (H/W) \times 100(\%) \)
Normalized value of \( K \) to \( W \): \( V = (K/W) \times 100(\%) \)

Normalized value of \( Z \) to \( Y \): \( S = (Z/Y) \times 100(\%) \)
Normalized value of \( X \) to \( Y \): \( Q = (X/Y) \times 100(\%) \)
Normalized value of \( J \) to \( I \): \( O = (J/I) \times 100(\%) \)
Normalized value of \( H \) to \( I \): \( M = (H/I) \times 100(\%) \)
Normalized value of \( K \) to \( I \): \( U = (K/I) \times 100(\%) \)

Table II and Fig. 2 give the results for the above values. The difference of duration between the singular and plural form for the values \( W, Y, I, Z, X, J, H, K, R, T, P, N, L, V, S, Q, O, M \) and \( U \) was examined via t-tests. Table III gives the results.

2.1 Difference in duration of nouns in the combined form

The difference in duration between the singular form (9 cases) and the
Fig. 2 Normalized values of duration of each segment of the combined form for singular and plural forms.
Table II: Relative duration of each segment in combined form

<table>
<thead>
<tr>
<th></th>
<th>/mumbepát/</th>
<th>/mum/</th>
<th>/b/</th>
<th>/e/</th>
<th>/p/</th>
<th>/a/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>s</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>15.5</td>
<td>12.3</td>
<td>11.9</td>
<td>15.0</td>
<td>17.2</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>pl</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>15.0</td>
<td>11.9</td>
<td>16.7</td>
<td>13.1</td>
<td>18.4</td>
<td>24.8</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>/ma’asepát/</th>
<th>/ma’a/</th>
<th>/s/</th>
<th>/e/</th>
<th>/p/</th>
<th>/a/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>s</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>20.5</td>
<td>13.6</td>
<td>9.7</td>
<td>14.6</td>
<td>15.6</td>
<td>26.0</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>17.6</td>
<td>13.3</td>
<td>15.5</td>
<td>12.7</td>
<td>16.4</td>
<td>24.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/mexabepát/</th>
<th>/mexa/</th>
<th>/b/</th>
<th>/e/</th>
<th>/p/</th>
<th>/a/</th>
<th>/t/</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>s</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>23.7</td>
<td>8.6</td>
<td>13.3</td>
<td>14.2</td>
<td>16.6</td>
<td>23.6</td>
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<tr>
<td></td>
<td>pl</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>22.4</td>
<td>9.3</td>
<td>15.8</td>
<td>12.3</td>
<td>16.9</td>
<td>23.2</td>
</tr>
</tbody>
</table>

singular: s, plural: pl
duration: d(msec), normalized duration: %

Fig. 3 Rate of duration of the word-final vowel /e/ of a governing noun to the duration of the combined form

Fig. 3 Rate of duration of the word-final vowel /e/ of a governing noun to the duration of the combined form

RATE OF DURATION (%)
2.2 Difference in duration of governing nouns in the construct state

The difference in duration between the singular form (9 cases) and the plural (14 cases) for three kinds of governing nouns was examined. The difference was not significant at the level of $p<0.05$ for any comparison.

2.3 Duration of the word-final vowel /e/ for governing nouns in the construct state their normalized values

The difference in duration of the vowel /e/ between the singular form (9 cases) and the plural (14 cases) for three kinds of governing nouns was examined. The difference was significant at the level of $p<0.05$ for the mean and normalized values of the duration.
Concerning the mean and normalized values of the duration of the vowel /e/, a remarkable difference was found between the singular and plural forms in the construct state for each governing noun (Fig. 3).

Conclusion

A difference was found in the duration of vowels between the singular and plural forms for Hebrew masculine nouns with the word-final vowel /e/ for governing noun in the construct state. The duration of the vowel in question was longer in the plural form than in the singular for both mean and normalized values.

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Notes