

Eye-tracking the Unaccusative Hypothesis in Spanish

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Introduction: The Unaccusative Hypothesis (Perlmutter, 1978; henceforth UH) claims that unaccusative verbs take a theme as a single argument while unergatives take an agent. Additionally, the UH also holds that unaccusative predicates are syntactically more complex than unergatives because they involve promotion/movement. The UH predicts (a) that there is a processing difference between unaccusative and unergative sentences in the reactivation of the subject after the verb, and (b) that unaccusatives are costlier to process than unergatives. A few experimental studies involving lexical decision tasks (Bever & Sanz, 1997; Friedmann et al., 2008; Lee & Thompson, 2011; Shetreet & Friedmann, 2012; Meltzer-Asscher et al., 2015; Momma, Slevc & Phillips, 2018) found evidence for these UH predictions in Spanish, English and Hebrew. In a seminal study using eye-tracking and the Visual World Paradigm (VWP) in Dutch, Koring, Mak and Reuland (2012) found earlier and larger reactivation of unergative subjects than unaccusative ones after verb offset, measured by the number of fixations towards the visual object semantically related to the sentential subject. However, Huang and Snedeker (2020) recently attempted to replicate these findings with no success, arguing that the methods in Koring et al. (2012) are ill-suited to test the UH and also that their findings may be a false positive. We aim to contribute to this debate with new evidence obtained from Spanish by investigating the processing correlates of different argument structure patterns employing the methods in Koring et al. (2012) and Huang and Snedeker (2020).

Method and participants: 44 Spanish native speakers listened to recorded sentences while they watched visual displays made up by 4 pictures located on each corner of the screen. Participants' eye fixations were monitored using a Tobii X120 mobile eye-tracker. We compared participants' eye fixations to pictures after they heard the verb in unaccusative (1), unergative (2) and transitive (3) sentences. Each condition had test and control trials. In test trials, the sentential subject (e.g. *mouse*) was semantically related to the target drawing (e.g. *cheese*). In control trials, the stimuli were kept identical except for the sentential subject, which was not semantically related to the target drawing (e.g. *chimpanzee* - *cheese*). Fixations to the semantically-related picture were interpreted as a measure of subject reactivation after verb offset.

- (1) *La niña cayó por las escaleras.*
'The girl fell down the stairs.'
- (2) *La niña corrió por la playa.*
'The girl ran at the beach.'
- (3) *La niña comió con mucho entusiasmo su bocadillo.*
'The girl ate her sandwich enthusiastically.'

Data processing and analysis: The position of the eye fixation in the visual display was down-sampled every 20 ms. Gaze fixation data was examined within two pre-defined time windows, as determined in Koring et al. (2012): (a) the verb frame (600 ms before verb offset until 1000 ms after verb offset); and (b) the post-verb frame (200 ms until 1700 ms after verb offset). We used the growth curve analysis (GCA) technique (Mirman, Dixon & Magnuson, 2008). The dependent variable was the difference of percentage of looks to the target in the test condition minus the percentage of looks to the target in the control condition. The independent variables were the

sentence condition (unaccusative, unergative, transitive) and different types of polynomials with random slopes (by subject per each condition).

Results and discussion: Results showed that participants fixated significantly more on the subject-related target drawing in unergative verbs than in unaccusative verbs both in the verb frame ($\beta = 11,417$; $t(44) = 3,915$; $p = <.001$) and in the post-verb frame ($\beta = 8,462$; $t(45) = 2,836$; $p = <.01$). In contrast, there was no difference on the differential looks to the target between unergative and transitive verbs either in the verb frame ($\beta = -0,536$; $t(44) = -0,169$; $p = >.05$) or in the post-verb frame ($\beta = -2,147$; $t(46) = -0,698$; $p = >.05$). In the verb frame, the models of the curves did not differ across the three verbal conditions, but in the post-verb frame there was an interaction between the unaccusative condition and the quadratic polynomial ($\beta = 29,83$; $t(92) = 2,288$; $p = <.05$). These results are compatible with the predictions made by the UH and converge with Koring et al.'s (2012) findings, since there is a larger reactivation effect in unergative and transitive subjects (i.e. agents) than in unaccusatives (i.e. themes) in both timeframes. Still, our results do not replicate the specific growth curve pattern described by Koring et al. (2012) in neither of the timeframes. This particular aspect of the results converges with Huang and Snedeker (2020), who question the assumption that the GCA is well-suited to make specific predictions on the time-course of argument reactivation. We found an interaction between the unaccusative condition and the quadratic polynomial in the post-verb timeframe, which indicates a late reactivation effect for unaccusatives that is not observed in the other conditions. These results provide new evidence consistent with the UH, since a processing difference is found between unaccusative and unergative sentences, with unergatives showing a larger and earlier reactivation effect. The magnitude and time-course of the effect may be an indicator of the processing cost of each predicate type, with larger and/or earlier fixations indicating greater preference to the visual stimuli and therefore greater processing ease.

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