Fool me once: Readers Adapt to NP/Z garden paths but not ORCs

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Syntactic adaptation is a key part of probabilistic expectation-based theories of comprehension, which hold that comprehenders adjust to the frequency of constructions in their environment [1,2,3]. Expectation-based theories hold that less expected structures are harder to process, but this difficulty can be attenuated through adaptation. This view predicts that, all else being equal, adaptation should occur for all syntactic structures. Yet the majority of recent studies on adaptation focus on difficult MainV/RelV garden paths [1,4]. These ambiguities may not be representative of general parsing because they cause conscious difficulty and so may be salient in an experimental context. For these structures, 'adaptation' might be a matter of developing an explicit task strategy rather than implicit expectation adjustment. This 'explicit learning' view of adaptation may more consistent with failures to replicate adaptation [5], as explicit strategies are more likely to vary arbitrarily across studies.

To test this, we directly compared adaptation to two structures: a salient garden path structure (NP/Z ambiguities; 2), and object-extracted relative clauses (ORCs; 1), which are infrequent but (intuitively) do not cause catastrophic garden pathing. We conducted paired eyetracking-while-reading studies (both N=72) to test adaptation to each structure. We varied the intra-experiment frequency of each construction: E1 used 32 ORCs (25% of trials), 8 SRCs, and 8 Z tokens; E2 had 32 Z tokens, 8 NP-resolved NP/Zs, 8 ORCs, and 8 SRCs. A pre-experiment sentence completion task confirmed ORCs had a very high initial surprisal of 8.38 (c.f. 6.97 for the MV/RRC ambiguity in [1]). In both experiments, we measured go-past and total reading times (RTs) at the disambiguating word. For both structures, expectation-based adaptation should result in an ORDERxSTRUCTURE interaction, with RTs getting faster for the more difficult structure across the experiment more than for the less difficult structure. Moreover, if adaptation is sensitive to frequency (as opposed to merely seeing salient garden paths in an experiment), the speed-up for a given structures should be more rapid when it is the most frequent structure in the experiment. We test this by looking at ORDERxEXPERIMENT interactions for the more difficult structure (e.g. RTs on the ORC subject noun in E1 vs. E2).

Results: Almost all measures showed a main effect of ORDER: RTs sped up across the experiment. However, we saw no significant adaptation (ORDERxSTRUCTURE) to ORCs in E1. In E2, we did see a significant adaptation in total times (ORDERxSTRUCTURE in maximal LMER model t=-5.11): the slowdowns on the disambiguating word of Z sentences diminished across the experiment above and beyond any simple effect of trial order. That this was seen only in total times is consistent with [4]. No ORDERxEXPERIMENT interaction was seen: there was no evidence that the rate of adaptation seen for NP/Zs in E1 was significantly greater in E2, when it was highly frequent. This suggests that the NP/Z adaptation in E2 is not due to the relative frequency of Z in context, though we may have lacked sufficient power for this interaction.

Across two experiments, we found only limited evidence for adaptation: there was adaptation to the difficult NP/Z garden path, but only in total time measures. The limited nature of the adaptation effects, and the fact that it only impacted late reading measures, is more consistent with an 'explicit learning' view of adaptation to garden paths than a probabilistic expectation-based view of adaptation. These results, in conjunction with the failure to replicate in [4], call into question the reliability and generality of syntactic adaptation effects.

(1) a. ORC: The biologist that/ **the botanist**/ consulted/ presented ...
b. SRC: The biologist that/ consulted/ **the botanist**/ presented …
(2) a. Z: While the artist sketched the deer in the field/ **munched/** late summer grass...
b. NP: While the artist sketched the deer in the field the herd/ **munched/**...

Example items for E1 (1) and E2 (2). RTs (total time and go-past) were measured on the critical **disambiguating word.**

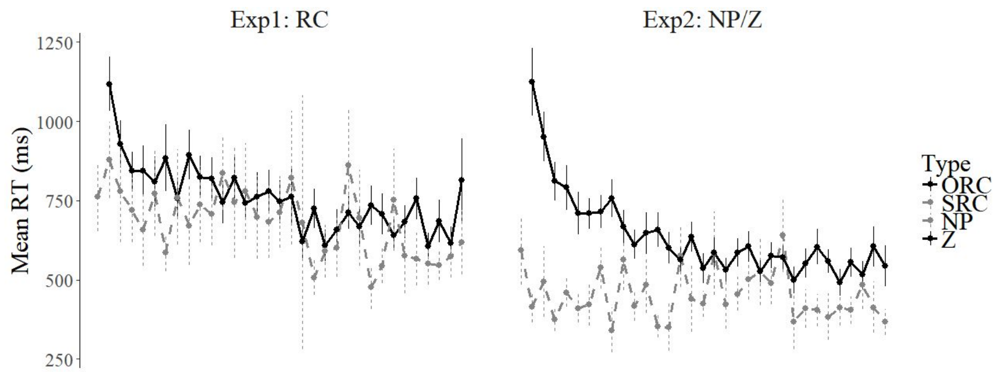

Figure 1: Total Time within-exp comparisons. Exp 1: 32 ORCs vs 8 SRCs; Exp 2: 32 Z vs 8 NP variants of NP/Zs.

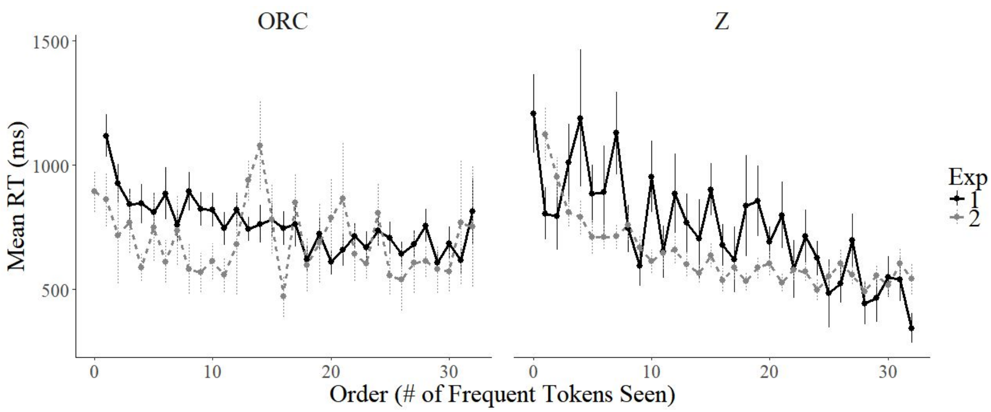

Figure 2: Between-exp comparisons in Total Times. ORCs: 32 tokens (Exp 1) vs 8 tokens (Exp 2); NP/Zs: 8 tokens (Exp1) vs 32 tokens (Exp 2)

		ORC (Rel NP)			Z (Disambiguating Verb)		
		β	SE	t	β	SE	t
Within Exp	Order	-8.03	39.27	18.37	-4.88	1.16	-4.22
	Structure	75.15	22.39	3.36	217.15	27.08	8.02
	Order X Structure	-2.33	2.42	**-0.92**	-13.53	2.54	**-5.32**
Between Exp	Order	-9.13	1.11	-8.22	-15.56	2.01	-7.73
	Exp	-78.98	69.21	1.14	-111.75	58.49	-1.91
	Order X Exp	3.98	2.55	**1.56**	3.62	2.25	**1.61**

Table 1: Results of LMERs for within and between experiment comparisons. For ORCs the control structure in the Within-Experiment model is SRCs, for NP/Zs the corresponding structure is the NP condition.

References: [1] Fine et al.,2013. *PloSOne*. [2] Levy. 2008. *Cognition*. [3] Kaan & Chun. *To appear.* [4.] Tooley & Traxler. 2018.*JML*. [5] Stack, James, Watson, 2018. *Mem&Cog*.