Agreement Attraction in Modern Standard Arabic Comprehension

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Introduction

- Much theorizing about agreement dependencies comes from Agreement Attraction errors (1):

(1) [NP The key [PP to the cabinets]] are on the table. (Bock & Miller, 1991)

- Agreement attraction is sensitive to morphological markedness and therefore is influenced by morphological representation (Bock & Miller, 1991, *et seq.*)
- Occurs in both production (sentence completion) and comprehension (self-paced reading, eye-tracking reading, EEG, MEG)
- **However:** *All* such studies are confined to Indo-European languages
- Thus, all results are confined to similar inflectional paradigms and similar pluralization types
- Modern Standard Arabic (Arabic) provides a nice place to expand the empirical base:
  - Large amount of inflectional morphology on verbs (gender, number, person)
  - Large amount of morphology on nouns (case, number)
  - Wide array of "irregular" plural types which involve non-concatenative, abstract morphemes representing plurality

The Present Study — Aims

- Document the existence of agreement attraction errors in Arabic
- Examine whether the presence of large numbers of ablauting plurals has an effect on attraction rates
  - Ablauting plurals utilize abstract/non-concatenative morphemes to represent number; does this noncontatenativity/abstractness have an impact on parsing?
- Validate the self-paced reading paradigm for investigating Arabic comprehension errors

The Present Study — Methods

Subjects:

- 84 native Arabic speakers (83 female; mean age 21.4 years)

Stimuli:

- 48 item sets in a 2 × 2 design
- All sentences of the form *NP Subj – Complementizer – RC Verb – NP Attr – Adv/PP – Verb – Continuation*
- Adverb inserted to avoid Attr spillover effects (Wagers, *et al.*, 2009)
- Systematically manipulated for:
  - Attractor Number: Singular, Plural (Attr) (AttrNum)
  - Verb Number: Singular, Plural (Verb) (Gram)
- Critical verbs balanced for tense/aspect (perfect/imperfect)
- Diacritics only used for lexical disambiguation; short-vowel case markers not written
- All subjects singular; example item appears in (2):

(2) a. المترجم الذي ساعد الرئيس احيانا يتكلم خمس لغات بفصاحة.

b. ʔal-mutarǧim-u ʔallaðii saaʕad-a
the-translator-NOM COMP.MASC.SG helped-3.SG.MASC
ʔal-raʔiis-a ʔaḥjaanan ja-takallamu xamsata
the-president-ACC often 3.SG.MASC-speaks five
luɣaat-in bi-fasˁaaḥatin.
languages-ACC with-fluency
"The translator who helped the president(s) often speak(s) five languages fluently."

- Additionally, Subj and & Attr (together) systematically counterbalanced for Plural Type:
  - Feminine Suffixing Plurals: formed by suffixation (*tˁaaliba – tˁaalib-aat*, "student(s) (fem.)")
  - Masculine Ablauting Plurals: formed by ablaut/vowel-change (*ʃajx – ʃujuux*, "sheikh(s)")
  - These plurals can be characterized by whether their CV-pattern is "ambiguous" (used for both singular and plural) or "unambiguous" (used only for plural)
  - Ambiguous: $C_1uC_2uuC_3$, with both singulars and plurals (*duxuul*, "entering (n.)" & *lusˁuusˁ*, "thieves")
  - Unambiguous: $C_1uC_2aaC_3$, only with plurals (*tˁulaab*, "students")
  - We did not control for ambiguity, but will exploit this difference in analysis
- Gender co-varies with plural types because of grammatical properties of Arabic (Ryding, 2005): case is orthographically marked on masculine suffixing plurals; there are very few feminine ablauting plurals
- Four conditions:

Grammatical Conditions	Ungrammatical Conditions
SS singular attractor, singular verb (*The key to the cabinet. . . is*)	SP singular attractor, plural verb (*The key to the cabinet. . . are*)
PS plural attractor, singular verb (*The key to the cabinets. . . is*)	PP plural attractor, plural verb (*The key to the cabinets. . . are*)

Procedure:

- Self-paced word-by-word moving window procedure using Linger software (Doug Rohde, MIT)
- Every item followed by a comprehension question (with feedback)

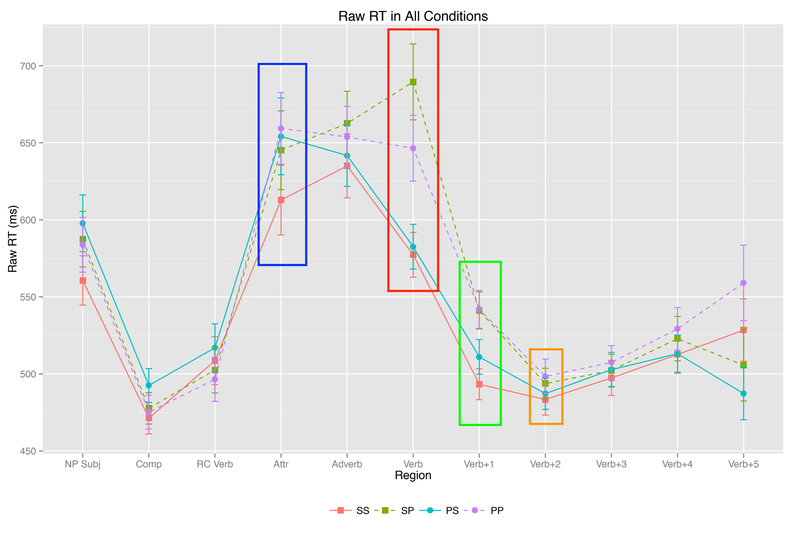
Analysis:

- 10% Winsorization of outliers by region and condition (not by subject)
- Single-word regions of analysis
- 2 × 2 repeated measures ANOVA by subjects and items
- Mixed-effects model and minF' also computed
- All qualitative results identical; only by-subjects Fs reported here

Predictions

- Main effect of Gram in verb region and spillover regions (ungrammatical > grammatical)
- Interaction of Gram × AttrNum in verb and spillover regions (Sg/Ungram > Pl/Ungram)
- Main effect of AttrNum in Attr region (Pl > Sg; Wagers, *et al.*, 2009)
- *No* impact of Attr plural type (Bock & Eberhard, 1993)

Results — All Nouns



Attr Region
- AttrNum: Pl > Sg; p = .002

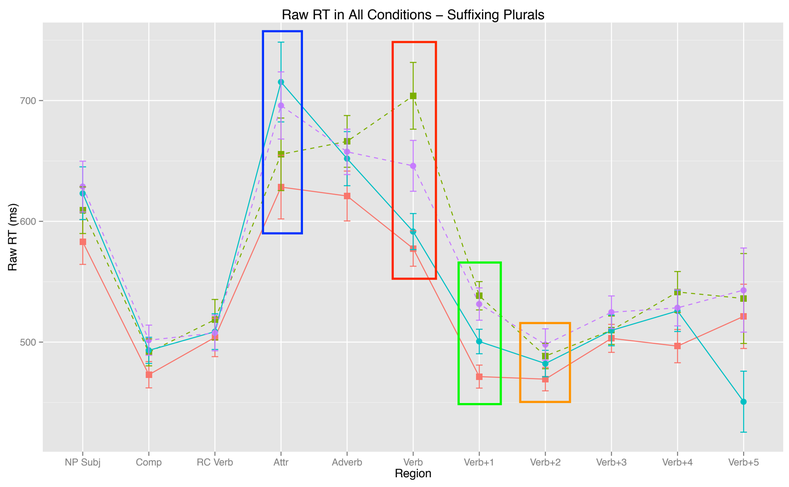
Verb Region
- Gram: Ungram > Gram; p < .001
- AttrNum: Pl > Sg; p = .02
- **Gram × AttrNum: SP > PP;** p = .003

Post-Verb Region #1
- Gram: Ungram > Gram; p < .001

Post-Verb Region #2
- Gram: Ungram > Gram; p = .02

Results — Different NP Plural Types

Suffixing Plurals (All Feminine)



Attr Region
- AttrNum: Pl > Sg; p < .0001

Verb Region
- Gram: Ungram > Gram; p < .0001
- **Gram × AttrNum: SP > PP;** p = .004

Post-Verb Region #1
- Gram: Ungram > Gram; p < .0001
- Gram × AttrNum: SP > PP; p = .008

Post-Verb Region #2
- Gram: Ungram > Gram; p = .006

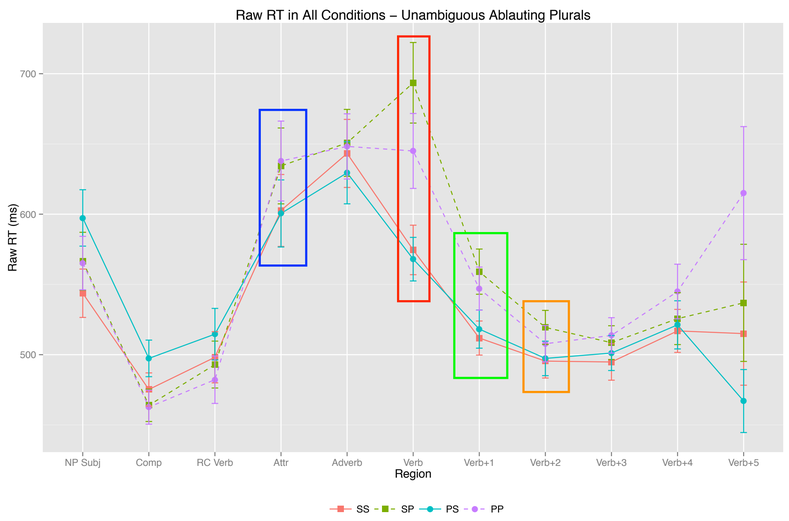
Ablauting Plurals (All Masculine)

Verb Region
- Gram: Ungram > Gram; p < .0001

Post-Verb Region #1
- Gram: Ungram > Gram; p = .002

⇒ No effect of Attr plurality in attractor region
⇒ No interaction of Gram × AttrNum

BUT: What happens if we only consider ablauting plurals with *unambiguous* CV-templates?



(no statistics due to small sample size, but the effect seems to re-emerge)

Discussion

All Nouns

- The main effect of Gram near the verb region is a standard reading-time response to grammatical errors
- **Interaction effect at the verb region is an Attraction Effect — the presence of a plural attractor (Attr) leads to less recognition of the erroneously plural verb which follows**
- The main effect of AttrNum in the Attr is unexplained at present, but has been observed in several studies by Wagers, *et al.* (2009)
- One particularly popular mechanism of explanation: improper cue-based retrieval from a content-addressable memory (Lewis & Vasishth, 2005, *et seq.*).
- This also explains the smaller difference between SP and PP in Arabic relative to English, Romance, *etc.*:
  - Arabic has more retrieval cues available (gender morphology, case on nouns, *etc.*)
  - Additionally, the complementizer in Arabic agrees with the subject and provides additional cues to correct retrieval

Suffixing Pluralizing Nouns

- In some sense, the feminine nouns display a more extreme version of the regular pattern seen with all nouns — attraction effects and a cost of processing plural NPs
- Main effect of Gram, AttrNum, and the interaction appear in the expected places
- The strength of the grammaticality effect at the verb and following regions is stronger
- The interaction effect lasts longer (into spillover region #1) — this is also seen in other attraction studies

Ablauting Pluralizing Nouns

- Masculine nouns, however, do not display all the hallmarks of plurality seen with feminines
- No effect of AttrNum in the Attr region (seen with all other plural nouns)
- No interaction/attraction effect at the verb or spillover regions
  - (Although there is a trend. . .)
- This isn't a failure of design: the Gram main effect appears in the verb and spillover region
- **Caveat:** The plural type is conflated with gender in this study
  - Partially unavoidable: very few human/animate feminine nouns with ablauting plurals
  - Probably not *entirely* attributable to gender: there is a trend toward attraction even with masculines
  - Nevertheless, there is no plural NP cost and a much lower attraction rate

Q: Why This Difference in Plural Type?

Explanation #1:

- Semantic/notional plurality is not sufficient for driving attraction in online processing
- Ablauting plurals are semantically plural but not always morphologically marked as such
- Some of the CV-/prosodic patterns ablauting plurals are seen with singular nouns, as well
- **⇒ for at least some patterns, morphological/prosodic shape alone is not sufficient to determine morphological number**
- Semantic plurality does not provide a cue for the retrieval event triggered at the verb; only morphological plurality does this
- More strongly: **agreement is about form-based feature matching, with no regard to semantics**
- Big counterargument to this is the finding of Bock & Eberhard (1993) that *ox~oxen* and *mouse~mice* both attract at levels similar to regular plurals in English

Explanation #2:

- Alternatively, one could take this to be about gender alone by focusing on the verb morphology
- In Arabic, the feminine plural verb ending is somewhat rare (group gender is resolved to the masculine)
- It could be that masculine plurals are not aggressively matched to preceding nouns to the same level that the marked feminine plural is
- Challenge here is that there is some weak attraction effect, and this explanation does not help make sense of the lack of a main effect of AttrNum at Attr.

Future Directions

- Disentangling gender and plural type:
  - Suffixing masculine plurals
  - Direct manipulation of number ambiguity of ablauting plural patterns
  - German provides a cross-linguistic check given the large number of ablauting plurals
- Dual number: Arabic has a dual which appears alongside singular and plural
- Gender on *all* verbal agreement — previously studied languages have gender only in certain inflectional paradigms
- Case is optionally orthographically present for some nouns — allows direct manipulation of presence of case feature/cue

Thanks & Selected References

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