Title. Ambiguity Advantage Effect in WH-Questions.

Overview. An Ambiguity Advantage Effect occurs when a globally ambiguous sentence is processed faster than its unambiguous counterparts. This has been observed in PP attachment height and pronominal reference *[1-3]*. This study tests for an ambiguity advantage in filler-gap dependencies in wh-questions. We hypothesize that multiple gap-sites in ambiguous sentences will lead to faster processing times due to the viability of all possible parses. A lack of effect would entail that multiple analyses create competition. We find a statistical trend towards an ambiguity advantage, which is more pronounced in ungrammatical sentences and interpret the results under the Unrestricted Race Model (URM), a serial stochastic parsing mechanism *[4].*

Current Study. We tested for an ambiguity advantage in filler gap dependencies in a speeded acceptability judgment paradigm. We used a 3x2 factorial design manipulating Dependency Type (Ambiguous, Short, Long) and Grammaticality (Grammatical, Ungrammatical). We use verbs that embed non-finite complement clauses (e.g. *want*) in combination with optionally transitive embedded verbs (e.g. *draw*) to create ambiguous wh-questions. In (1), the string can either be interpreted as a question regarding the embedded subject or the embedded object (possible gap sites denoted with multiple underscores).

(1) Who did the teacher want __ to draw __?

When the long dependency is formed, *want* functions as a Subject Control verb, where *who* is interpreted as the object of *draw*. When short, *want* is an Exceptional Case Marking verb where the subject of *draw* receives its case from *want (*in this case the filler *Who*). We created unambiguous long dependencies with obligatory subject control verbs, like *agree*, and unambiguous short dependency questions with obligatory object control verbs, like *tell*. Ungrammatical sentences were formed by filling all possible gaps in a sentence. The Short condition only has one gap, but the optional transitivity of the embedded verb creates a second gap for Long and Ambiguous conditions. A sample item set is given in Table 1.

Methods. 36 experimental items were created in the design above, combined with 108 fillers. Items were presented in RSVP style 250 ms per word with 100 ms pause in between words. 43 participants gave speeded acceptability judgments within a 2000 ms post-stimulus window.

Results. Log-transformed RTs were analyzed using linear mixed-effect models with Dependency Type and Grammaticality as fixed effects and random effects for Participant and Item. There were significant effects of Ambiguity β = $_{95}$(0.013,0.11), Grammaticality β = $_{95}$(-0.11,-0.017) and their interaction β = $_{95}$(0.037, 0.26). Pairwise comparisons between Ambiguous & Long and Ambiguous & Short were performed. Significant effects were present for Long β = $_{95}$(0.026, 0.13) but not for Short β = $_{95}$(-0.014, 0.10). A significant interaction between Long and Grammaticality was found β = $_{95}$(0.03, 0.24) but not Short and Grammaticality β = $_{95}$(-0.11, 0.11). Accuracy was analyzed using a X^2 test, yielding no significant effect (p = .13). The results are summarized in Figure 1 & 2.

Discussion. We observe a trend towards an ambiguity advantage. In grammatical and ungrammatical conditions, ambiguous sentences have faster RTs than Short and Long sentences. This is because the presence of two potential gap sites for Ambiguous verbs speeds up processing times. The ambiguous sentences pattern with the preferred interpretation, Long in grammatical and Short in ungrammatical. These findings replicate Frazier, Randall & Clifton (1983)*[5]*. The results fit under the URM. There is a surprising preference for long dependencies in grammatical sentences, which can be explained by the lack of competition between competing parses where ambiguity aids the parser instead of inhibiting it. Thus the optional transitivity of the embedded verb helps the parse in Long conditions and hinders it in Short ones. The reverse pattern is seen in ungrammatical conditions. If lexical information was unavailable, Ambiguous and Long sentences would pattern together for ungrammatical sentences. This is not the case. An ambiguous sentence with two possible gaps is responded to faster than the unambiguous ones bearing only one potential gap. The ambiguous sentences are initially interpreted as Long and then are sped-up at the final gap site.

Table 1: Sample Item Set

Grammatical	
AMBIG	Who did the teacher want ___ to draw ___?
LONG	Who did the teacher agree to draw ___?
SHORT	Who did the teacher tell ___ to draw?
Ungrammatical	
AMBIG	Who did the teacher want the student to draw the model?
LONG	Who did the teacher agree to draw the model?
SHORT	Who did the teacher tell the student to draw the model?

Figure 1: Experiment Results

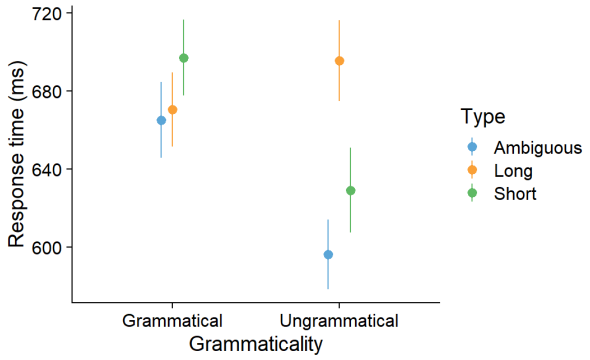

Figure 2: Linear mixed effects regression

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                                t value Pr(>|t|)
(Intercept)                     207.915  < 2e-16 ***
TypeAmbiguity                     2.490  0.01290 *
TypeLength                        1.518  0.12927
Grammaticality1                  -2.688  0.00729 **
TypeAmbiguity:Grammaticality1     1.304  0.19255
TypeLength:Grammaticality1        2.622  0.00886 **
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) TypAmb TypLng Grmmt1 TyA:G1
TypeAmbigty -0.001
TypeLength   0.002  0.004
Grammtclty1  0.005  0.020  0.001
TypAmbgt:G1  0.007  0.002  0.003 -0.004
TypLngth:G1  0.000  0.002  0.027  0.004  0.003
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[1] Dillon et al. (2019), *Journal of Experimental Psychology: Learning, Memory, and Cognition;*
[2] Grant et al. (2020), *Glossa: a journal of general linguistics;*
[3] Traxler et al. (1998), *Journal of memory and language;*
[4] van Gompel et al. (2000), *Reading as a perceptual process;*
[5] Frazier, Clifton & Randall (1983), *Cognition*