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 × DISTANCE
- Predictability Strength: (Strong/Weak)
- In the Strong condition, the preverbal noun (ara:rezouyee ‘wish’) predicts the light verb (kard ‘do’), while in the Weak condition the object (shokola:ti ‘chocolate’) does not predict the verb (kard ‘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 wish-INDEF do-PST and . . .
   ‘Ali made a wish for me and . . .’

   b. Weak predictability, short distance (PP)
   ‘Ali chocolate-INDEF barya:ye man xarid for . . .’
   Ali chocolate-INDEF buy-PST and . . .
   ‘Ali bought a chocolate for me and . . .’

The long distance condition in experiments 1 & 3 had a RC + PP: ke besya: va doost-da:shit-am barya:ye man ‘that I liked a lot for me’ intervening ara:rezouyee/shokola:ti and kard/xarid.

The long distance condition in experiments 2 & 4 had a longer PP: barya:ye doost-e xa:har-e man ‘for my sister’s friend’ intervening ara:rezouyee/shokola:ti and kard/xarid.

The critical region was the verb (kard ‘do’ in 1a; xarid ‘buy’ in 1b).

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. Frazer & 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.

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 rPCA function (Bates et al., 2015).

Log-transformed data was used for these analyses.

Figure 1: Reading times in ms (with 95% CI) at the critical region 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.

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/2blFaYS