# Morphological priming without semantic relationship in Hebrew spoken word recognition

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## 1. Introduction

Does **semantics** constrain **morphological processing** in Semitic languages? In spoken word recognition?

Early work using visual masked priming suggests that morphological decomposition occurs **independent of semantics** based on orthographic form alone (e.g. English *corner* → *corn* + *-er*) (Rastle et al. 2004). More recent work instead suggests that **semantic transparency mediates** morphological processing (Jared et al. 2017; Milin et al. 2017).

In Semitic languages (e.g. Arabic, Hebrew, Maltese), word stems consist of two discontinuous morphemes:

1. A consonantal **root** (provides core meaning);
2. A vocalic/consonantal **pattern** (grammatical, thematic).

| *lašon* לשון | *malšin* מלשין | *halšana* הלשנה | *balšanut* בלשנות |
|---|---|---|---|
| 'tongue, language' | 'informer' | 'informing' | 'linguistics' |

**Sample Hebrew words containing the root *lšn* 'SPEAKING'**

Under visual masked priming, readers are faster to judge words when primed by a root-related word (e.g. Hebrew *porets* פורץ 'burglar' primes *pritsa* פריצה 'burglary'; root: *prts*). In contrast, pattern-related words fail to reliably prime (e.g. Frost et al. 1997, 2000, 2005).

This holds **even in the absence of transparent semantic overlap between words**: e.g. *porets* 'burglar' and *mifrats* 'gulf' both prime *pritsa* 'burglary' (Frost et al. 1997: Exp. 5).

**Confound:** Hebrew (and most Semitic languages) uses an orthography in which **primarily consonants are written**; root priming effects could reflect an **orthographic bias**.

**Solution:** Look for root priming in the auditory modality, where consonants and vowels have equal representation. Work using auditory masked priming in Moroccan Arabic (Schluter 2013), Maltese (Ussishkin et al. 2015), and Hebrew (Ussishkin et al. in prep.) has found comparable root priming.

**Present Study:** We test for effects of semantic overlap in root priming in Hebrew, replicating Frost et al.'s (1997) Exp. 5 using the auditory masked priming paradigm.

## 2. Methods

Thirty-one native Hebrew speakers (undergrad students at Tel Aviv University & Amazon Mechanical Turk workers in Israel) completed an auditory lexical decision task.

Items included 60 real Hebrew words and 60 non-words.

Real-word targets occurred in four priming conditions:

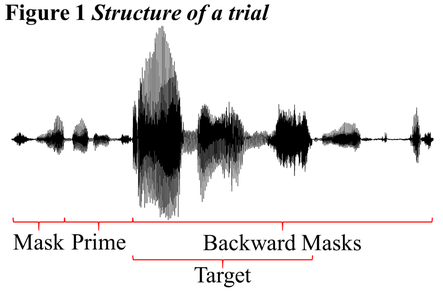
| | | |
|---|---|---|
| **Repetition** | e.g. *pritsa* 'burglary' priming *pritsa* 'burglary' | |
| **M+S+** | e.g. *porets* 'burglar' | (root: *prts*) |
| **M+S−** | e.g. *mifrats* 'gulf' | (root: *prts*) |
| **Unrelated** | e.g. *ʔaritsut* 'tyranny' | (root: *ʔrts*) |

**M+S+** primes are morphologically and semantically related to the target; **M+S−** are morphologically related but lack a transparent semantic relationship with the target.

Items were presented using the auditory masked priming paradigm (Kouider and Dupoux 2005; Schluter 2013): the primes were (a) compressed to 240 ms, (b) amplitude-attenuated, and (c) embedded in a series of "masks" (Figure 1).

The experiment was run remotely: Participants downloaded a .exe file which ran the experiment in DMDX (Forster and Forster 2003) and sent the results to us upon their completion.

**Figure 1** ***Structure of a trial***




## 3. Results

RTs to real-word targets were analyzed in R using a linear mixed effects regression analysis (lme4; Bates et al. 2015).

lmer(-1000/RT ~ prime + log(duration) + log(frequency) + (1|Subjects) + (1|Targets))

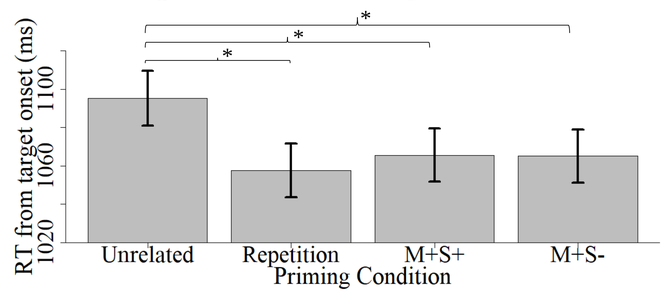
RTs were significantly faster in the **Repetition** ($t(1,645) = -4.86$, $p < 0.001$; $M$ = 1,058 ms), **M+S+** ($t(1,654) = -3.08$, $p < 0.005$; $M$ = 1,065 ms), and **M+S−** conditions ($t(1,644) = -2.54$, $p < 0.05$; $M$ = 1,066 ms) than in the unrelated condition ($M$ = 1,095 ms).

## 4. Discussion

Hebrew primes facilitate the recognition of targets sharing a root **even in the absence of a transparent semantic relationship**. The results support models of spoken word recognition in which Semitic morphology (namely, roots) influences word processing independent of meaning.

They are inconsistent with learning-based models (e.g. NDL; Baayen et al. 2011) which hold that apparent morphological priming effects reflect the coactivation of form and meaning.

Future work will explore the contribution of phonological form to morphological priming by comparing priming by morphological relatives with priming by unrelated words which exhibit greater form overlap (cf. Frost et al. 2005).




## Acknowledgements

The authors wish to thank Skye Anderson, Netta Ben-Meir, Evan Gary Cohen, Stephen Cowen, Kenneth I. Forster, Roey Gafter, Lior Laks, Kevin Schluter, and Hadas Velan for their support and expertise; the native Hebrew speaker who recorded the items for this study; and the Tel Aviv University Department of Linguistics for their assistance in recruiting participants. All remaining mistakes are the responsibility of the authors.

## References

Baayen, R. H., Milin, P., Đurđević, D. F., Hendrix, P., and Marelli, M. (2011). An amorphous model for morphological processing in visual comprehension based on naive discriminative learning. *Psychological Review* 118: 438-481.

Bates, D., Maechler, M., Bolker, B., and Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67: 1-48.

Forster, K. I., and Forster, J. C. (2003). DMDX: a Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers* 35: 116-124.

Frost, R., Deutsch, A., and Forster, K. I. (2000). Decomposing morphologically complex words in a nonlinear morphology. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 26: 751-765.

Frost, R., Forster, K. I., and Deutsch, A. (1997). What can we learn from the morphology of Hebrew? A masked-priming investigation of morphological representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 23: 829-856.

Frost, R., Kugler, T., Deutsch, A., and Forster, K. I. (2005). Orthographic structure versus morphological structure: principles of lexical organization in a given language. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 31: 1293-1326.

Jared, D., Jouravlev, O., and Joanisse, M. F. (2017). The effect of semantic transparency on the processing of morphologically derived words: evidence from decision latencies and event-related potentials. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 43: 422-450.

Kouider, S. and Dupoux, E. (2005). Subliminal speech priming. *Psychological Science* 16: 617-625.

Milin, P., Smolka, E., and Feldman, L. B. (2017). Models of lexical access and morphological processing. In Fernandez, E. M., and Smith Cairns, H. (Eds.), *The Handbook of Psycholinguistics*: 249-268. Wiley-Blackwell.

Rastle, K., Davis, M. H., and New, B. (2004). The broth in my brother's brothel: morpho-orthographic segmentation in visual word recognition. *Psychonomic Bulletin & Review* 11: 1090-1098.

Schluter, K. T. (2013). *Hearing words without structure: subliminal speech priming and the organization of the Moroccan Arabic lexicon*. PhD Thesis, University of Arizona.

Ussishkin, A., Dawson, C. R., Wedel, A., and Schluter, K. (2015). Auditory masked priming in Maltese spoken word recognition. *Language, Cognition, and Neuroscience* 30: 1096-1115.