# Hebrew t-sibilant sequences: two ways to represent morphologically conditioned phonology

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# t-sibilant sequences in Hebrew

Sequences of [t] followed by a sibilant [s, z, ʃ, ts] are attested in Hebrew

- Within morphemes: [i-**tʃ**iʃ] 'to exhaust'
- Across morphemes [**t-ʃ**uva] 'answer'

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However:

- Statistically rare: **26** in a corpus of 11k tokens (compare S-t: **233**)
- Exceptionlessly repaired via metathesis in a single morphological context: verbs of the *hit-CaCeC* prosodic template

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# Questions

Do Hebrew speakers have a dispreference against t-S sequences…

- in all contexts?
- that is specific to certain morphological contexts?

How is the dispreference for t-S in different morphological contexts affected by…

- distributional evidence?
- alternation evidence?

# Phonotactic judgement experiment

# Experimental design

Three key 2-consonant sequences:
- t-S: [tʃ]
  - e.g., nonce root *ʃ-b-g* and BM-V template *hitCaCeC* ➜ [hi**tʃ**abeg]
- S-t: [ʃt]
  - e.g., nonce root *ʃ-b-g* and BM-V template *hitCaCeC* ➜ [hi**ʃt**abeg]
- Control: [tk], [tʁ]
  - e.g., nonce root *ʁ-p-ʃ* and BM-V template *hit-CaCeC* ➜ [hi**tʁ**apeʃ]

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    - e.g., nonce root ʁ-p-ʃ and BM-V template *hit-CaCeC* ➜ [hi**tʁ**apeʃ]

Four morphological contexts signaled by prosodic templates:

|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hi**t-C**aCeC | Template: hi-**CC**iC |
| Not-verb (Noun) | Template: ha-**t-C**uCa | Template: ma-**CC**eCa |

# Condition: BetweenMorpheme-Verb

|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hit-CaCeC<br>e.g., [hiʃtapeʁ] 'he improved' |  |
| Not-verb (Noun) |  |  |

BM-V: *hit-CaCeC* prosodic template (*hitpa'el*)

- t-S sequences exceptionlessly repaired by metathesis (Bolozky 1978)
- Ex: /hit-ʃapeʁ/ ➜ [hiʃtapeʁ] 'he improved'

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- t-S sequences exceptionlessly repaired by metathesis (Bolozky 1978)
- Ex: /hit-ʃapeʁ/ ➜ [hiʃtapeʁ] 'he improved'

⇒ Strong, converging evidence for S-t > t-S

# Results: BetweenMorpheme-Verb

- based on 50 participants (8 tokens per condition)
- rated nonce words after hearing them
  - from 0 (not Hebrew-like at all) to 100 (very Hebrew-like)
  - z-transformed
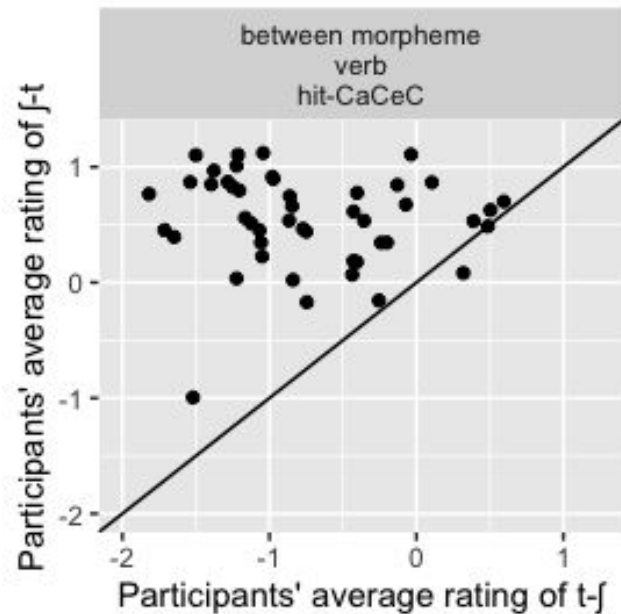
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**control = S-t > t-S**



between morpheme
verb
hit-CaCeC

control   ʃ-t   t-ʃ

rating (z-transformed)
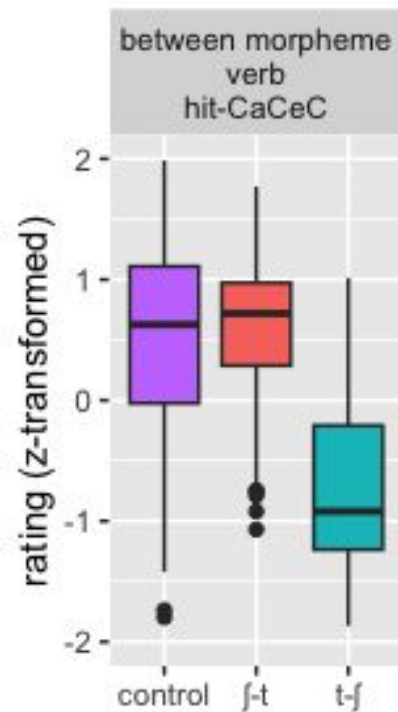
# Results: BetweenMorpheme-Verb

All participants agree S-t > t-S
(dots above the diagonal)

# Condition: WithinMorpheme-Verb/Noun

|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hit-CaCeC<br>Phonotactic evd: strong<br>Alternation evd: strong | Template: hi-CCiC<br>e.g., [hit.sis] 'to ferment sth' |
| Not-verb (Noun) |  | Template: ma-CCeCa<br>e.g., [maʃ.te.la] 'nursery' |

Within morpheme, for both nouns (*maktela* template) and verbs (*hif'il* template):
- t-S occurs rarely; S-t occurs more often
- No metathesis - linear order of consonants is important

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|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hit-CaCeC<br>Phonotactic evd: strong<br>Alternation evd: strong | Template: hi-CCiC<br>Phonotactic evd: medium<br>Alternation evd: none |
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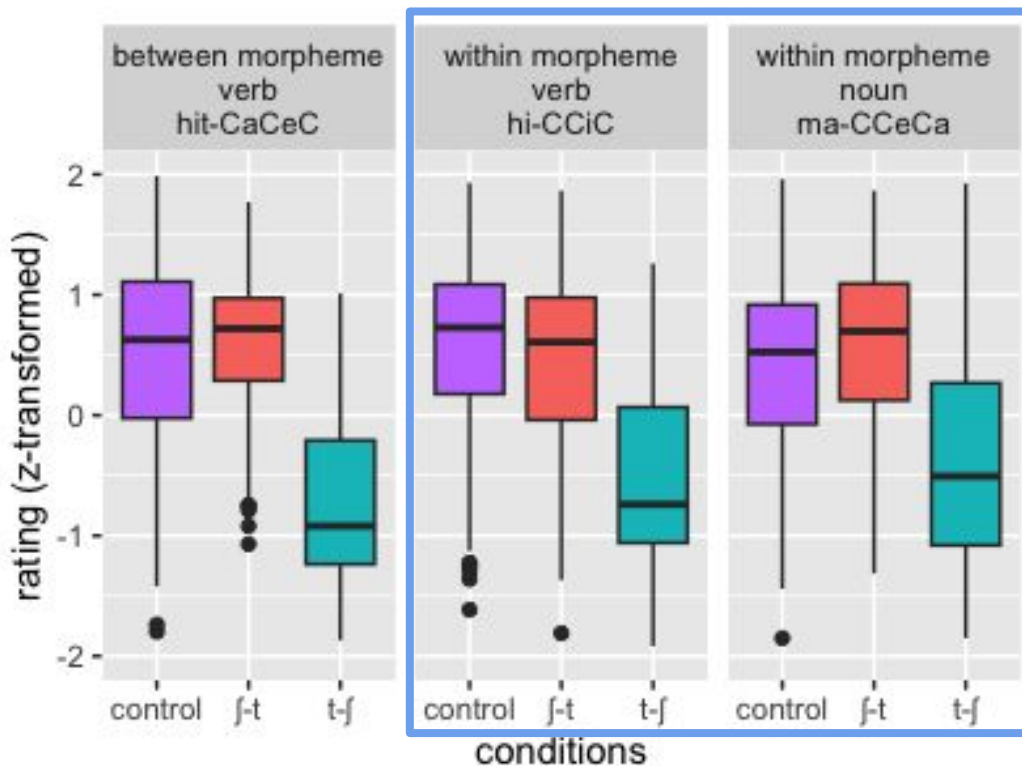- No metathesis - linear order of consonants is important

⇒ (less) Strong phonotactic evidence for S-t > t-S

# Results: WithinMorpheme-Verb/Noun
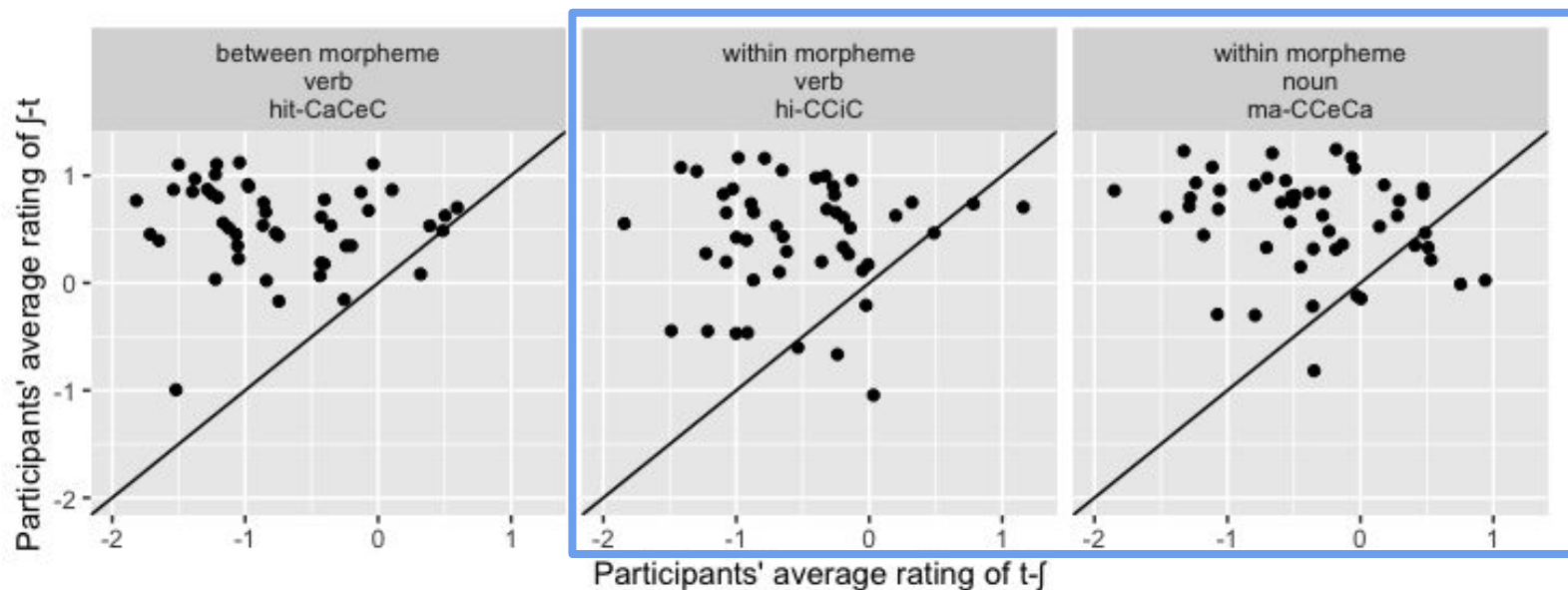
**control** = **S-t** > **t-S**

Statistically identical compared to BM-V

➜ Gradient phonotactic evidence alone is enough to make speakers disprefer t-S



insig. interaction of Condition * MorphemeContext (pd = 83%)

# Results: WithinMorpheme-Verb/Noun



Slightly more variable than BM-V

But most participants prefer S-t > t-S

# Condition: BetweenMorpheme-Noun

|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hit-CaCeC<br>Phonotactic evd: strong<br>Alternation evd: strong | Template: hi-CCiC<br>Phonotactic evd: medium<br>Alternation evd: none |
| Not-verb (Noun) | ? | Template: ma-CCeCa<br>Phonotactic evd: medium<br>Alternation evd: none |

Difficult to find appropriate nominal template
- Template for irregular (biliteral) roots (*ha-t-kula* template)
- Nonce template (*ha-t-katla* template)

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Difficult to find appropriate nominal template
- Template for irregular (biliteral) roots (*ha-t-kula* template)
- Nonce template (*ha-t-katla* template)
- Nominal template derived from *hit-CaCeC*: (*hit-katlut* template)
  ⇒ Behaves exactly like *hit-CaCeC*

# Note on biliteral roots

Most words formed from a (usually tri-)consonantal root and a prosodic template

- e.g., root *g-d-l* (related to concept of 'size')
  - + verbal template *hi-CCiC* ➜ *hi**gd**il* 'enlarged'
  - + nominal template *mi-CCaC* ➜ *mi**gd**al* 'tower'

Biliteral (irregular) roots: frequently/always occur with only two consonants

- Much rarer than triconsonantal roots
- e.g., root *q-y-m* + verbal template *hi-CCiC* ➜ *he**qim*** 'raised'

# Condition: BetweenMorpheme-(Biliteral) Noun

|  | Between morpheme (BM) | Within morpheme (WM) |
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| Verb | Template: hit-CaCeC<br>Phonotactic evd: strong<br>Alternation evd: strong | Template: hi-CCiC<br>Phonotactic evd: medium<br>Alternation evd: none |
| Not-verb (Noun) | Template: ha-t-CuCa<br>Example: [hat.ʃu.va] 'the answer' | Template: ma-CCeCa<br>Phonotactic evd: medium<br>Alternation evd: none |

Combination of determiner *ha-* 'the' and nominalizer prefix *t-*
- t-S occurs rarely (e.g., *hatʃuva* 'the answer')
- No metathesis in this template - S-t never occurs

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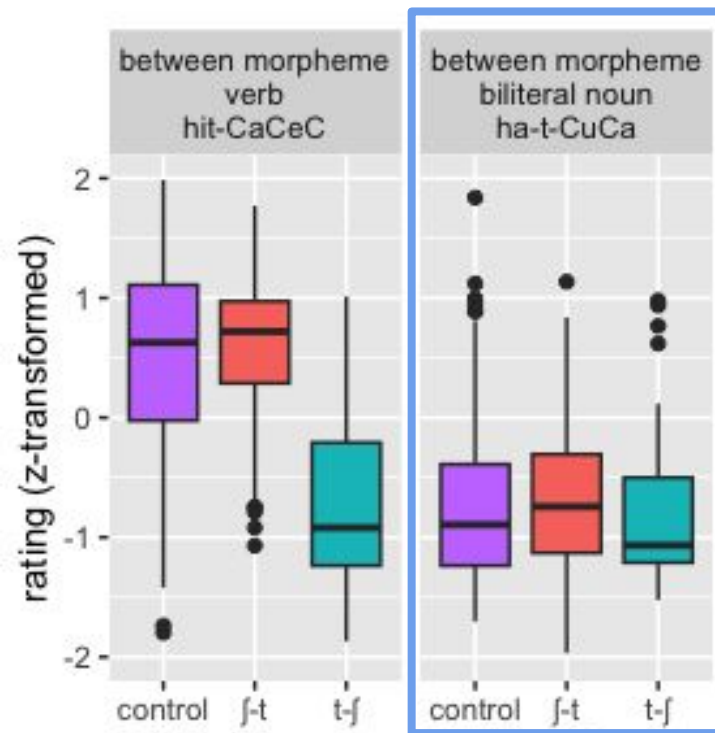Combination of determiner *ha-* 'the' and nominalizer prefix *t-*
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⇒ Neither phonotactic nor alternation evidence for S-t > t-S

# Results: BetweenMorpheme-Noun

BM-N overall dispreferred
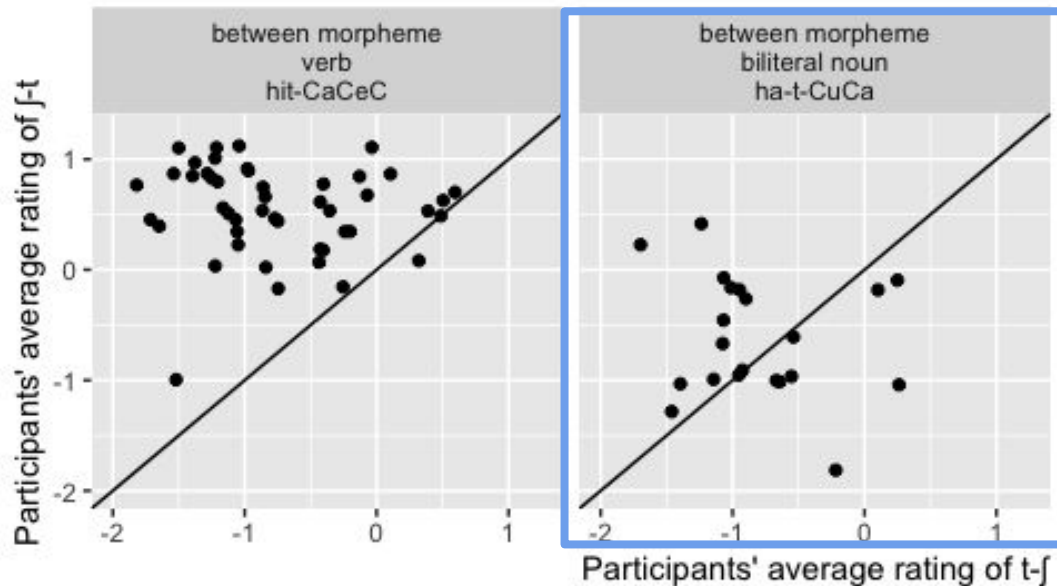
S-t > t-S not significant, but trending



trending effect of Condition in BM-BN (pd = 90%)

# Results: BetweenMorpheme-Noun

Despite no sig. overall effect, most speakers showed a preference

Two distinct preferences among the participants:

- S-t > t-S
- t-S > S-t

# Issue with *ha-t-CuCa* template

Biliteral roots are rare, not very productive

- Likely difficult to generalize template to new irregular roots
- Likely speakers would dislike new irregular roots (esp. vs regular roots)

# Condition: BetweenMorpheme-(Nonce) Noun

|  | Between morpheme (BM) | Within morpheme (WM) |
|---|---|---|
| Verb | Template: hit-CaCeC<br>Phonotactic evd: strong<br>Alternation evd: strong | Template: hi-CCiC<br>Phonotactic evd: medium<br>Alternation evd: none |
| Not-verb (Noun) | Template: ha-t-CaCCa<br>Example: [hat.ʃag.ma] | Template: ma-CCeCa<br>Phonotactic evd: medium<br>Alternation evd: none |

Based on combination of two existing nominal templates (with syllable structure modifications):

- Biliteral template: *ha-t-CuCa*
- Related (regular) triliteral template: *ha-ta-CCVC*
- Does not exist - no evidence for distribution of t-S or S-t

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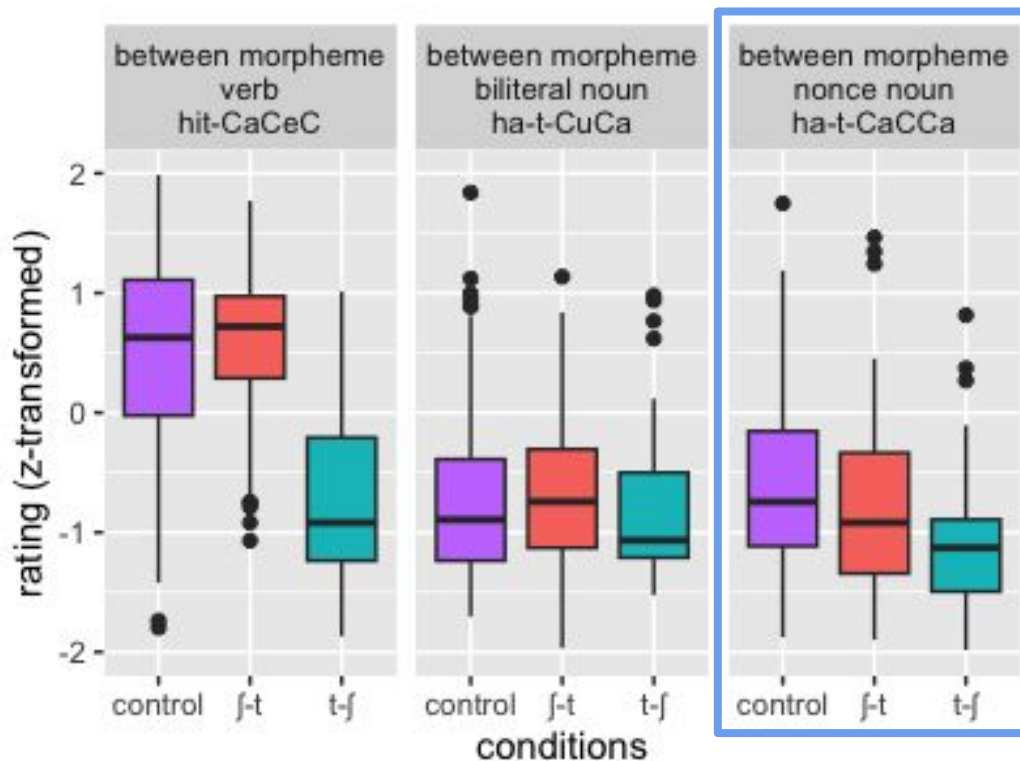| | Between morpheme (BM) | Within morpheme (WM) |
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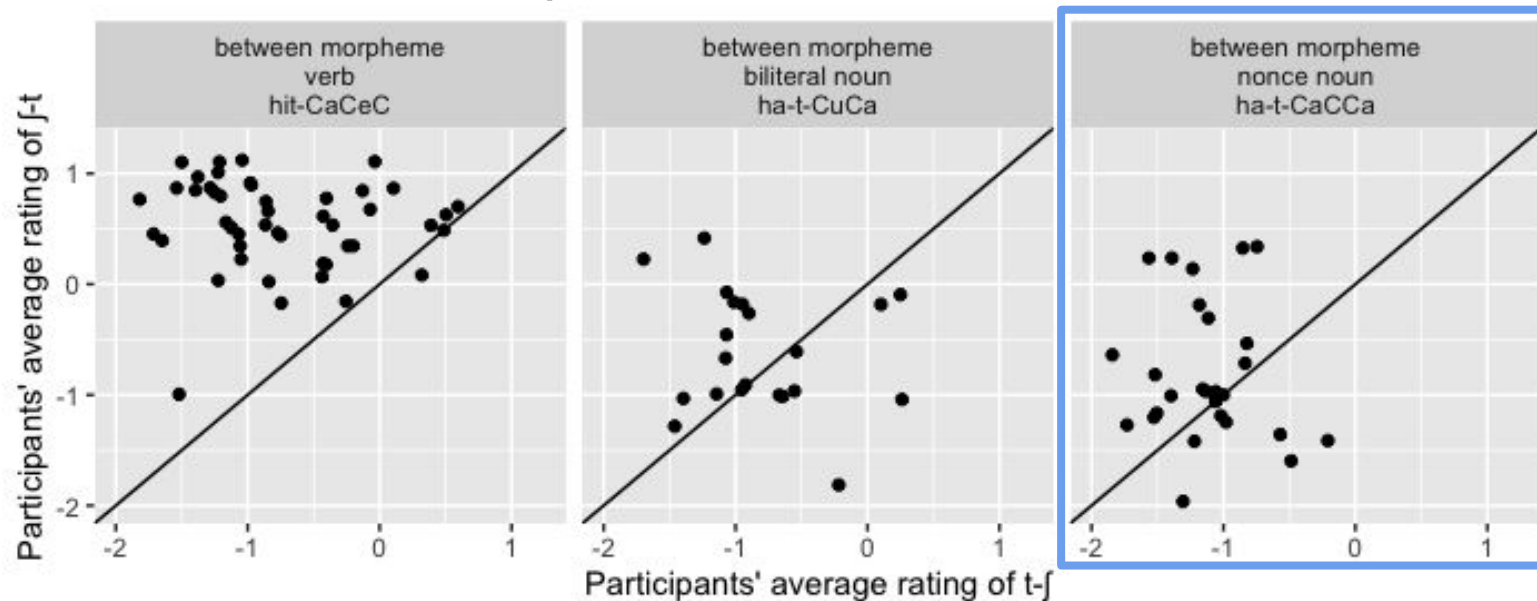
# Results: BetweenMorpheme-Noun

Similar to BM-Biliteral Noun

S-t > t-S not significant, but trending



trending effect of Condition in BM-N Nonce (pd = 90%)

# Results: BetweenMorpheme-Noun



Also two distinct patterns among participants

More preferred S-t compared to Biliteral Noun condition

# Summary

Clear preference for S-t > t-S in BM-V and WM-V/N conditions

- Equally strong ➜ participants have a general phonotactic restriction *t-S
- Slightly more variation in WM conditions ➜ participants slightly sensitive to the fact that t-S sequences do occur within morphemes

Split preference for S-t/t-S in BM-N condition

- Group S-t
- Group t-S

# Discussion

# Morphologically-conditioned phonology

Hebrew t-S metathesis similar to morphologically derived environment effects (MDEEs) - repair of phonological sequences only occur in certain morphological contexts

Chong (2019) shows that such patterns may appear similar, but require completely different analyses

- Two case studies analyzed using a constraint-based framework & indexed constraints to account for lexical/morphological exceptionality (Pater et al. 2012)

# Morphologically-conditioned phonology

Crucial factors(Chong 2019):
- Factor 1: Avoidance of key sequence supported by general phonotactics?
- Factor 2: Repair process is general or specific to limited contexts?
➜ Korean and Turkish differ from each other in both aspects

| Pattern | Korean palatalization /Ti/ -> [Ci] across morphemes | Turkish velar deletion /VKV/ -> [VV] across morphemes |
|---|---|---|
| Factor 1: Phonotactic evidence | Supports *Ti* | Doesn't support *VKV* |
| Factor 2: Repair context | Triggered by all affixes | Triggered by some affixes |
| Analysis | General markedness & specific faithfulness for roots | specific markedness for some affixes |

# Morphologically-conditioned phonology in Hebrew

| Pattern | Korean palatalization | Turkish velar deletion | Hebrew metathesis |
|---|---|---|---|
| Factor 1: Phonotactic evidence | Supporting | Not supporting | Supporting |
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Evidence for general markedness constraint *tS:
   dispreference for tS in BM-V as well as within morpheme
How about the split behavior in BM-N?

# Is Hebrew metathesis like Korean palatalization?

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|---|---|---|---|
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| Factor 2: Repair context | General | Constrained | Constrained |
| Analysis | **General markedness & root-specific faithfulness** | (some) Affix-specific markedness | **General markedness Specific faithfulness for root & affixes** |

**Group S-t say yes:**

      specific faithfulness of other t- prefixes except *hitCaCeC*:

            outweighs *tS in BM-N

      Specific faithfulness for actual words with morpheme-internal tS

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| Analysis | **General markedness** & root-specific faithfulness | (some) **Affix-specific markedness** | **General markedness** **General faithfulness** **Specific markedness** |

**Group t-S say yes:**

Despite general *t-S, repair is only supported in *hitCaCeC* by specific markedness

Highly weighted faithfulness prevents repair from happening in other contexts

# Conclusion

Overall, Hebrew speakers disprefer *t-S

Due to the restrictedness of the repair process to *hitCaCeC*, speakers split in extending this preference to unfamiliar between-morpheme contexts

Possibly suggests different grammars

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Future work:

- Wug tests looking at:
    - Behavior with borrowed words
    - Behavior with nonce Hebrew roots
- Modeling

# Acknowledgements

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