Focus slowdowns arise due to the computation of alternative sets, not unpredictability

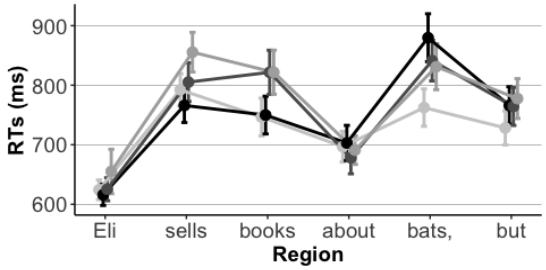
Comprehenders have been argued to expend more resources processing foci than non-foci, as evinced by longer reading times [1-4] and more accurate responses in both memory [5-6] and error/change detection tasks [7-8]. In three reading studies, we disentangle four potential causes for these focus effects, listed in (1). Under (1a), slowdowns on foci have been explained by appealing to newness [2], which should always require more processing effort than material that has recently been processed, but foci need not be new [9]. Experiments (E)1-3 here found slowdowns on given foci [4] and fully predictable foci, contra what would be expected if material were more costly to process for the reasons given by (1b-c). We argue that such slowdowns are instead driven by (1d), the computation of *contrastive alternatives,* i.e., expressions that can substitute for and contrast with the focus [10]. This suggests that the allocation of resources is guided, not just by prioritization of importance or (un)predictability, but also by representations of the relevant contrasts in discourse that are not reducible to non-linguistic concepts.

E1. (n=56) used context questions in different conditions to manipulate the Size of focus in a subsequent target sentence (held constant within each item), to obtain reading time measures on wide and given foci. Of particular interest was whether readers would slow down on the left edge / beginning of a wide focus. 60 target sentences as in (2) were presented using the Maze task [11-12]. Bayesian mixed effects models in `brms` [13] were fit to log and raw RTs on all |target| regions. Only effects reliable in both measures are reported here (Table 1). **Results.** Models revealed reliable slowdowns on the verb in the VP focus condition, on the first noun in the NP1 focus, and on the second noun in the NP2 focus condition, thus replicating the given focus slowdown and indicating slowdowns throughout foci larger than one word. Focus slowdowns thus cannot be explained by newness. But, since the goal of conversation is often taken to be expansion of the common ground [14-15], perhaps focus slowdowns arise because comprehenders spend more time reading information not already established in the common ground (1b). Or, (1c) since conversation may primarily be involved with the resolution of a series of (implicit) questions [16], foci may slow down reading because they answer such questions.

E2. (n=48) crossed focus Size (WIDE vs NARROW) with focus Type (NEW focus vs second-occurrence focus/SOF) to test this. Target foci in SOF conditions were always entailed by their contexts ((3a) already entails that someone read a book about bats), and answered neither an explicit question nor the current (implicit) QUD, e.g., in the context of (3a) this would be *Who only read a book about bats?* The |target| region in these stimuli was always the first object NP as this word was focused in the WIDE but not the NARROW conditions, and WIDE-NARROW RT differences there thus index focus marking. Maze RTs for 48 items like (3) were analyzed as in E1. **Results.** Models revealed a main effect of focus Size (faster RTs in WIDE than NARROW conditions), a main effect of focus Type (faster RTs on SOF than NEW foci), and an interaction between focus Size x Type, such that the focus Type effect was only reliable in the WIDE focus conditions. E2 thus found wide and given focus slowdowns even for SOF foci. This suggests that comprehenders generally encode what contrastive alternatives are relevant in a discourse context, and that contrast among such alternatives guides the allocation of resources during sentence comprehension, not newness, entailment or answerhood. **E3.** aimed to show that contrast plays a role in discourse comprehension even when the need to consider alternatives is not explicitly signaled by a particle. The particle was removed from E2's SOF materials, thus creating conditions in which the |target| was either the second occurrence of a BOUND focus as in (4b) or that of a FREE focus as in (4d). **Results** again revealed both a main effect of focus Size and focus Type, as well as an interaction indicating focus slowdowns in both BOUND and FREE conditions. **In sum,** these findings go against a general understanding in which linguistic material expressing less crucial information is somehow more shallowly parsed. Future work should determine whether the obtained effects carry over to other measures in which effects of focus have been found.

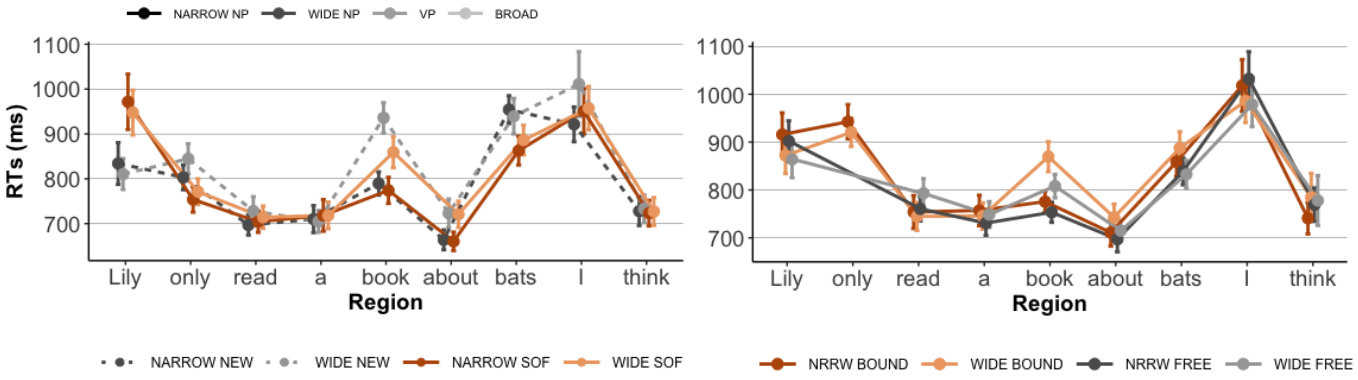
(1) **Potential reasons for prioritization:** Material is prioritized if it is…
(a) discourse new (i.e., unmentioned, see [6])
(b) not already entailed by the discourse context
(c) an answer to the current question-under-discussion (QUD)
(d) standing in some (implicit) contrast with other material

(2)	a. Does Eli sell books about **bats**, or **gorillas**?	NARROW NP
	b. Does Eli sell **books about bats**, or **articles about gorillas**?	WIDE NP
	c. Does Eli **sell books about bats**, or **edit articles about gorillas**?	VP
	d. Does Eli sell books about bats?	BROAD
	Target: I think Eli said he |sells|$_1$ |books|$_2$ about |bats|$_3$, but I'm not entirely sure.	
(3)	a. Abby read a book about **penguins$_F$**, Bob read a book about **gorillas$_F$**	NARROW NEW
	b. Abby read **a report about penguins**, Bob read **an article about gorillas$_F$**	WIDE NEW
	c. Abby read a book about **penguins$_F$**, but Bob only read a book about **bats$_F$**	NARROW SOF
	d. Abby read **a report about penguins**, but Bob only read **a book about bats$_F$**	WIDE SOF
	Target: {And (NEW) | No, (SOF)} Lily$_{F1}$ only read a |book| about bats	
(4)	a. Abby read a book about **penguins$_F$**, but Bob only read a book about **bats$_F$**	NARROW BOUND
	b. Abby read **a report about penguins**, Bob only read **a book about bats$_F$**	WIDE BOUND
	c. Abby read a book about **penguins$_F$**, but Bob read a book about **bats$_F$**	NARROW FREE
	d. Abby read **a report about penguins**, but Bob read **a book about bats$_F$**	WIDE FREE
	Target: No, Lily$_{F1}$ { only (ASSOC) | __ (FREE) } read a |book| about bats	



	Verb (*sells*)			NP1 (*books*)			NP2 (*bats*)		
	β	**(err.)**	**95% Cr.I.**	**β**	**(err.)**	**95% Cr.I.**	**β**	**(err.)**	**95% Cr.I.**
Intcpt	2.88	(.01)	[2.86,2.9]	2.85	(.01)	[2.83,2.87]	2.86	(.01)	[2.84,2.89]
NRRW	-.01	(.01)	[-.03,.00]	0.00	(.01)	[-.01,.02]	0.06	(.01)	[.04,.07]
WIDE	0.00	(.01)	[-.01,.02]	0.04	(.01)	[.02,.05]	0.04	(.01)	[.02,.05]
VP	0.03	(.01)	[.01,.05]	0.04	(.01)	[.03,.06]	0.03	(.01)	[.01,.05]

Table 1: Posterior estimates per region of E1 (logRTs)



	β	**(error)**	**95% Cr.I.**
Intcpt	2.90	(0.01)	[2.87, 2.92]
Type	0.05	(0.01)	[0.02, 0.04]
Size	0.03	(0.01)	[0.03, 0.07]
Type x Size	0.04	(0.01)	[0.01, 0.06]

Table 2: Posterior estimates of E2 (logRTs)

	β	**(error)**	**95% Cr.I.**
Intcpt	2.88	(0.01)	[2.85, 2.91]
Type	0.04	(0.01)	[0.03, 0.05]
Size	0.02	(0.01)	[0.01, 0.03]
Type x Size	0.01	(0.01)	[–.01, 0.03]

Table 3: Posterior estimates of E3 (logRTs)

References [1] Birch & Rayner (1997) *Mem. & Cogn.* **[2]** Benatar & Clifton (2013) *JML.* **[3]** Lowder & Gordon (2015) *Psych. Bulletin & Review.* **[4]** Hoeks et al., (2023) *JML.* **[5]** Birch & Garnsey (1995) *JML.* **[7]** McKoon et al. (1993) *JML.* **[8]** Bredart & Modolo (1988) *Acta Psychologica.* **[9]** Sanford & Sturt (2002) *Trends in Cog. Sci.* **[10]** Rooth (1992). *Nat. Lang. Semantics*. **[11]** Forster et al. (2009) *Behav. Res. Methods*. **[12]** Boyce et al. (2020) *JML*. **[13]** Bürkner (2017) *J. Stat. Soft*. **[14]** Stalnaker (1978) *Pragmatics.* **[15]** Lewis (1979) *Semantics from Different Points of View*. **[16]** Roberts (2012) *Sem. & Prag.*