Crosslinguistic Variation in Structural Prediction as Learned Behavior

John Duff (Saarland University), Delaney Gomez-Jackson (Motorola Mobility), Fe Silva Robles (Senderos), Maziar Toosarvandani (UC Santa Cruz), and Matt Wagers (UC Santa Cruz)
jduff@lst.uni-saarland.de

Cross-linguistic variation in sentence processing behavior has provided critical evidence for the source of that behavior, e.g. [1,2]. To this literature, we add a puzzling observation from a visual-world eye-tracking study on the incremental comprehension of relative clauses (RCs) in Santiago Laxopa Zapotec (SLZ). Despite rapid and accurate RC interpretation, sensitive to expected effects of similarity-based interference [3], participants showed no sign of structural prediction based on the animacy of the head noun, an effect familiar in other languages [4-6]. We argue that this variation can be best explained if language-specific experience determines whether comprehenders engage in procedural strategies like structural prediction. We see this as a natural result of treating processing as a learned human skill [7].

SLZ is an Oto-Manguean language of southern Mexico with VSO word order. Transitive RCs feature one pre-verbal argument (the head) and one post-verbal co-argument. They are ambiguous between interpretations where the head serves as the RC subject vs. the RC object (SRC/ORC) (1), unless they feature a grammatical resumptive pronoun (RP) marking the subject or object dependency explicitly (2-3). RPs are highly productive even in simple RCs. RPs and other pronouns mark animacy, e.g. HU(man) vs. IN(animate).

Methods Eye movements were recorded from 62 native speakers of SLZ (after exclusions) as they listened to stimuli (1) with relative clauses specifying which of two pictures to select, including in 24 critical trials (Table 1) crossing *Dependency Type* (Gap/ObjRP), *Head Animacy* (HU/IN), and *Co-Argument Animacy* (±Match).

Results We analyzed likelihood of new fixations on target images binarized by region in logistic m.-e. models in brms. Gap conditions received equibiased responses regardless of head animacy, and new fixations to SRC images (Fig. 2) were no less likely for IN heads, $\beta=_{.95}(-0.63, 0.28)$. Comparing trials with ORC responses in Gap and ObjRP conditions (Fig. 3), ObjRPs cued rapid reduction in SRC looks in the following region, and this interpretation was slower when co-arguments matched in animacy, $\beta=_{.95}(0.06, 0.72)$, consistent with the presence of similarity-based interference, and also trended slower when the *co-argument* was IN, $\beta=_{.95}(-0.04, 1.06)$, consistent with a preference to take HU co-arguments as subjects.

Discussion The absence of animacy-based SRC predictions in SLZ is a problem for any universalist account of this behavior, despite existing cross-linguistic evidence [6]. Even a [2]-like account using experience-based biases would struggle to explain a subject bias for HU co-arguments, but not HU heads. Instead, we hypothesize that predictive dependency resolution as a whole is a learned behavior which is not motivated in SLZ RCs. Indeed, even in English, these predictions are not intrinsic to comprehension, but emerge over development [8], perhaps because SRC predictions can help avoid overlaps between lexical processing and dependency resolution. In contrast, in SLZ, even without predictions, either an RP will provide a dedicated cue to the dependency tail, or else a gap can be chosen flexibly later.

Although this hypothesis allows for substantial variation across languages, a prediction which needs much further testing and modeling, we see it as a promising idea which brings theories of sentence processing closer to theories of rational adaptive human behavior across other disciplines of cognitive science [7].

					Head	$_{RC}$[**V**	(_?)	**Co-Arg**	(_?)	**…**]
(1)	Udanh	fotografia’nh	tse	bi’i xyage’nh		txube		coche’nh		
	touch	the.picture	of	the.boy		pull		the.car		

“Touch the picture of {**SRC** the boy who is pulling the car / **ORC** the boy who the car is pulling} …”

(2)	… bi’i xyage’nh	txube	**=ba’**	coche’nh
	the.boy	pull	**=he**	the.car

“…the boy who (he) is pulling the car” (**SRC**)

(3)	… bi’i xyage’nh	txube	coche’nh	**leba’**
	the.boy	pull	the.car	**him**

“…the boy who the car is pulling (him)” (**ORC**)

Dependency Type	Co-Argument Animacy			
N1 = HU	*Mismatch*		*Match*	
Argument Gap (Ambig.)	boy pull car	(HU V IN)	boy pull girl	(HU V HU)
Object RP	boy pull car him	(HU V IN RP)	boy pull girl him	(HU V HU RP)
N1 = IN	*Mismatch*		*Match*	
Argument Gap (Ambig.)	car pull boy	(IN V HU)	car pull truck	(IN V IN)
Object RP	car pull boy it	(IN V HU RP)	car pull truck it	(IN V IN RP)

Table 1: The eight conditions of one 2 x 2 x 2 item frame.

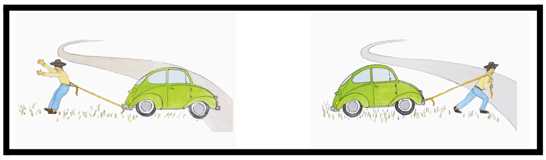

Figure 1: Example image choices for a Mismatch trial. For (1), L = ORC and R = SRC.

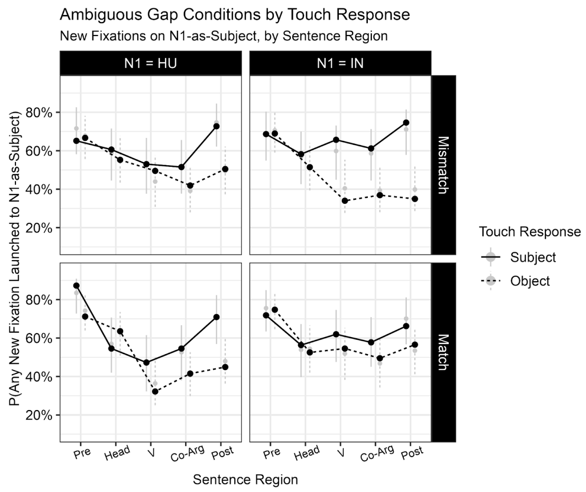

Figure 2: Gaze in ambiguous gap conditions.

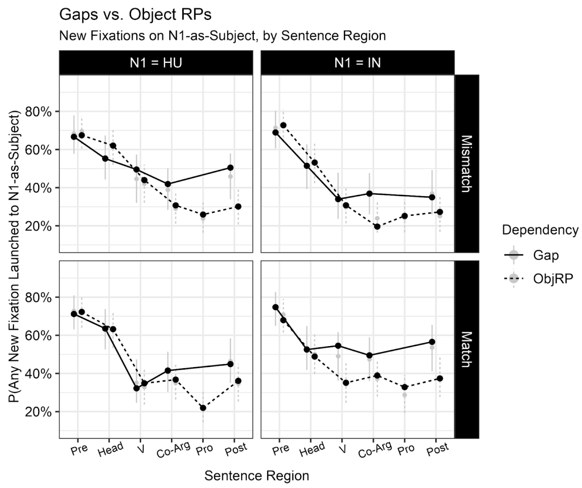

Figure 3: Comparing Gaps and ObjRPs.

Please see our anonymized OSF repository (link) for complete descriptions of methods, results, and analysis.

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