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 is also licensed by the sentence and forms a dependency with S. On the other hand, Who 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 ([3,4]), 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 /b.why/c.how/d.that [i. [w. the teacher [w. that the dean employed]]] [w. happily [w. 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 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 noticed that [s [NP the teacher [RC that the dean employed]] [v. happily [v gave] the gift (to the student)].

Pairwise comparisons revealed that dean in (1a: who) was read significantly slower than (1b: why) (β = 0.04, SE = 0.01, t=2.6) and (2: who) (β = 0.03, SE = 0.01, t=2.39) but dean in (2: who) 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 & 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]).