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Semantic effects in morphological priming: A cross-modal study of Hebrew

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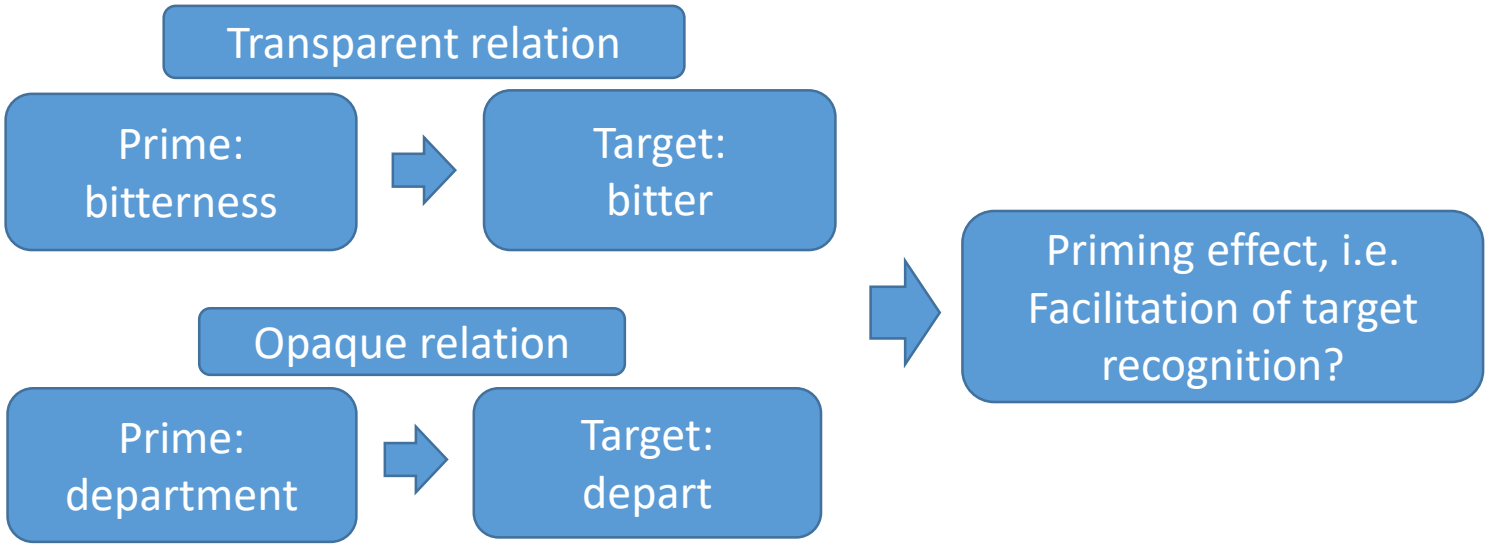
Interface of morphology and semantics

- Morphologically related words are often closely related in meaning (*transparent semantic relation):*
  - E.g. bitterness – bitter

- But not always (*opaque semantic relation):*
  - E.g. department – depart, archer – arch

How do morphological and semantic properties interact in the organization of representations in the mental lexicon?

Morphological priming



- Masked priming
  - prime is shown visually briefly
  - Access-level: morpho-orthographic representations (modality-specific)
- Cross-modal priming
  - Auditory primes, visual targets
  - Central-level: core morpho-semantic representations

Priming in Indo-European languages

In cross-modal (e.g. Marslen-Wilson et al., 1994; Longtin et al., 2003)

- Transparent relation (*bitterness – bitter*) → priming effect
- Opaque relation (*department – depart*) → no priming effect

➢ Cross-modal priming reflects stored properties of central lexical representations and the relationship between them.

But in masked priming (e.g. Rastle et al., 2004; Marslen-Wilson et al., 2008; Rastle & Davis, 2008)

- Transparent relation (*bitterness – bitter*) & Opaque relation (*department – depart*) → priming effect (compared to brothel-broth)

➢ Masked priming taps into an initial phase of decomposition that is blind to semantic factors (but counter evidence in Feldman et al, 2009;2015)

Priming in Semitic languages

Similar pattern of morphological priming (root priming) in masked and cross-modal (Boudelaa & Marslen-Wilson, 2005, 2015; Frost et al., 2000)

- Transparent relation (TaKLIT – *HaKLaTaH* 'a record' – 'recording') → priming effect
- Opaque relation (*KLITaH* – *HaKLaTaH* 'intake' – 'recording') → priming effect

➢ Therefore, it was proposed that in the Semitic lexicon morphological operations are separated from the computation and representation of meaning even at the central-level (Boudelaa & Marslen-Wilson, 2015)

Morphology separated from semantics?

In Hebrew cross-modal priming (Frost et al., 2000):
Priming in transparent pairs **>** priming in opaque pairs

→ Are morphological operations really separated from meaning in Hebrew?

Verbal classes in Hebrew: *binyanim*

Binyan name	Vowel pattern	Pattern in Hebrew	Example (l-m-d, r-g-S)	Example translation	Semantic properties
Paal	**CaCaC**	**_ _ _**	**LaMaD**	**He learned**	**Active**
Piel	**CiCeC**	**_ _ י _**	**LIMeD**	**He taught**	**Active**
Hitpael	hitCaCeC	_ _ _ התּ	HiTLaMeD	He interned	Reflexive, reciprocal, change of state
Hif'il	hiCCiC	_ י _ _ ה	HiRGIS	He felt	Active, causative
Nif'al	niCCaC	_ _ _ נ	NiLMaD	He was learned	Passive, active
Pu'al	CuCaC	_ _ ו _	LUMaD	He was taught	Passive
Huf'al	huCCaC	_ _ _ הו	HURGaS	He was felt	Passive

Verbal classes: Paal & Piel

Similar type frequency of Paal (19.4% of all verbs) and Piel (17.1%)

Productivity differences (Bolozky,1999; Aronoff, 1994)

- Piel (CiCeC), Hitpael (hitCaCeC): open classes
- Paal (CaCaC): closed class

Productivity modulates root priming in masked priming (Farhy et al. 2017)

- Significant root priming in Piel (NiSaKTI – HiTNaSeK)
- But not in Paal (NaSaKTI – HiTNaSeK)

➢ Piel verbs are decomposed at early stages of processing, but not Paal verbs

Productivity may also modulate semantic effects

- Productive classes (Piel) → structured stems → no semantic effect
- Non-productive classes (Paal) → unstructured stems → semantic effect

The present study

Paal (closed-class): /nashakti/ - HiTNaSeK
Piel (open-class): /nishakti/ - HiTNaSeK

1. Is the organization of morphological representations in Hebrew dependent on meaning?
   - Root priming in cross-modal priming
   - Semantic relatedness effect: semantic relatedness between prime and target as a continuous variable.
   - Direct comparison of a closed-class vs. open-class
2. Are there differences between cross-modal and masked priming?
   - Comparison of semantic effects in previous masked priming study (Farhy et al., 2017)

Hypotheses

The common approach

In the Semitic lexicon morphological operations are separated from the computation and representation of meaning even at the central-level (e.g. Boudelaa & Marslen-Wilson, 2015) → root priming without semantic relatedness effects for Paal & Piel

But…

If the relation between semantics and structure in Hebrew is modulated by productivity → root priming but semantic relatedness effect only for Paal: larger semantic relation → shorter RTs

Design & Materials (from Farhy et al., 2017)

42 target words in Hitpael

Prime Type:

1. **Paal** (same root as target)
2. **Piel** (same root as target)
3. **Unrelated** (half Paal, half Piel), different root

	1sg Past (root N-S-K)			**Infinitive (root L-M-D)**		
	paal	piel	unrelated	paal	piel	unrelated
Prime (auditory)	נשקתי /nashakti/ kissed/ touched	נישקתי /nishakti/ kissed	טיפסתי /tipasti/ climbed	ללמוד /lilmod/ to learn	ללמד /lelamed/ to teach	לבחור /livxor/ to choose
Target (visual)	**התנשק HiTNaSeK**			**התלמד HiTLaMeD**		

Design & Materials (from Farhy et al., 2017)

Form Type:

1. **1sg Past**
2. **Infinitive**

to overcome (1) ambiguity and (2) alternative explanation of orthographic overlap (initially part of the masked priming design)

	1sg Past (root N-S-K)			**Infinitive (root L-M-D)**		
	paal	piel	unrelated	paal	piel	unrelated
Prime (auditory)	נשקתי /nashakti/ kissed/ touched	נישקתי /nishakti/ kissed	טיפסתי /tipasti/ climbed	ללמוד /lilmod/ to learn	ללמד /lelamed/ to teach	לבחור /livxor/ to choose
Target (visual)	**התנשק HiTNaSeK**			**התלמד HiTLaMeD**		

- Matched for **lemma frequency** (frequency list from the MILA project, Itai & Wintner, 2008)

Design & Materials (from Farhy et al., 2017)

Semantic relatedness between prime and target pairs was assessed based on a pre-test:

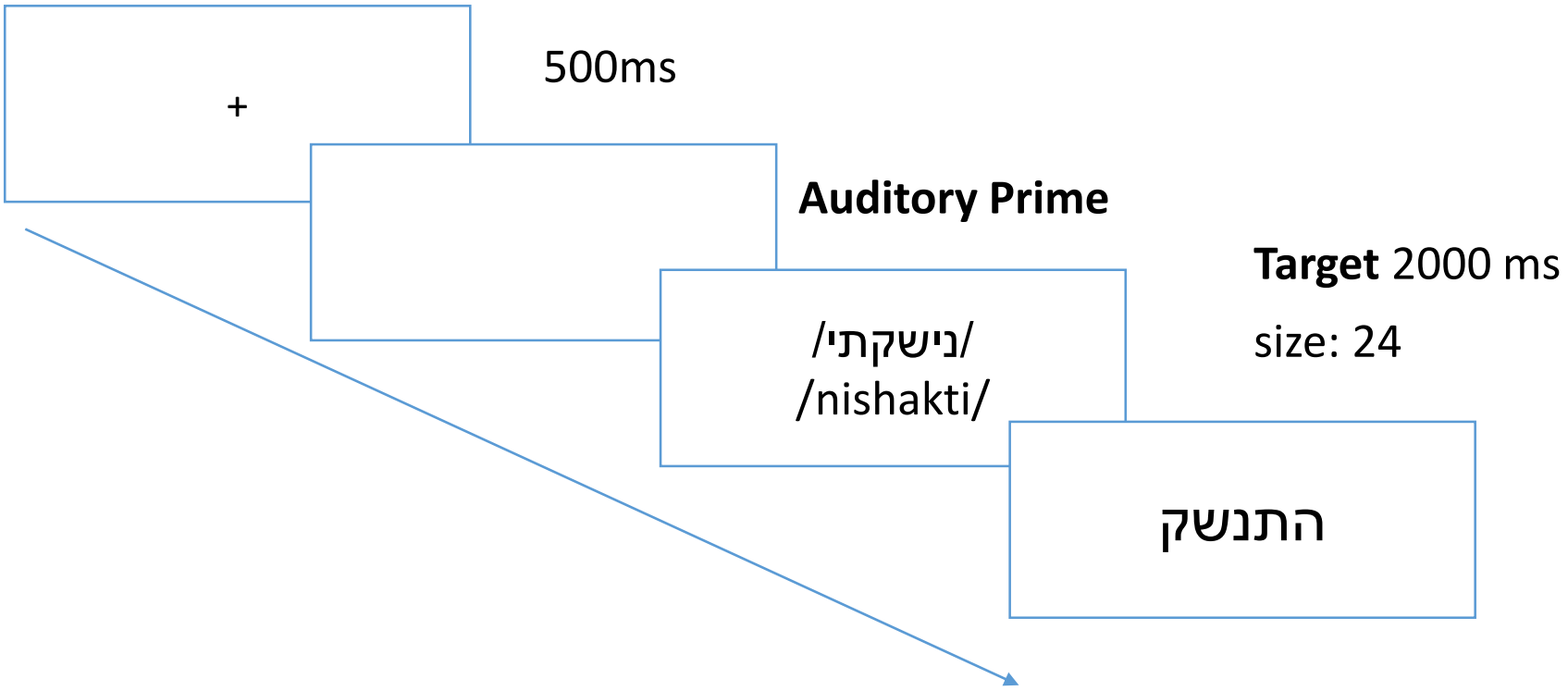
- 26 native Hebrew speakers (mean age: 30.77, sd: 12.80)
- Rating on a scale of 1 ('very small degree') to 7 ('very high degree')
- Paal and Piel scores were matched

- Mean semantic relatedness scores (SD)

1sg Past			**Infinitive**		
Paal	Piel	Unrelated	Paal	Piel	Unrelated
3.78 (0.78)	3.97 (0.84)	1.40 (0.33)	3.57 (0.94)	3.78 (0.80)	1.42 (0.25)

Procedure

- 336 items overall: 42 test items
- Lexical decision task



Participants

30 native Hebrew speakers (14 males)

- Age: 18-39 (mean= 28.6)

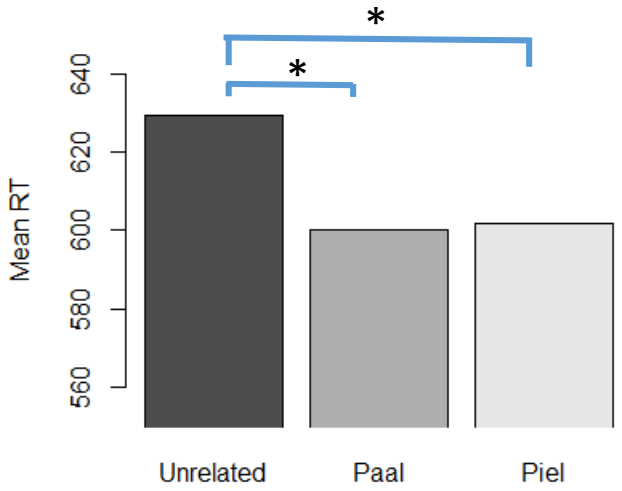
Analysis

- 1 item was removed (less than 50% accuracy)
- Cutoff 1500ms (0.5 %)
- Raw RTs were log transformed
- Mixed-effects models

Results – root priming effects

	Unrelated		Paal		Piel	
	RT (ms)	**Accuracy (%)**	**RT (ms)**	**Accuracy (%)**	**RT (ms)**	**Accuracy (%)**
1sg Past	618 (10.96)	95	588 (9.80)	95.5	603 (10.39)	95
Infinitive	641 (13.01)	92.4	612 (10.49)	96.7	601 (10.30)	99
Both	**629 (8.51)**	**93.7**	**600 (7.20)**	**96.1**	**602 (7.31)**	**97.1**

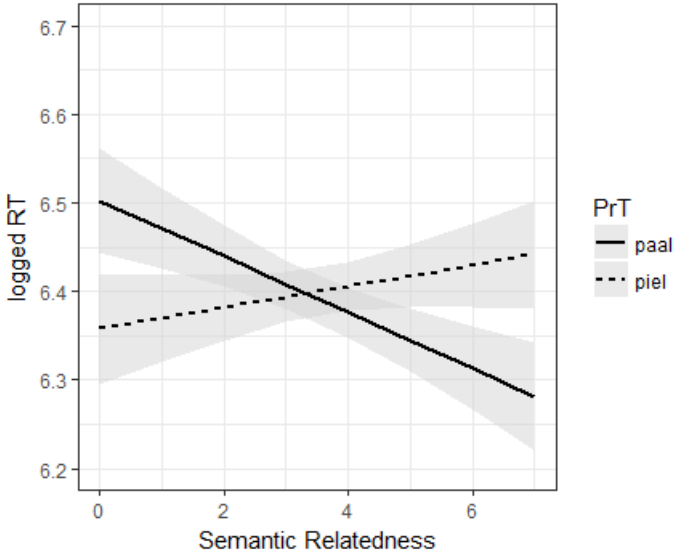
- No interaction of PrimeType x FormType (p=.33)
- Root priming effect for both Paal (t=-3.11) and Piel (t=-2.85)



Results – semantic relatedness

Significant interaction: Experiment (masked vs. cross-modal) X Prime Type (Paal vs. Piel) X Sem.Related (t=2.15)

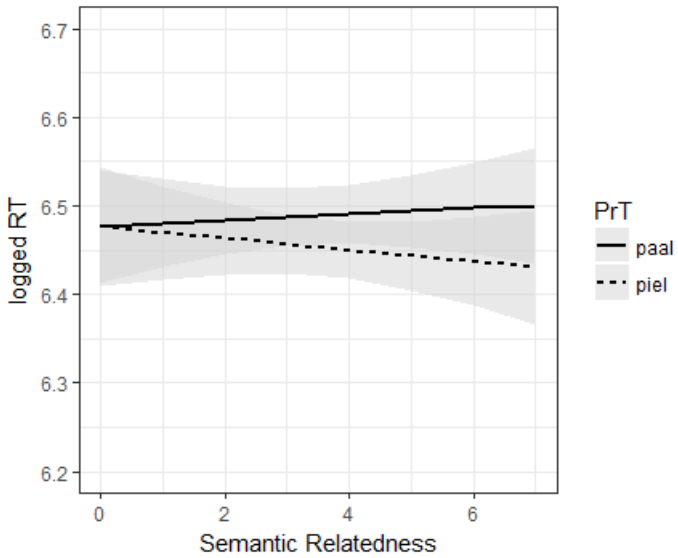
Cross-modal



Semantic Relatedness affects Paal RTs

and does not affect Piel RTs

Masked (Farhy et al., 2017)



Semantic Relatedness

does not affect RTs

Summary of results

	Paal /nashakti/ - HiTNaSeK התנשק-נשקתי /lilmod/ - HiTLaMeD התלמד-ללמוד		**Piel** /nishakti/ - HiTNaSeK התנשק-נישקתי /lelamed/ - HiTLaMeD התלמד-ללמד	
	Root priming	Semantic effect	Root priming	Semantic effect
Cross-modal	✓	✓	✓	✗
Masked priming (Farhy et al., 2017)	✗	✗	✓	✗

Discussion

- Semantic relatedness effect and root priming for Paal verbs in cross-modal (central-level)
- This finding challenges the view that morphological operations in Semitic languages are independent of semantic properties at the central-level.
- Productivity mediates the relation between meaning and morphological structure
  - Paal: stored stem representations, root priming is dependent on semantic properties
  - Piel: decomposed representations (root+pattern), root priming is not mediated by semantic properties

Morphology and meaning in the Semitic lexicon are less separated than previously thought.

Thank you