



Dependency resolution difficulty increases with distance in Persian separable complex predicates

Molood Sadat Safavi,^{1,2} Samar Husain,³ and Shravan Vasishth¹

¹University of Potsdam, Germany, ²University of Groningen, The Netherlands, ³Indian Institute of Technology, India



INTRODUCTION

- ▶ Prior research has shown that memory-constraints (Gibson, 2000; Lewis & Vasishth, 2005) and predictive processing (Hale, 2001; Levy, 2008) affect comprehension
 - ▶ Locality effect: Slowdown at the head with increased distance between the head and its dependent. Attributed to memory constraints (e.g., Grodner & Gibson, 2005)
 - ▶ Anti-locality effect: Facilitation at the head with increased distance between the head and its dependent. Attributed to predictive processing (e.g., Konieczny, 2000)
- ▶ Recent research has argued for a unified processing approach in order to account for experimental results (e.g., Staub, 2010; Vasishth & Drenhaus, 2011)

EXPERIMENTS

- ▶ Experiments 1 (ns = 42) and 2 (ns = 43) were phrase-by-phrase moving window self-paced reading experiments
- ▶ Experiments 3 (ns = 40) and 4 (ns = 40) respectively replicated experiments 1 and 2 using the eye-tracking paradigm
- ▶ 2 x 2 factorial design: PREDICTABILITY STRENGTH x DISTANCE

PREDICTABILITY STRENGTH :: (Strong/Weak)

- ▶ In the **Strong** condition, the preverbal noun (*a:rezouyee* 'wish') predicts the light verb (*kard* 'do'), while in the **Weak** condition the object (*shokola:ti* 'chocolate') does not predict the verb (*xarid* 'buy')

DISTANCE between noun and verb :: (Short/Long)

- ▶ In the **Short** condition a PP intervened the noun and the verb; in the **Long** condition a relative clause & a PP intervened the noun and the verb. In experiment 2, short condition was the same as experiment 1, however in the long condition a longer PP intervened the noun and the verb

(1) a. Strong predictability, short distance (PP)

Ali *a:rezouyee* *bara:ye man* **kard** *va...*
 Ali wish-INDEF for 1.S do-PST and...
 'Ali made a wish for me and...'

b. Weak predictability, short distance (PP)

Ali *shokola:ti* *bara:ye man* **xarid** *va...*
 Ali chocolate-INDEF for 1.S buy-PST and...
 'Ali bought a chocolate for me and...'

- ▶ The long distance condition in experiments 1 & 3 had a RC + PP:
ke besya:r doost-da:sht-am bara:ye man 'that I liked a lot for me' intervening *a:rezouyee/shokola:ti* and *kard/xarid*
- ▶ The long distance condition in experiments 2 & 4 had a longer PP:
bara:ye doost-e xa:har-e man 'for my sister's friend' intervening *a:rezouyee/shokola:ti* and *kard/xarid*
- ▶ 36 experimental items were constructed
- ▶ Items were normed to ensure strong vs weak predictability (using sentence completion studies) and also to ensure grammaticality (using acceptability rating study)
- ▶ The critical region was the verb (*kard* 'do' in 1a; *xarid* 'buy' in 1b)

RESEARCH QUESTIONS & HYPOTHESES

How do prediction and memory-constraints interact?

- ▶ Locality effect manifests only when expectation is weak; strong expectation leads to facilitatory (anti-locality) effect (Husain et al., 2014)
- ▶ Type of the intervening material between the dependent and its head affects processing at the head
- ▶ In addition, we explore if increase in entropy at the dependent can lead to locality effect at the head

We test these predictions using complex predicates in Persian

- ▶ Complex predicates in this study comprise of a predicative noun and a verb, e.g., *latme zad* 'harm' (literally, 'damage hit')

RESULTS

- ▶ All analyses were performed using linear mixed-effects models. For the reading time data, the most complex model possible given the data and the design was chosen based on the rePCA function (Bates et al., 2015)
- ▶ Log-transformed data was used for these analyses

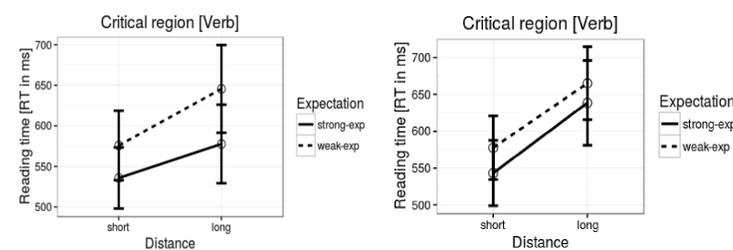


Figure 1 : Reading times in ms (with 95% CIs) at the critical regions in Experiments 1 and 2

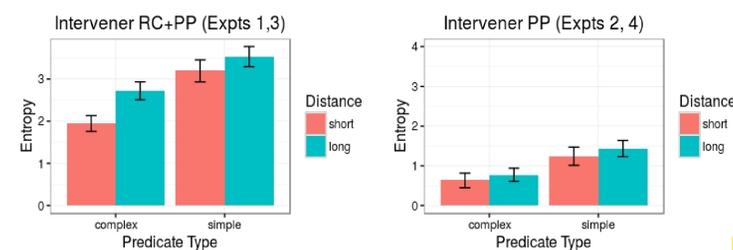


Figure 2 : The estimated entropy (with 95% confidence intervals), computed using the sentence completion data, for the two experiment designs.

- ▶ To investigate if entropy affects reading times at the verb, we fit a linear mixed model with predicate type, distance, as sum-coded factors, and entropy (centered) as a continuous factor; the dependent variable was log reading time at the critical verb
- ▶ In Experiment 1, we find an effect of entropy (t=2.8), and an interaction between distance and entropy (t=2.3), such that long distance conditions lead to a greater effect of entropy
- ▶ To our knowledge, this is the first demonstration that locality effects may arise due to factors other than memory costs

- ▶ **Experiment 1:** A main effect of predictability (t=-2.94) was found such that the strong predictability conditions were read faster than the weak conditions; a main effect of distance (t=3.88) was also found, such that the short conditions were read faster than the long conditions
- ▶ A marginal interaction (t=1.7) suggests that the locality effect may be somewhat stronger in the weak predictability condition (weak support for Husain et al., 2014)
- ▶ **Experiment 2** replicates Experiment 1: main effect of predictability (t=-2.28) and a main effect of distance (t=3.99) was found; in fact the effects are much stronger in this experiment
- ▶ A secondary analysis shows that the locality effect is strengthened in experiment 2 compared to experiment 1
- ▶ Recall that the long condition in experiment 2 was a long, uninterrupted PP while in experiment 1, the intervener was a short RC followed by a PP
- ▶ It is possible that processing a single long intervening phrase may be harder than processing two different phrases because it may be harder to chunk a single long phrase compared to two shorter phrases (cf. Frazier & Fodor, 1978)
- ▶ **Experiment 3 and 4** respectively replicate experiments 1 and 2 in first pass reading time, regression path duration (only Expt 4) as well as total fixation time

CONCLUSIONS

- ▶ The evidence from Persian wrt distance manipulation is in favor of working-memory accounts, although entropy is also a candidate explanation
- ▶ Not much evidence that strong-predictability cancels locality effects
- ▶ There is no evidence for the prediction of the expectation account that increasing argument-verb distance facilitates processing due to increasing conditional probabilities of the upcoming verb
- ▶ One implication of our findings from Persian is that locality and expectation effects observed across studies seem to be highly conditional on the language and syntactic construction being considered – broad cross-linguistic generalizations may be difficult to make

For full details, please read this paper: <http://bit.ly/2bIFaYS>