Object Who* is processed differently from *Subject Who*, *Why* and *How

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Introduction: *Wh-Phrases (whPs)* form a dependency with different grammatical elements: *Why* modifies (and thus is licensed by) the whole sentence and forms a dependency with S(entence) node ([1,2]), *Who*$_{Sub}$ is also licensed by the sentence and forms a dependency with S. On the other hand, *Who*$_{Obj}$ forms a dependency with the verb, as the verb assigns a thematic role and case to the object and grammatically licenses the object NP. *How* is a manner adverb, a modifier for VP, thus, forms a dependency with VP. Thus, these four different types of wh-phrases forms different types of dependencies with different dependency lengths. If it is the case that a longer dependency is more difficult to process ([3]), we expect a different processing difficulty effect for different wh-dependencies.

This study: How can we test the processing difficulty effects of these wh-dependencies? In the previous studies, it has been suggested that the number of open dependencies is a predictor of the processing complexity ([3,4]). If this is the case, we can test the processing complexity effect of these wh-phrases in a configuration like (1). In (1) a relative clause is attached to the embedded subject NP, and this long and complex NP intervenes between the wh-phrases and the verb in a center-embedding configuration.

(1) The aide noticed a. who$_{Obj}$ /b.why/c.how/d.that [$_{S}$ [$_{NP}$ the teacher [$_{RC}$ that the **dean** employed]] [$_{VP}$ happily [$_{V}$ gave] the gift (to the student)].

In (1), the number of open dependencies is largest at the subject noun within the relative clause ***dean***. Thus, we expect that processing complexity is the highest at the point of ***dean***. In this configuration, a whP that forms a dependency with matrix verb, ***gave***, creates an additional open dependency and additional processing complexity at ***dean***. But, if the wh-phrase that forms a dependency with S does not create an additional open dependency at ***dean***, we do not expect additional processing complexity. Importantly, if the number of open dependencies is not a predictor of the processing complexity, we do not expect any complexity effect in the ***dean*** region.

Experiment 1 (n=70): In a self-paced moving window experiment, *wh*-type was manipulated as an independent factor in a 1x4 design as in (1). Pairwise comparisons revealed that *dean* in (1a: *who*) was read significantly slower than (1b: *why*) (β = 0.04, SE= 0.02, t=2.23), and (1c: *how*) was read significantly slower than (1b: *why*) (β = 0.04, SE= 0.02, t=2.20) whereas there was no significant difference between (1a: *who*) and (1c: *how*) (β = 0.01, SE= 0.02, t=-0.38). The clear difference between *why* and *who*/*how* shows that these different whPs are processed differently in a way that they are licensed by different phrases.

Experiment 2 (n=70): In experiment 2, (2), which involves the subject *who,* was compared to (1a/b/d) in a 1x4 design.

(2) **Who$_{Sub}$** noticed that [$_{S}$ [$_{NP}$ the teacher [$_{RC}$ that the **dean** employed]] [$_{VP}$ happily [$_{V}$ gave] the gift to the student]?

Pairwise comparisons revealed that *dean* in (1a: *who*$_{Obj}$) was read significantly slower than (1b:*why*) (β = 0.04, SE= 0.01, t=2.6) and (2:*who*$_{Sub}$) (β = 0.03, SE= 0.01, t=2.39) but *dean* in (2:*who*$_{Sub}$) was not significantly slower than (1b: *why*) (β = 0.00, SE= 0.02, t=0.26).

Discussion: Those whPs that are linked to V and VP (*who*$_{Obj}$ & *how*) created additional complexity effects at ***dean***. These findings suggest the following. First, whPs are maintained in memory and cause processing complexity effects in the middle of the sentence like (1). Second, once the wh-dependency is formed, these whPs are released from maintenance, thus whPs that form shorter dependencies did not create a processing complexity effect. These findings, in turn, support theories of online wh-dependency formation that involve a maintenance component ([3,4]).

References: [1] Ko. 2005. NLLT. [2] Yoshida et al., 2015. NLLT. [3] Gibson 1998. Cognition. [4] Grodner & Gibson 2005. Cognitive Science