

## Computing complex events and beyond: ERP data on prediction with complex verbs

Chia-Hsuan Liao & Ellen Lau (University of Maryland)

cliao@umd.edu

How quickly can verb-argument relations be computed? How quickly can such relations impact predictions of a subsequent argument? Previous studies in English have shown that event knowledge encoded by a simple verb could effectively restrict predictions of a following argument [1]. However, in the simple verb case it is difficult to disentangle if predictions are driven by event structure per se or low-level semantic association. In the current study, we address this question by looking at complex verbs, where successful predictions depend on computing the argument structure and mapping the complex event to existing semantic memory representations. We take advantage of the substantial differences in verb-argument structure provided by Mandarin Chinese: Mandarin has compound verb constructions that can encode complex event relations, such as the resultative construction (*Kid bit-broke lip*, meaning that a kid bit his lip such that it broke) and the coordinate construction (*Store owner hit-scolded employee*, meaning that a store owner hit and scolded an employee). Using the N400 as a measure of lexical/conceptual pre-activation, we find evidence that prediction is specifically delayed at verbs instantiating the causality relation (*breaking-BY-biting*) relative to the coordinate relations (*hitting-AND-scolding*). Our finding adds to the literature that lexical predictions are not always fast; given limited cognitive resources, not all information from the context can be computed to update predictions in a timely manner.

Coordination and resultative complex verb formation in Mandarin is common and productive; while both involve a sequence of two verbs (V1-V2), they can usually be distinguished by the transitivity of V2. Here we created coordinate and resultative item sets in which an object noun was more predictable after the complex verb V1-V2 (e.g. *bit-broke*) than its corresponding simple V1 predicate (e.g. *bit*; an aspect marker was added to match number of characters). Offline 'cloze' completion norming resulted in item sets in which the target object noun cloze was 40% after the complex verb and only 10% after the simple verb (Table 1).

In Experiment 1 (n=33), the target noun immediately followed the verb, with an 800ms SOA. Sentences were presented with RSVP, and the V1-V2 sequence was presented together on a single screen. Our hypotheses focused on the N400 response to the target noun. If computations at a complex verb are always rapid or are always costly, we would expect either a main effect of predictability on N400s or no effect of predictability on N400s across both coordinate and resultative sets. However, if predictions are specifically delayed by some aspect of the more complex causal V1-V2 relation in the resultative, we would expect a verb type by predictability interaction, with an N400 effect of predictability in the coordinate contrast but not the resultative. Results indeed showed a significant interaction, with an N400 effect in the coordinate set but not the resultative, indicating that prediction on the basis of the resultative takes more time (Figure 1).

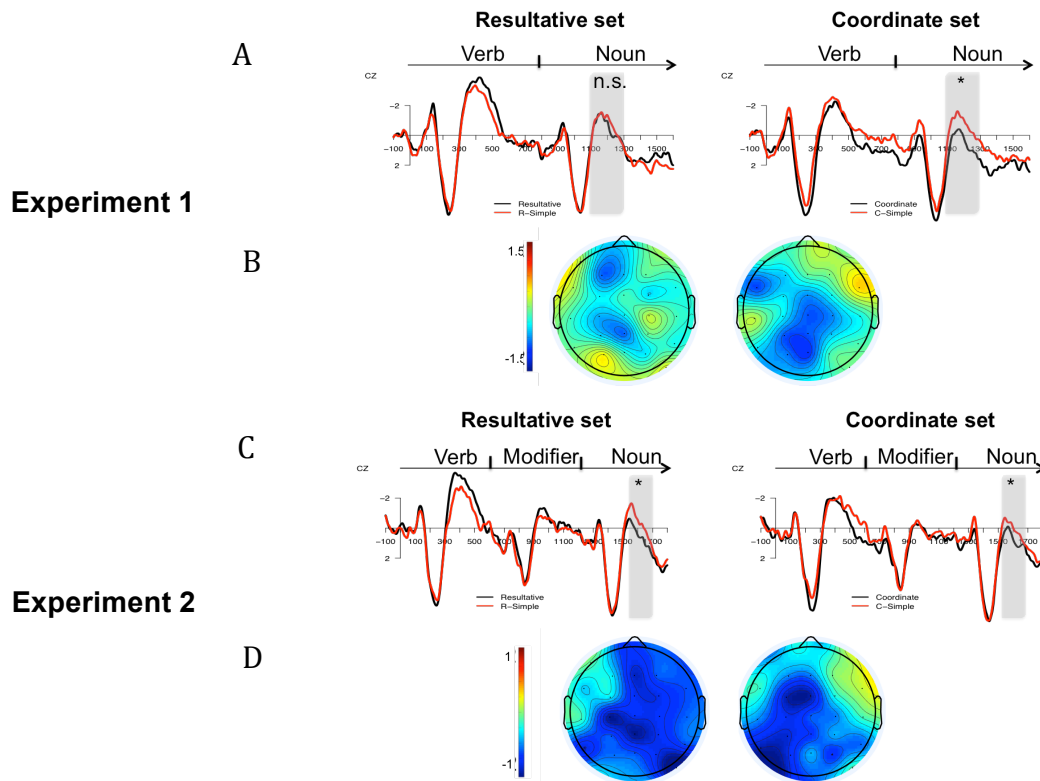
In Experiment 2 (n=38), we further investigated the timecourse of resultative computation to impact predictions. We added a one-word buffer between the verb and object noun by inserting a possessive/quantifier between them (Table 1). However, we slightly reduced the overall SOA to 600ms in order to reduce the length of the experiment; therefore altogether from Exp. 1 to Exp. 2 the delay from verb to noun onset increased from 800ms to 1200ms. With this additional 400ms of processing time, we now observed N400 effects in both sets of verbs (Figure 1).

Taken together, we show that complex event relations could impact predictions of a subsequent argument, but not every event relation can be computed in a timely manner. We propose several possible reasons for the slow down in resultative: (A) the computation of a resultative verb was more taxing and/or (B) memory search of a candidate that fits the resultative context requires longer amount of time. These possibilities can now be explored in future investigations.

**Table 1: Example stimulus in each condition in Experiment 1 and in Experiment 2 (averaged cloze probability in parenthesis)**

Condition	Verb	Sentence context	Target	Cloze
<b>Resultative sets</b>				
Resultative	V1-V2	Xiaohai yao-po le <b>tade</b> <sup>1</sup> The kid <b>bit-broke</b> le <b>his</b>	zuichun lip	High(39%)
		"The kid bit his lip such that his lip was broken."		
Simple (Baseline of Resultative)	V1-ASP	Xiaohai yao-guo le <b>tade</b> The kid <b>bit-ASP</b> le <b>his</b>	zuichun lip	Low(9%)
		"The kid had bitten his lip"		
<b>Coordinate sets</b>				
Coordinate	V1-V2	Laobanniang da-ma le <b>bushao</b> The store owner <b>hit-scolded</b> le <b>some</b>	yuangong employee	High(38%)
		"The store owner hit and scolded the employee."		
Simple (Baseline of Coordinate)	V1-ASP	Laobanninang da-guo le <b>bushao</b> The store owner <b>hit-ASP</b> le <b>some</b>	yuangong employee	Low(10%)
		"The store owner had hit the employee."		

Note<sup>1</sup>: The highlighted modifier (possessive/quantifier) was added in Experiment 2



**Figure 1 A & 1C: Grand average ERPs from the verb to object nouns at CZ; 1B & 1D: Topographic distribution of ERP effects in the 300-500 ms intervals at the noun (Left: R-Simple minus Resultative; Right: C-Simple minus Coordinate).**

Reference: [1] Kuperberg G, & Wlotko E. (2017). Poster presented at the 30th Annual CUNY Conference