The enduring effects of default focus in *let alone* ellipsis: Evidence from pupillometry.

Jesse A. Harris*

Abstract. The study of clausal ellipsis in sentence processing has revealed that comprehenders are sensitive to multiple, sometimes conflicting, pressures when recovering elided content. This paper presents a pupillometry experiment investigating how the human language processing system responds to sentences in which the location of a pitch accent clashes with global preferences for local correlates. The results are discussed in light of existing literature, including the Enduring Focus Principle, in which locations for default pitch accent continue to influence focus-sensitive processes regardless of overt markers of focus.

Keywords. Ellipsis; sentence processing; prosody; pupillometry

1. Introduction. Ellipsis poses a set of analytical and empirical problems for the study of the human language processing system. The processor must impute the elided content by establishing an interpretive link with an antecedent clause. As the interpretation of ellipsis depends on many factors, placing different kinds of information in conflict affords psycholinguists the unique opportunity to investigate aspects of the underlying architecture of the language processing system.

In contrastive clausal ellipsis, the remnant is placed in focal contrast with its correlate. A particularly intriguing case is *let alone* ellipsis, as in *John can't run a mile, let alone a marathon* (Hulsey 2008, Toosarvandani 2010, Harris 2016, to appear, for ellipsis analyses). To interpret the remnant (*a marathon*), the processor locates the contrasting correlate phrase (*a mile*) in the antecedent clause from among other same-category competitors using multiple, possibly competing, preferences. Experimental and corpus research finds that the nearest / most local possible correlate is vastly preferred (Harris & Carlson 2016, 2018). Similar biases have been observed for other clausal ellipsis structures, like sluicing (Frazier & Clifton 1998) and replacives (Carlson 2002). However, semantic and prosodic parallelism have also been shown to interact with locality (Harris & Carlson 2016, 2018), suggesting a general, but violable, preference for pairing a remnant with a correlate that is maximally similar along multiple dimensions.

This paper concentrates on how contrastive pitch accent location interacts with global preferences for local correlates in the *let alone* construction. The pupillometry method is employed as a means to identify processing costs during online auditory comprehension. An introduction to *let alone* ellipsis is provided next, followed by a brief discussion of pupillometry. It is argued that misleading pitch accent asymmetrically interrupts the processing of *let alone* ellipsis, providing partial support for the Enduring Focus Principle (Harris & Carlson 2018).

2. The *let alone* structure. Sentences with *let alone* exhibit a complex interaction of syntactic, semantic, pragmatic, and prosodic properties (Fillmore, Kay & O'Connor 1988, Hulsey 2008,

*Many thanks to the amazing undergraduate research assistants in the UCLA Processing Lab for adminstering the study, including Ani Babekhanean, Lily Kawaoto, Joonhwa Kim, Alison Suh, Marina Suh, Chenchen Wang, Richard Wang, and Rebecca Wu. Thanks also to the audiences at ELM2 and WCCFL 40 for helpful feedback. Author: Jesse A. Harris, University of California Los Angeles (jharris@humnet.ucla.edu).

Toosarvandani 2010). Central properties are provided in (1).[1]

(1) *Properties of* let alone
   a. Coordinates or compares elements in contrastive focus;
   b. Presupposes a scalar relationship between items in contrastive focus along some contextually salient scale;
   c. Typically licensed by negative element;
   d. Hosts stripping ellipsis.

For example, speaker B might answer A's question using *let alone* in (2). The elements under comparison are marked with contrastive pitch accent (denoted by SMALL CAPS). These items are placed on a contextually salient scale that might be reconstructed as something like *eating escargot is less likely (or less desirable, etc.) than eating caviar.* Negating a lower element on the scale contextually entails the negation of any higher element (Toosarvandani 2010).

(2) A. Did John try the any of the special *hors d'oeuvres* tonight?
   B. John didn't eat the $\underbrace{\text{CAVIAR}}_{\textit{Correlate}}$, let alone $\underbrace{\text{ESCARGOT}}_{\textit{Remnant}}$.

A stripping ellipsis approach will be adopted for such cases (Harris 2016, to appear). The fragment (*escargot*) following *let alone* corresponds to the remnant of ellipsis, and is paired with a correlate (*caviar*) in the antecedent clause. Assuming a move-and-delete style analysis, the remnant fronts into a focus (3-a) or contrastive topic (3-b) position, while the given material in the rest of the clause is deleted (denoted by $\langle\cdot\rangle$).[2]

(3) a. John didn't eat CAVIAR, let alone $[_{\text{FocP}}$ ESCARGOT$]_1$ $\langle$John eat $t_1\rangle$

   b. JOHN didn't eat caviar, let alone $[_{\text{CTP}}$ SUE$]_1$ $\langle$ t_1 eat caviar$\rangle$

While object contrasts (3-a) seem fairly natural, subject contrasts (3-b) are deemed less acceptable and appear only rarely in corpora (Harris & Carlson 2016, 2018). Intuitively, the implausible parse in which *Sue* is an object is at least temporarily available, despite the explicit pitch accent on the subject, producing an effect reminiscent of the garden path produced by coordination ambiguities (Frazier 1987, Engelhardt & Ferreira 2010). The rest of this paper is devoted to exploring a series of related issues: (i) why ellipsis structures with subject contrasts might be perceived as less acceptable, (ii) how factors such as pitch accent placement contribute to the effect, and (iii) how pitch accent placement affects the online processing of *let alone* ellipsis.

3. Processing ellipsis. The processing of elliptical sentences is complex. It is likely that the sentence processing system draws on many different information channels to establish an interpretation of the ellipsis site. In the case of clausal ellipsis, the interpretation requires the recognition of the ellipsis site, some kind of representation of the elided material, and the location of a correlate

[1] Note that some dialects permit a positive use of *let alone* (Fillmore et al. 1988, Toosarvandani 2009), which does not require negation and presents an afterthought, rather than a scalar comparison between items in contrastive focus (Cappelle, Dugas & Tobin 2015). Such cases are relatively rare in corpora (Harris & Carlson 2016).

[2] For purposes of exposition, I will adopt a syntactic approach to ellipsis, although few, if any, of the central points below depend on this conception.

for the remnant (Yoshida 2018). In particular, I follow Harris & Carlson (2018) and assume that processing clausal ellipsis requires, at a minimum, the processor to engage in the following tasks:

(4) *Basic tasks of the processor in ellipsis processing:*
   a. Parse the remnant by constructing the appropriate phrase structure for the remnant given the input.
   b. Locate the correlate, if any, from the antecedent clause.
   c. Construct the elided phrase by regenerating or copying a structure at Logical Form.

Task (4-a) falls under the domain of standard parsing routines, in which phrase structure is assigned to a string. Tasks (4-b) and (4-c) have been the focus of much previous research. In what follows, our attention will remain on the former, and so discussion of the latter will consequently be suppressed (however, see Frazier 2018, Yoshida 2018, for review). The second task will be referred to as the *remnant-correlate pairing* process.

Recent studies have concentrated on how the following two major factors guide remnant-correlate pairing:

(5) RECENCY/LOCALITY: Prefer the object / closest correlate (e.g., Frazier & Clifton 1998, Harris & Carlson 2016).

(6) PARALLELISM: Match internal properties (e.g., semantics, pitch accent) of DPs in similar structural positions (e.g., Carlson, 2002).

Evidence for a preference for recent or local correlates has been observed in many different types of clausal ellipsis, including sluicing (Frazier & Clifton 1998, Carlson et al. 2009, Harris 2015, 2019), replacives (Carlson 2002, 2013), and *let alone* ellipsis (Harris & Carlson 2016, 2018). To take the case of *let alone* ellipsis, Harris & Carlson (2016) found that the vast majority (approximately 84%) of remnants were paired with the nearest correlate in corpora. In two self-paced reading studies, they also found an online cost for violating locality. For example, in one study, the location of a contrastive adjective like *nicest* was placed in either object (7-a) or subject (7-b) position. The adjective forms a parallel contrast with the remnant *the meanest one*, which was held constant across the two conditions.

(7) a. The nurse couldn't stand the *nicest* patient, let alone the *meanest* one, and no one at the hospital was happy at all.
   b. The *nicest* nurse couldn't stand the patient, let alone the *meanest* one, and no one at the hospital was happy at all.

Sentences with a subject position adjective were read slower on the remnant and the region immediately following (*and no one*). The results suggest that associating the remnant with a non-local correlate taxes the processing system, despite clear semantic parallelism between the correlate and the remnant.

Another way to establish parallelism between the correlate and the remnant is through prosodic marking of information structure, which is integral to ellipsis in at least two ways: first, only given material can be elided and, second, the remnant to ellipsis must contain new or contrastive information (Winkler 2018, for overview). In a corpus study of radio interviews, Harris & Carlson (2018)

found that every correlate and remnant in *let alone* ellipsis bore pitch accent, most of which were realized as a L+H* contrastive accent (79% on correlates and 73% on remnants). In acceptability judgments, however, the location of pitch accent only partially mitigated the cost for non-local correlate-remnant pairings. In that study, ratings decreased for both sentences with either a subject pitch accent (8-b) or a subject remnant (*let alone* KAYLA). The factors interacted, so that subject pitch accent reduced the ratings cost of a subject remnant.

(8) a. *Object accent:* Danielle didn't pass the QUIZ, let alone # KAYLA / the FINAL
b. *Subject accent:* DANIELLE didn't pass the quiz, let alone KAYLA / # the FINAL

Crucially, however, mismatching cases elicited qualitatively different kinds of penalties. A subject remnant paired with an object accent elicited a greater cost than an object remnant paired with a subject accent.

Following suggestions by Büring (2012, 2016), Harris & Carlson (2018) proposed the ENDURING FOCUS PRINCIPLE, in which "locations that typically bear default focus continue to provide potential locations for focus, regardless of overt markers of focus." In the context of clausal ellipsis, the object remains a tempting correlate for *let alone* ellipsis because the object receives Nuclear Pitch Accent by default in English SVO sentences. The failure of overt pitch accent to overturn locality preferences was attributed not to a specific preference for correlate location in the antecedent clause, but to global informational structure expectations for focus placement. In addition, listeners might be more willing to tolerate some degree of prosody-focus misalignment in auditory processing. According to Enduring Focus, listeners would thus be more tolerant of mismatches that preserved global expectations of the prosody. Although there is evidence that sentences with a local correlate are advantaged in online processing during silent reading, whether locality operates during online auditory sentence processing remains an open question.

Recent research indicates that language comprehenders are strongly guided by their expectations of the input, and that those expectations are likely to be influenced by multiple factors including grammatical constraints, experience, contextual information, and what is known about the speaker. One possibility is that prosodic expectations for pitch accent location will guide auditory sentence processing, allowing listeners to accommodate or correct prosodic mismatches relatively quickly. In this case, the mismatch asymmetry would be replicated in online processing. Another possibility is that the accommodation of prosodic mismatch is delayed, perhaps as a post-interpretive repair process. Under this scenario, any penalties generated by mismatching pitch accent would be of similar magnitude regardless of correlate location. The experiment below capitalizes on the unique advantages of pupillometry to investigate these questions. As this technique is not widely used, a brief introduction to pupil dilation and its sensitivity to linguistic variables follows. After discussing the experiment and its central findings, the paper concludes first by contextualizing the results within the current literature on ellipsis and prosodic processing and then by exploring alternative accounts of the findings.

4. Pupillometry study.

4.1. METHOD. Pupil size fluctuates naturally in response to multiple factors. In addition to environmental factors, such as change in luminance, the pupil dilates in response to increases in cognitive load, mental effort, and emotional stimulation (Laeng, Sirois & Gredebäck 2012, for

review). The pupil begins to respond within 200ms of stimulus onset, yet its cumulative effects are relatively slow, peaking approximately 700-1200ms after stimulus onset. Pupillometry is the quantitative study of pupil size change over time. Early pupillometry studies found that tasks that involved greater memory and attention (Hess & Polt 1960, 1964, Kahneman & Beatty 1966), including sentences that were difficult to process (Just & Carpenter 1993), were associated with greater pupillary excursions.

After a period of relative quiet, pupillometry is now enjoying a resurgence in the psycholinguistics literature (Schmidtke 2018). Recent studies have found an association between increased pupil size and lexical frequency or increased emotional valence (Kuchinke et al. 2007), structurally complex sentences (Demberg & Sayeed 2016), prosodic disambiguation in garden path sentences (Engelhardt, Ferreira & Patsenko 2010, Harris & Jun 2018), attachment ambiguities (Harris, Lawn & Kaps 2019a, Harris et al. 2019b), semantic anomalies (Demberg & Sayeed 2016), inadequate or misleading pitch accent (Zellin et al. 2011), and violations of expected meter (Scheepers et al. 2013, Breiss, Harris & Rysling 2021).

While there is no perfect measurement for studying cognition, pupillometry is appealing for many reasons. Relative to neurophysiological measures, it is inexpensive and easy to administer. Further, pupil size cannot be controlled consciously and is unlikely to reflect task-specific strategies employed during the experiment. In addition, pupillometry is particularly useful in auditory sentence processing as the listenter may be required to engage in no other task besides listening naturally and for comprehension. Thus, pupillometry studies offer a highly promising avenue for exploring the role of prosodic information in online sentence processing.

4.2. DESIGN AND MATERIALS. The 20 items from Experiment 1 in Harris & Carlson (2018) formed the basis of the 2×2 design, crossing *remnant type* (ObjectRem vs. SubjectRem) with contrastive *pitch accent location* on the correlate (ObjectPA vs. SubjectPA). Experimental materials were modified to include post-remnant material on which to record pupil size dilation. Items were then re-recorded by a trained phonologist familiar with ToBI, but who was not involved in the project. Materials were inspected for pitch accent location and overall quality and were re-recorded as needed.

Audio files were truncated after the remnant, where 100ms of computer generated silence was inserted. One critical post-remnant region was selected from each quartet and was spliced into each condition, so that the pupillary response was recorded on the identical acoustic material (11). The procedure was repeated for each quartet. The resulting recording was then normalized and checked for naturalness.

(9) *Object remnant*
   a. *Object accent:* Danielle didn't pass the QUIZ, let alone the FINAL
   b. *Subject accent:* DANIELLE didn't pass the quiz, let alone FINAL ...

(10) *Subject remnant*
   a. *Object accent:* Danielle didn't pass the QUIZ, let alone KAYLA ...
   b. *Subject accent:* DANIELLE didn't pass the quiz, let alone KAYLA ...

(11) *Follow on clause for pupil recording:* before the evening class on business law.

Half of the items were followed by two-alternative forced choice comprehension questions (12).

(12) *Comprehension question:* What was the class on?
   a. Law
   b. Ethics

Filler items consisted of 40 sentences from two unrelated experiments on attachment ambiguity and 20 non-experimental fillers. Half of the fillers were followed by comprehension questions similar to (12).

4.3. PARTICIPANTS AND PROCEDURE. Forty-eight self-reported native speakers of English were recruited from UCLA to participate in the study, which lasted 30 minutes on average. All subjects reported having normal hearing. Subjects received course credit for their participation.

Materials were presented with Experiment Builder (SR Research) over high-quality Seinhauser sound-isolating headphones. Eye position and pupil area were recorded using an SR Research EyeLink 1000 Plus eye tracker sampling at 250Hz. The tracker was mounted to the table at 55cm from a 27 inch LCD monitor with a light gray background. The room was moderately lit at consistent levels to control the effect of light contamination on pupil size. A 5-point calibration procedure was used before recording and as necessary, and a drift correction was conducted before every trial.

Subjects were instructed to avoid blinking while the sentence played. After each pre-trial drift correct, subjects were allowed to rest their eyes and blink as needed before self-initiating the trial with a gamepad. After listening to the sentence, subjects answered any comprehension question associated with the sentence by selecting their answer on a gamepad.

Pupil size was recorded for the entire sentence with a high-speed SR Research eye-tracker. Only the 2 second period after the offset of the remnant is reported here. In this period, material was acoustically identical within a quartet. Data cleaning followed the recommendations in the literature (Mathôt et al. 2018, Winn et al. 2018, van Rij et al. 2019). Blinks and other artefacts were removed automatically with PupilPre (Kyröläinen et al. 2019) with 200ms of padding around the event. Any remaining blinks or track losses were removed by hand through visual inspection. The 100ms period of silence after the remnant was taken as the baseline period to calculate change over time. Trials with less than 50% of data in the baseline or less than 80% of data in the period of interest were removed. Subjects with less than 4 trials per condition were excluded. Missing data points on the remaining data were interpolated with spline-smoothing. The data was downsampled to 10Hz to reduce autocorrelation. The data was then normalized by trial to reflect change in pupil size over time by subtracting the mean pupil size obtained from the 100ms baseline, rather than absolute pupil size. Finally, a low-pass Butterworth filter was applied to reduce fast measurement noise that is unlikely to originate from a physiological source

4.4. RESULTS. A generalized additive mixed effects model (GAMM) was used to capture changes in pupillary excursion (van Rij et al. 2019). GAMMs are useful for capturing non-linear relationships that develop over time. GAMMs use smoothing splines, polynomial functions divided into continuous segments, to find the best-fitting non-parametric curves fitting the data (see Baayen & Linke 2020, for a general introduction for linguists). Predictor variables consisted of the factors underlying the experimental manipulation, i.e., Remnant type and Pitch accent location, along with

their interaction. To account for variation among individual subjects and items, random effects included subjects and items over time.

Assuming that greater pupil response signals that more cognitive resources were consumed during processing, we make several key predictions. First, object remnants should be associated with less pupil dilation than subject remnants. Second, pitch accent on an object should elicit less pupil dilation than pitch accent on a subject. Finally, the two factors should interact, so that the subject pitch accent mediates the effect of a subject remnant. Within the expected interaction, there are two possibilities, as the design generated two conditions where the pitch accent location matched the location of pitch accent on the correlate, (9-a) and (10-b), and two conditions where they did not, (9-b) and (10-a). Pitch accent location could completely reverse any subject remnant penalty, so that the matching conditions pattern together: SubjectRem-SubjectPA (10-b) and ObjectRem-ObjectPA (9-a) would both be associated with lower pupil dilation. If, however, the location of pitch accent only partially mitigates the subject remnant penalty, SubjectRem-SubjectPA (10-b) might instead pattern with the SubjectRem-ObjectPA (10-a) condition.

Results of the GAMM are summarized in Table 1. There was a penalty for subject remnants and a penalty for accented subject correlates, as predicted. There was also an interaction between the factors, in which the effect of subject remnants was reduced when the subject in the antecedent clause was pitch accented.

	Estimate	Std. Error	t-value	p-estimate
(Intercept)	-1.47	4.81	-0.31	0.76
SubjectPA	5.79	0.75	7.78	$< .001$
SubjectRem	2.62	0.75	3.51	$< .01$
SubjectPA $\times$ SubjectRem	-5.40	0.75	-7.24	$< .001$

Table 1: Summary of the generalized mixed effects model.

To explore the interaction more closely, marginal means of the model were estimated with *emmeans* (Lenth 2022). In the object remnant condition, accented object correlates significantly reduced the pupil size compared to accented subject correlates ($\hat{\beta} = -22.39, SE = 2.10, t = -10.64, p < .0001$). In the subject remnant condition, however, pitch accent location did not induce significantly different pupillary responses ($\hat{\beta} = -0.79, SE = 2.11, t = -0.372, p = 0.71$), suggesting that the location of pitch accent mitigated, but did not reverse, the subject remnant penalty.

The interactive effect is clearly visualized in the plots in Figure 1 below. As expected, the condition with an object remnant and an object pitch accent was associated with the least amount of pupil rise. When an object remnant was preceded by a pitch accented subject, the greatest effect on pupil change was observed. Pitch accent location in the subject remnant conditions, in contrast, appeared to have no effect. In other words, prosodic parallelism did affect the pupillary response, but failed to completely reverse the effect of locality.

4.5. DISCUSSION. The findings of this pupillometry study partially corroborate Harris & Carlson's (2018) offline ratings study in an online method. Both methods found an advantage for object remnants over subject remnants, in support of an real-time preference for local correlate-remnant

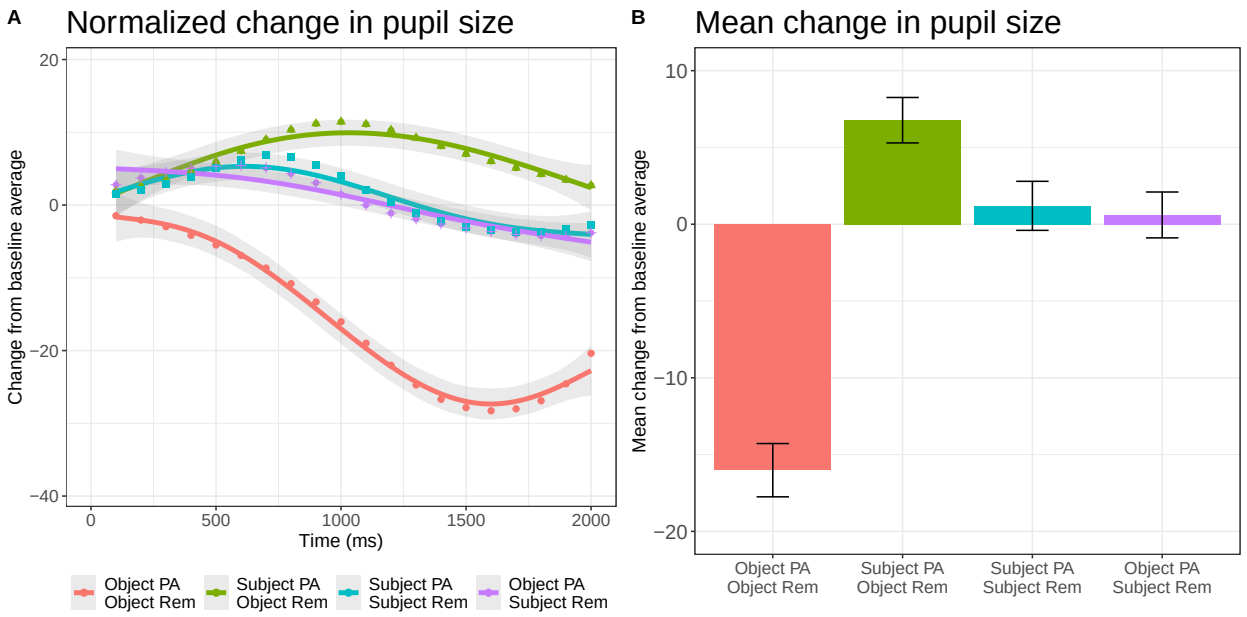

Figure 1: Change in pupil size obtained by subtracting points from the 100ms baseline of silence at each 100ms bin (left panel). The average pupillary response obtained over the entire 2000ms post-remnant interval (right panel).

pairings. Further, subject accent elicited a general penalty compared to object accent, in keeping with a preference for accent in the default position. However, while there was evidence for a pitch accent mismatch asymmetry, the direction of the interaction differed from previous findings. In Harris & Carlson (2018), the effect of mismatch was greater for subject remnants than object remnants. In the present experiment, the mismatch effect was eliminated for subject remnants.

There are several ways that the differences between studies might be reconciled, two of which are considered here. First, subject remnants require forming a contrast with the subject correlate. That process might require greater cognitive reserve in general, thereby delaying the prosodic mismatch effect with subject remnants. Assuming that different measures capture distinct stages of processing, the effect of prosodic mismatch for subject remnants only becomes apparent in later stages of interpretation, perhaps after the object remnant parse has been completely eliminated.

A second possibility is that the licensing conditions for subject remnants were not completely met in the materials. In Harris (to appear), I argue that subject remnants are low contrastive topics (CTs), syntactically located between TP and vP. Contrastive topics are typically licensed in contexts with a pair list answer, a partial answer, or when the speaker initiates a topic shift to another individual Büring (2003, 2014). Without an appropriate Question Under Discussion (QUD), the listener must also accommodate some kind of salient relationship between the subject correlate and the remnant.[3] In addition, CTs tend to appear in multiple-focus constructions: a CT followed

[3]Given that a contextual question placing contrast on the subject induces a reading time penalty (Harris & Carlson 2016), it is unlikely that providing a QUD with an explicit subject contrast is alone sufficient to salvage a sentence with a non-local subject remnant.

by another focused item that together constitute a question-answer pair (van Hoof 2003, Wagner 2012). It is possible that processing was delayed as listeners monitored the input for another focused element, e.g., *the* FINAL, in the gapped variation in (13).

(13) DANIELLE didn't pass the QUIZ, let KAYLA – the FINAL

If correct, *let alone* ellipsis with subject correlates may be more complex than *let alone* with object correlates, in terms of syntax or information structure, unlike what has been proposed for replacive ellipsis, *Alex hit Bob, not Carl* (Carlson 2002, Stolterfoht 2005). A comparison between kinds of contrastive ellipses would be a highly informative direction for future research.

5. Conclusion. The results of a pupillometry study investigating the interpretation of *let alone* ellipsis was reported. The experiment was designed to determine how the language processor responds to sentences in which prosodic parallelism and global locality preferences conflict. A penalty for non-local correlate-remnant pairings was observed. Although pitch accent placement on a non-correlate elicited a greater pupillary response in object remnant cases, it had no effect on the subject remnant cases. Consistent with previous studies on *let alone* ellipsis and the literature on ellipsis in English at large, the pattern was interpreted as reflecting the prioritization of syntactic over prosodic information in the interpretation of ellipsis (van der Burght et al. 2021). While pitch accent type and location clearly guides processing expectations, it would appear that the syntactic information has a more robust effect when it comes to interpreting ellipsis.

References

Baayen, R. Harald & Maja Linke. 2020. An introduction to the generalized additive model. In Magali Paquot & Stefan Th Gries (eds.), *A Practical Handbook of Corpus Linguistics*, 563–591. New York: Springer.

Breiss, Canaan, Jesse A. Harris & Amanda Rysling. 2021. The online advantage of repairing metrical structure: Stress shift in pupillometry. In Tecumseh Fitch, Claus Lamm, Helmut Leder & Kristin Teßmar-Raible (eds.), *The Proceedings of the 43rd Annual Meeting of the Cognitive Science Society*, 2883–2890. Vienna, Austria.

Burght, Constantijn L. van der, Angela D. Friederici, Tomás Goucha & Gesa Hartwigsen. 2021. Pitch accents create dissociable syntactic and semantic expectations during sentence processing. *Cognition* 212. 104702.

Büring, Daniel. 2003. On D-trees, beans, and B-accents. *Linguistics and Philosophy* 26(5). 511–545.

Büring, Daniel. 2012. Focus and intonation. In Gillian Russell & Delia Graff Fara (eds.), *Routledge Companion to the Philosophy of Language*, 103–115. Abingdon: Routledge.

Büring, Daniel. 2014. (Contrastive) topic. In Caroline Féry & Shin Ishihara (eds.), *Handbook of Information Structure*, 64–85. Oxford, UK: Oxford University Press.

Büring, Daniel. 2016. *Intonation and meaning*. Oxford, UK: Oxford University Press.

Cappelle, Bert, Edwige Dugas & Vera Tobin. 2015. An afterthought on let alone. *Journal of Pragmatics* 80. 70 – 85.

Carlson, Katy. 2002. *Parallelism and prosody in the processing of ellipsis sentences*. New York: Psychology Press.

Carlson, Katy. 2013. The role of only in contrasts in and out of context. *Discourse Processes* 50. 249–275.

Carlson, Katy, Michael Walsh Dickey, Lyn Frazier & Charles Clifton, Jr. 2009. Information structure expectations in sentence comprehension. *The Quarterly Journal of Experimental Psychology* 62(1). 114–139.

Demberg, Vera & Asad Sayeed. 2016. The frequency of rapid pupil dilations as a measure of linguistic processing difficulty. *PloS one* 11(1). e0146194.

Engelhardt, Paul E. & Fernanda Ferreira. 2010. Processing coordination ambiguity. *Language and Speech* 53(4). 494–509.

Engelhardt, Paul E., Fernanda Ferreira & Elena G. Patsenko. 2010. Pupillometry reveals processing load during spoken language comprehension. *Quarterly Journal of Experimental Psychology* 63(4). 639–645.

Fillmore, Charles J., Paul Kay & Mary Catherine O'Connor. 1988. Regularity and idiomaticity in grammatical constructions: The case of let alone. *Language* 64. 501–538.

Frazier, Lyn. 1987. Syntactic processing: evidence from Dutch. *Natural Language & Linguistic Theory* 5(4). 519–559.

Frazier, Lyn. 2018. Ellipsis and psycholinguistics. In Jeroen van Craenenbroeck & Tanya Temmerman (eds.), *The Oxford Handbook of Ellipsis*, 253–275. Oxford, UK: Oxford University Press.

Frazier, Lyn & Charles Clifton, Jr. 1998. Comprehension of sluiced sentences. *Language and Cognitive Processes* 13(4). 499–520.

Harris, Jesse A. 2015. Structure modulates similarity-based interference in sluicing: An eye tracking study. *Frontiers in Psychology* 6. e1839.

Harris, Jesse A. 2016. Processing *let alone* coordination in silent reading. *Lingua* 169. 70–94.

Harris, Jesse A. 2019. Alternatives on demand and locality: Resolving discourse-linked wh-phrases in sluiced structures. In Charles Clifton, Jr., Janet Dean Fodor & Katy Carlson (eds.), *Grammatical Approaches to Language Processing*, 45–75. Cham, Switzerland: Springer.

Harris, Jesse A. to appear. The height of *let alone* in English: Evidence from inversion and contrastive topics. In *Proceeding of the 40th West Coast Conference on Formal Linguistics (WCCFL)*.

Harris, Jesse A. & Katy Carlson. 2016. Keep it local (and final): Remnant preferences for 'let alone' ellipsis. *Quarterly Journal of Experimental Psychology* 69(7). 1278–1301.

Harris, Jesse A. & Katy Carlson. 2018. Information structure preferences in focus-sensitive ellipsis: How defaults persist. *Language and Speech* 61(3). 480–512.

Harris, Jesse A. & Sun-Ah Jun. 2018. Using pupillometry to assess prosodic alignment in language comprehension. In Sasha Calhoun, Paola Escudero, Marija Tabain & Paul Warren (eds.), *Proceeding of the 19th International Congress of Phonetic Sciences*, 2926–2930.

Harris, Jesse A., Alexandra Lawn & Marju Kaps. 2019a. Investigating sound and structure in concert: A pupillometry study of relative clause attachment. In Ashok Goel, Colleen Seifert & Christian Freksa (eds.), *The 41st Annual Meeting of the Cognitive Science Society*, 1880–1886.

Harris, Jesse A., Chie Nakamura, Bethany Sturman & Sun-Ah Jun. 2019b. Prosody-meaning

mismatches in PP ambiguity: Incremental processing with pupillometry. Poster presented at the 32nd Annual CUNY Conference on Human Sentence Processing.

Hess, Eckhard H. & James M. Polt. 1960. Pupil size as related to interest value of visual stimuli. *Science* 132. 349–350.

Hess, Eckhard H. & James M. Polt. 1964. Pupil size in relation to mental activity during simple problem-solving. *Science* 143(3611). 1190–1192.

Hoof, Hanneke van. 2003. The rise in the rise-fall contour: does it evoke a contrastive topic or a contrastive focus? *Linguistics* 41(3). 515–563.

Hulsey, Sarah. 2008. *Focus sensitive coordination*. Cambridge, MA: Massachusetts Institute of Technology dissertation.

Just, Marcel A. & Patricia A. Carpenter. 1993. The intensity dimension of thought: pupillometric indices of sentence processing. *Canadian Journal of Experimental Psychology* 47(2). 310–339.

Kahneman, Daniel & Jackson Beatty. 1966. Pupil diameter and load on memory. *Science* 154(3756). 1583–1585.

Kuchinke, Melissa L.-H. Võ, Markus Hofmann & Arthur M. Jacobs. 2007. Pupillary responses during lexical decisions vary with word frequency but not emotional valence. *International Journal of Psychophysiology* 65. 132–140.

Kyröläinen, Aki-Juhani, Vincent Porretta, Jacolien van Rij & Juhani Järvikivi. 2019. PupilPre: Tools for preprocessing pupil size data. https://CRAN.R-project.org/package=PupilPre.

Laeng, Sylvain Sirois & Gustaf Gredebäck. 2012. Pupillometry: A window to the preconscious? *Perspectives on Psychological Science* 7(1). 18–27.

Lenth, Russell V. 2022. *emmeans: Estimated Marginal Means, aka Least-Squares Means*. https://CRAN.R-project.org/package=emmeans. R package version 1.7.4-1.

Mathôt, Sebastiaan, Jasper Fabius, Elle Van Heusden & Stefan Van der Stigchel. 2018. Safe and sensible preprocessing and baseline correction of pupil-size data. *Behavior Research Methods* 50(1). 94–106.

Scheepers, Christoph, Sibylle Mohr, Martin H. Fischer & Andrew M. Roberts. 2013. Listening to limericks: a pupillometry investigation of perceivers' expectancy. *PLoS One* 8(9). e74986.

Schmidtke, Jens. 2018. Pupillometry in linguistic research: An introduction and review for second language researchers. *Studies in Second Language Acquisition* 40. 529–549.

Stolterfoht, Britta. 2005. *Processing word order variations and ellipses: The interplay of syntax and information structure during sentence comprehension.* Leipzig: Max Planck Institute for Human Cognitive and Brain Sciences dissertation.

Toosarvandani, Maziar. 2009. Letting negative polarity alone for 'let alone'. In Tova Friedman & Satoshi Ito (eds.), *Proceedings of Semantics & Linguistics Theory (SALT)*, vol. 18, 729–746. Amherst, MA.

Toosarvandani, Maziar. 2010. *Association with foci*. University of California, Berkeley dissertation.

Rij, Jacolien van, Petra Hendriks, Hedderik van Rijn, R. Harald Baayen & Simon N. Wood. 2019. Analyzing the time course of pupillometric data. *Trends in Hearing* 23. 1–22.

Wagner, Michael. 2012. Contrastive topics decomposed. *Semantics and Pragmatics* 5(8). 1–54.
Winkler, Susanne. 2018. Ellipsis and prosody. In Jeroen van Craenenbroeck & Tanya Temmerman (eds.), *The Oxford Handbook of Ellipsis*, 357–287. Oxford, UK: Oxford University Press.
Winn, Matthew B., Dorothea Wendt, Thomas Koelewijn & Stefanie E. Kuchinsky. 2018. Best practices and advice for using pupillometry to measure listening effort: An introduction for those who want to get started. *Trends in Hearing* 22. 1–32.
Yoshida, Masaya. 2018. Parsing Strategies. In Jeroen van Craenenbroeck & Tanya Temmerman (eds.), *The Oxford Handbook of Ellipsis*, 444–457. Oxford, UK: Oxford University Press.
Zellin, Pannekamp, Ulrike Toepel & Elke van der Meer. 2011. In the eye of the listener: Pupil dilation elucidates discourse processing. *International Journal of Psychophysiology* 81(3). 133–141.