Elided material is present in prosodic structure

Abstract

Because elided material is silent, we might not expect it to have direct representation in the prosodic structure. I argue with experimental evidence that the presence or absence of elided structure does have an effect on the prosodic realization. This result suggests that elided material must be present in narrow syntax in order to be mapped onto prosodic structure (e.g. Johnson 2001; Merchant 2001, 2004; van Craenenbroeck 2010). It challenges alternative theories which claim that elided material is not fully present in syntax by assuming that elided material is copied at LF (Chung et al. 1995), is partially present in syntax as a pronoun (e.g. Landau 2021), or has an enriched meaning by a discourse rule (Groenendijk & Stokhof 1984; Ginzburg & Sag 2000; Jacobson 2016). Furthermore, this result supports a derivational view of the syntax-prosody mapping with a particular ordering of operations. For example, if ellipsis involves PF-deletion, then elided material has not yet been deleted at the point of prosodification. This experiment also demonstrates the value of experimental methods in understanding theories of ellipsis. Theories make concrete testable predictions about prosody, which are borne out by subtle effects in prosodic boundaries. These boundary effects are so subtle that they may not be detectable impressionistically, but only by phonetic measures such as durations.

Keywords: fragment answer, ellipsis, coordination, syntax-prosody mapping, prosodic boundary, pre-boundary lengthening

1. Introduction

Prosodic structure largely reflects syntactic structure, but there are also mismatches between the two. There is rich literature and debate on syntax-prosody correspondence (e.g., edge-based theory Selkirk 1986, 1995; Align and Wrap constraints Truckenbrodt 1995, 1999; Match Theory Selkirk 2009, 2011, Elfner 2012, 2015, Bennett et al. 2016, Ito & Mester 2013, 2015; embedding-based mapping Wagner 2010), but it has largely focused on the prosody of *pronounced* syntactic structure. The prosodic literature that does discuss *unpronounced material* often assumes that silent material does not affect prosody at all (e.g. Chen 1987, Lin 1994, Truckenbrodt 1999, Elfner 2012, Hamlaoui & Szendrői 2015, 2017).

If we apply this assumption to ellipsis, a paradigmatic type of silence, then we'd expect elided material to not affect prosody. This seems like a reasonable assumption because elided material has no phonological content. But prosodic effects include not only *prominence effects* on pronounced material, but also effects on *prosodic boundaries* around (pronounced or potentially unpronounced) material.

This paper presents an experimental production study of the prosodic effects of ellipsis through an investigation of its boundary effects. I study the prosody of ellipsis in a domain with already close syntax-prosody correspondence–English coordination. Downing (1970), Wagner (2005, 2010) and others observed that coordinated clauses are followed by a larger prosodic boundary

than coordinated DPs. For example, (1) involves syntactic coordination of two clauses, and (2) coordination of DPs. This syntactic difference is realized prosodically: there is a larger prosodic boundary between *restaurant* and *and* in (1) than in (2).

(1) *Clausal coordination*
She went to the restaurant and she went there at midnight.

(2) *DP-coordination*
She went to the restaurant and the giftshop.

I take advantage of this insight, and ask what happens if I put ellipsis in (1) (elided material is struckthrough), as in (3).

(3) *Clausal coordination with ellipsis*
~~She went to~~ the restaurant and she went there at midnight.

Is the prosodic difference between the fully overt structures (1) and (2) still present when one of them contains ellipsis? If we call the difference in the boundary size between (1) and (2) Δ_1, and the boundary difference between (3) and (2) Δ_2, then how does Δ_2 compare with Δ_1?

If elided material has no prosodic representation, because there is less overt structure in (3), we may expect the boundary to be smaller in (3) than in (1), and thus Δ_2 to be smaller than Δ_1. If on the other hand elided material has prosodic representation just like pronounced material, then Δ_1 should be roughly equal to Δ_2.

Furthermore, the prosodic investigations of (1)–(3) also sheds light on the syntactic representation of ellipsis. Let us follow the standard assumption in the literature that syntax affects prosody, and the prosodic difference Δ_1 between (1) and (2) is due to a difference between their syntactic structures. If Δ_2 is comparable to Δ_1, then this suggests that there is also a syntactic difference between (3) and (2), even though part of that syntactic structure has been silenced by ellipsis in (3). This suggests that elided material has syntactic representation, despite being silent.

The rest of this paper presents an experimental study whose results support the presence of elided material in syntax and prosody. Section 2 lays out the key assumptions of this study. Section 3 presents opposing views on how elided material is represented syntactically and prosodically, and section 4 presents the logic of the experimental design to test the predictions of those opposing views. Section 5 presents the methods of the production study, section 6 its results and section 7 the discussion of the results. Section 8 discusses possible alternative explanations for the results and empirical challenges to them, which includes a follow-up experiment. Section 9 concludes the paper.

2. Key assumptions

This section lays out the key assumptions on which the current study is based. Theories on syntax-prosody mapping differ in how much match and mismatch there are between syntactic structure and prosodic structure, and in particular whether the prosodic structure can replicate the recursive nature of syntactic structure. Some theories (e.g., Elfner 2012, 2015 and Wagner 2010) claim that it can by positing that a syntactic phrase that dominates another syntactic phrase corresponds to a stronger prosodic phrase than the embedded phrase. Other theories (e.g., Selkirk 1986) claim that prosodic structure is much flatter than syntactic structure in lacking recursivity.

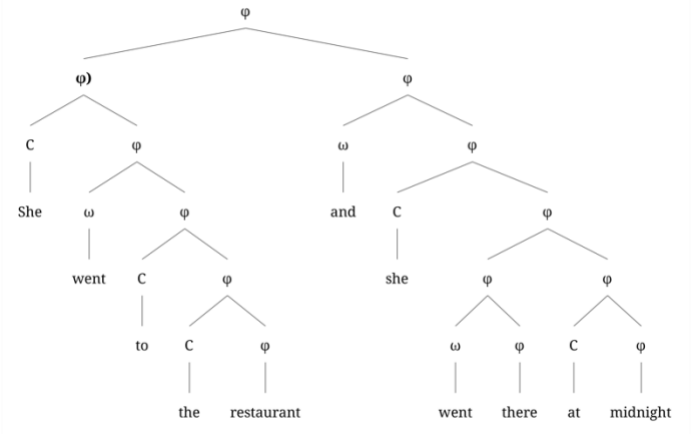
This paper follows the former type of theories because there is independent evidence suggesting that the prosodic structure can indeed be recursive (e.g. Ladd 1986, 1988; Kubozono 1989, 1992; Féry & Truckenbrodt 2005; Ito & Mester 2007, 2010, 2012, 2013; Selkirk 2009, 2011;Wagner 2005, 2010; Elfner 2015), and also the former type of theories can easily account for the observed prosodic difference between (1) and (2). In (1) *she went to the restaurant* dominates *the restaurant*, and therefore corresponds to a strong prosodic phrase. In contrast, in (2) *she went to the restaurant* does not form a constituent. *The restaurant* in (2) is a DP that dominates fewer syntactic phrases than the clause *she went to the restaurant* in (1), and therefore *the restaurant* in (2) should correspond to a weaker prosodic phrase than *she went to the restaurant* in (1).

For concreteness, I illustrate how the prosodic contrast between (1) and (2) can be captured by a specific mapping theory–Elfner's (2015) version of Match Theory. I will introduce the relevant components of Match Theory, and propose an auxiliary assumption that is necessary for independent reasons. These components together can capture the observed prosodic difference between (1) and (2).

2.1. Assumptions about syntax-prosody mapping

Elfner's version of Match Theory posits that prosodic structure replicates the dominance relations in the syntactic structure, where a syntactic maximal projection (XP) is mapped to a phonological phrase (φ), and a syntactic head (X^0) is mapped to a prosodic word (ω). But not all syntactic constituents are mapped onto prosody. An assumption crucial to the literature on syntax-prosody mapping is that silent material (e.g., phonologically empty heads and their projections, and movement traces) is not mapped onto prosody, based on evidence from Chichewa (Truckenbrodt 1999) and Xiamen Chinese (Chen 1987; Lin 1994), etc.

Following these principles, (1) and (2) have the following prosodic structures.[1] I map pronouns and prepositions to clitics (C) to represent the fact that they are prosodically weak, but exactly how they are mapped does not matter to us here because the strings under comparison (i.e., the strings up to *restaurant*) are string-identical: they have pronouns and prepositions in the same positions.



1 Match Theory was actually based on Optimality Theory, a framework in which mapping principles may not be followed if there are higher-ranked constraints. Based on empirical observations, I assume that at least in English coordination, the mapping principles are ranked highly enough that they are always followed, and thus omit the OT ranking exercises for simplicity.

Figure 1: Prosodic structure for (1).

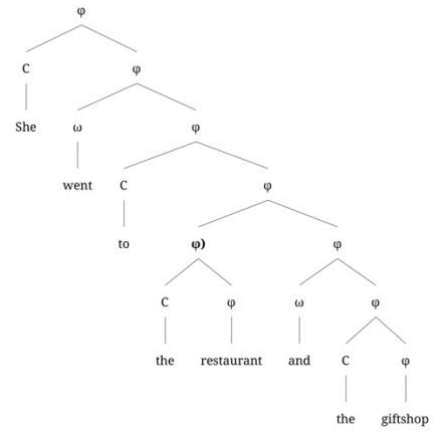


Figure 2: Prosodic structure for (2).

2.2. Auxiliary assumption about the phonetic effects of prosodic structure

These abstract prosodic structures have phonetic effects that we can hear. We thus need a theory that connects the prosodic structure to phonetic effects in prominence and phrasing, such as effects in duration, pitch and intensity. In the tradition of Match Theory, there have been many proposals that connect the prosodic structure to categorical phonological processes such as the presence or absence of a segment or a tone, or the occurrence or blocking of sound change, but to my knowledge no proposal in Match Theory has explicitly connected the prosodic structure to *gradient* phonetic effects such as the degree of lengthening of a segment.

In order to capture gradient phonetic effects, I add the following assumption to Match Theory: the more levels a node dominates in the prosodic structure, the phonetically "stronger" this node is. Phonetic "strength" can be reflected by phonetic effects at the left and right edges of this node, such as domain-final lengthening. By this assumption, a φ must be phonetically stronger than its daughter φ' because the mother φ dominates one more level of φ than the daughter.

Having introduced Match Theory and the auxiliary assumption about mapping from prosodic structure to gradient durational effects, let us apply this framework to (1) and (2). I focus on the highest φs in which the word *restaurant* is final, which is *she went to the restaurant* in (1) and *the restaurant* in (2). The right boundaries of these φs are marked in bold in Figure 1 and Figure 2 respectively. The φ *she went to the restaurant* in (1) dominates four levels of φ, while the φ *the restaurant* in (2) dominates one level. The strength of a phrase is reflected by lengthening effects: as Wightman et al. (1992) showed, the final rime of a word is lengthened before a phrase boundary, and the stronger / larger this boundary, the longer the rime. Because the word *restaurant* in (1) is followed by a stronger phrase boundary than in (2), we would thus expect the last rime of *restaurant* in (1) to be longer than that in (2).

Having shown how Match Theory along with my auxiliary assumption can capture the prosodic difference between (1) and (2), I now present the main research question–that is, whether elided material has prosodic representation.

3. Syntactic and prosodic representation of ellipsis

To answer this question, I put ellipsis in (1) and turn it into (3). (3) may be strange out of the blue, but it can be the *fragment answer* to the question in (4A). Assuming that answers to questions

denote propositions (e.g., (4B1)), fragment answers are those that nevertheless appear as a subpart of a proposition (e.g., (4B2)).

(4) A: Where did Loretta go?
B1: She went to the restaurant.
B2: The restaurant.

A common analysis of fragment answers posits that they are still a full clause, but with clausal ellipsis (e.g., Merchant 2004). According to this analysis, (3) involves movement of *the restaurant*, the phrase that survives ellipsis (*the remnant*), to a higher position (e.g., Spec, CP), plus deletion of the clause *she went to trace*.[2]

(5) [$_{CP}$ [The restaurant]$_i$ ~~she went to t$_i$~~] and she went there at midnight.

The prosodic structure for (5) depends on two factors: (a) how elided material is represented syntactically; and (b) how elided material is represented prosodically.

There are mainly two approaches to the syntactic representation of ellipsis. Some argue that it is fully present in narrow syntax but later deleted at PF (e.g., Johnson 2001; Merchant 2001, 2004; van Craenenbroeck 2010). Others argue that elided material is not fully present in syntax by assuming that elided material is copied at LF (Chung et al. 1995), is partially present in syntax as a pronoun (e.g. Landau 2021), or has an enriched meaning by a discourse rule (Groenendijk & Stokhof 1984; Ginzburg & Sag 2000; Jacobson 2016).

If the first approach is right that elided material is fully present in syntax, then we can further ask how it is mapped onto prosody. There are two possibilities: (a) it is not represented in prosody at all like other phonologically empty material, leading to the prosodic structure in Figure 3, where the relevant φ (in bold) dominates a single level of φ; or (b) it is represented in prosody despite having no phonological content, leading to Figure 4, where the relevant φ dominates two levels of φ. Approaches that assume elided material is not fully present in syntax in the first place would predict the prosodic structure in Figure 3, and the question of prosodic representation of ellipsis is mute.

2 Not all syntactic analyses of fragment answers posit movement. For example, Griffiths (2019) claims that the remnants of ellipsis stay in-situ, and ellipsis deletes the rest of the material:

(i) *In-situ syntactic analysis of (4B2)*
[$_{TP}$ ~~She went to~~ the restaurant].

I do not discuss this analysis in detail because for our purposes it leads to the same results as an analysis that posits movement.

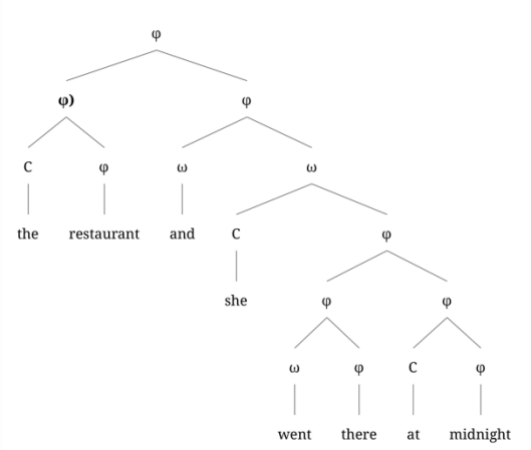


Figure 3: Prosodic structure for (5), if elided material is not represented in syntax or prosody.

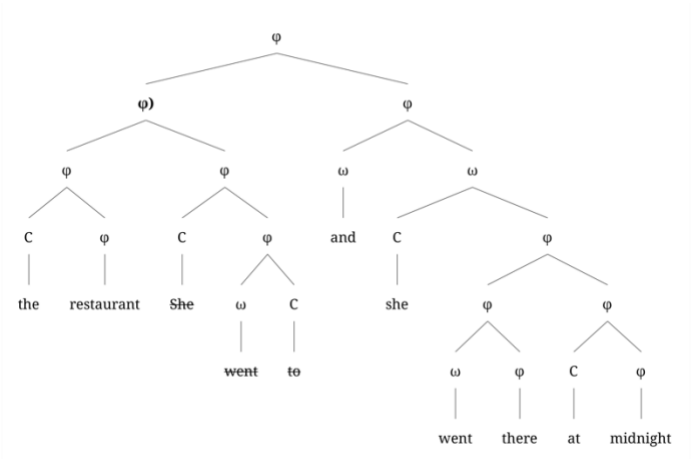


Figure 4: Prosodic structure for (5), if elided material is represented in syntax and prosody.

4. Design to test the research question

I test the prosody of (5) by putting it into the paradigm introduced in section 1. First, I compare the prosodic difference between sentences with fully overt structures (*Control Condition*; (6A1&2)). To make sure the difference between the sentences is minimal, I make (6A1&2) answers to the question (6Q). To control for the total number of syllables, there is ellipsis in the second conjunct in (6A1), but that does not matter to us here because I focus on the prosodic boundary following the first conjunct (i.e. the boundary following *restaurant*).

(6) a. *Control Condition; Clausal Conjuncts*
Q: Where did Loretta go?
A1: [She went to the restaurant] and [at midnight].
b. *Control Condition; DP Conjuncts*
A2: She went to [the restaurant] and [the giftshop].

I expect a significantly larger prosodic boundary following *restaurant* in (6A1) than in (6A2), and call that prosodic difference Δ_1. I then compare Δ_1 with the prosodic difference Δ_2 between a phrase

that contains ellipsis (7A1) and one that doesn't (7A2) (*Critical Condition*). (7A1&2) differ in the location of ellipsis: there is ellipsis inside the first conjunct in (7A1) but outside the first conjunct in (7A2).

(7) a. *Critical Condition; Clausal Conjuncts*
Q: Where did Loretta go?
A1: [~~She went to~~ the restaurant] and [at midnight].
b. *Critical Condition; DP Conjuncts*
A2: ~~She went to~~ [the restaurant] and [the giftshop].

If Δ_2 is not significantly different from Δ_1, then it suggests that elided material is represented fully in syntax, and then mapped onto prosody. If Δ_2 is smaller than Δ_1, then it suggests that either elided material is not fully represented in syntax, or it has syntactic representation, but is not mapped onto prosody.

5. Methods

5.1. Materials

The materials consisted of 20 target sentences (2 conditions x 2 coordination types x 5 sets), with (6A1&2) and (7A1&2) exemplifying a set. The two conditions were Critical and Control, and the two coordination types were clausal and DP. To elicit the intended information structure, each target sentence was shown to the subjects along with a leading context sentence and a *wh*-question. For example, for (7A1), the following materials were presented to the speaker. Every set of items had the same context and question.

(8) Context: Loretta has disappeared.
Question: Where did Loretta go?
Answer: The restaurant and at midnight.

The speaker was to read the context silently, and say the question and the answer in the given order. There were 88 filler items, some of which contained a context, a question and an answer, and others lacked a context.

5.2. Participants

I conducted a production study with six native speakers of North American English, who were all graduate students at X University. They were remunerated a small sum for their time, and granted their written consent to being tested.

5.3. Data collection

Due to the pandemic, participants did the recording at their own homes following step-by-step instructions on how to set up the recording environment. They looked for a place at home with the least reverberation possible (e.g., a place with a lot of soft furniture), and sat in front of a computer that displayed one context-question-answer trio at a time in a pseudo-randomized order. Participants were given instructions about the task at the beginning of the experiment, and were encouraged to act out the dialogues naturally rather than reading mechanically.

5.4. Data analysis

Two research assistants labeled in Praat the last rime of the word immediately before the prosodic boundary (e.g., for (6) & (7), *ant* of *restaurant*) and the pause after that word (e.g., the pause following *restaurant*), if there is such a pause. Their annotations for the same segment differed by 13.7ms on average, and my data analysis was based on the more seasoned annotator's work.

During the recordings, I observed that some speakers sometimes contract *and* into *'n*, and a tendency that *and*'s contraction seemed to be correlated with the size of the prosodic boundary in question: *and* seemed more likely to be contracted when *and* is in a weaker prosodic domain. Thus, I used whether *and* is contracted as a third measure, and asked the research assistants to also label that for each sentence.

I fitted 2 linear mixed effects models, with the duration of the last rime and the duration of the pause as the dependent variable in each model, and coordination (clausal vs. DP) and condition (Critical vs. Control) as fixed effects. I also ran an ordinal logistic regression analysis whose dependent variable was binary–whether there is *and*-contraction, and whose fixed variables were coordination and condition. I calculated p-values using Satterthwaite's degrees of freedom method. The models included random intercepts and slopes by speaker and item group where those effects didn't result in a singular fit.

5.5. Predictions

I expect to replicate the experimental findings by Downing (1970), Wagner (2005, 2010) and others with a significant prosodic difference between coordination types in the Control Condition Δ_1, which would be realized as a longer rime and pause for clausal coordination (6A1) than for DP-coordination (6A2).

The question is whether there is also a significant prosodic difference within the Critical Condition, and if so, how that difference Δ_2 compares with the difference within the Control Condition Δ_1. If there is no significant difference in the Critical Condition (Figure 5), then elided material may not be present in the prosodic structure, and ellipsis does not affect prosody. The prediction figures in this subsection illustrate with the durations of the rime and the pause, but I expect the same predictions if the y-axis is replaced with the proportion of sentences that do not have *and*-contraction.

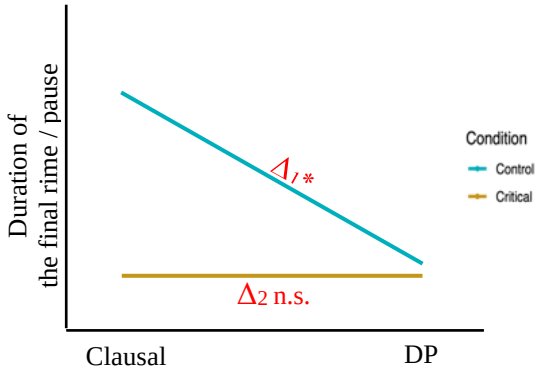


Figure 5: Predicted data if elided material is not present in the prosodic structure.

If there is a significant prosodic difference between coordination types within the Critical Condition, where the rime and the pause are both significantly longer for clausal coordination (7A1) than for DP-coordination (7A2), then we can further ask what is the reason for this

difference by comparing it with the difference in the Control Condition. If the difference within the Critical Condition Δ_2 is comparable to (i.e., not significantly different from) that of the Control Condition Δ_1 (i.e., the slopes from the two conditions are not significantly different; roughly parallel lines in Figure 6), then this suggests that elided material is present prosodically.

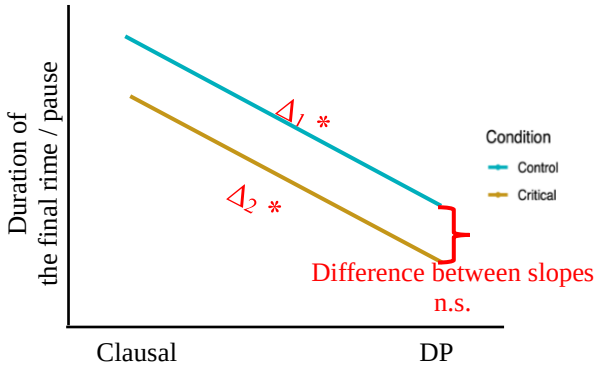


Figure 6: Predicted data if elided material is present in the prosodic structure.

6. Results

I begin by discussing the durational results. Within the Control Condition, the final rime before *and* is on average 77.4 ms longer in clausal coordination than in DP coordination ($p < 0.001$; Figure 7), and the pause before *and* is on average 101.8 ms longer in clausal coordination than in DP coordination ($p < 0.01$; Figure 8). This is expected and consistent with previous findings that different syntactic structures correspond to different prosodic realizations in coordination (e.g., Wagner 2005, 2010).

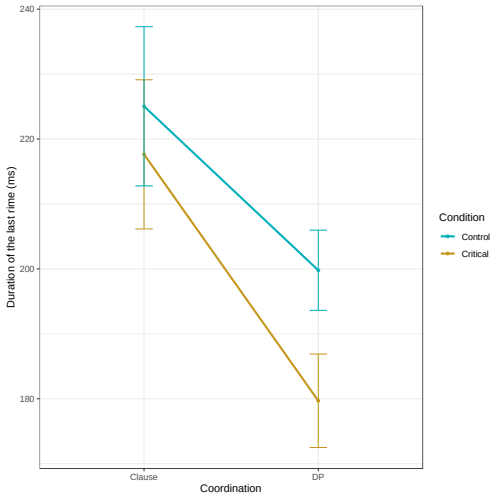


Figure 7: Duration of the final rime before *and*.

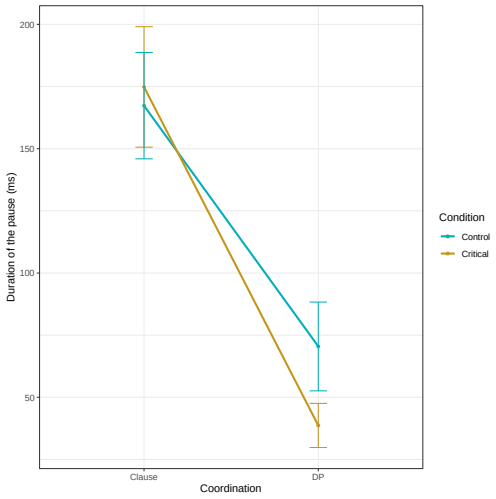


Figure 8: Duration of the pause before *and*.

Within the Critical Condition, the final rime before *and* is on average 55.8 ms longer in clausal coordination than in DP coordination ($p < 0.001$), and the pause before *and* is on average 146.9 ms longer in clausal coordination than in DP coordination ($p < 0.01$). This suggests that the

prosodic boundary following that rime is larger in clausal coordination than in DP coordination, even though that difference has been obscured by ellipsis on the surface.

Furthermore, there is no significance in the interaction between coordination type and condition type–the differences in rime duration and pause duration within the Critical Condition are not significantly different from those within the Control Condition (i.e., no difference between the differences Δ_1 and Δ_2), suggesting that the reason for the prosodic difference within the Critical Condition was underlying syntax. This is expected if elided material is fully present in the prosodic structure.

As for *and*-contraction, I did not find any statistical significance, both within each Condition and between the Conditions (Figure 9).

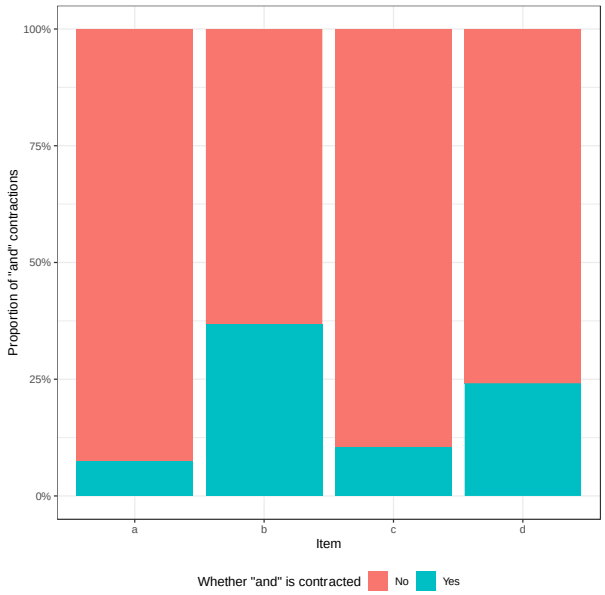


Figure 9: Proportions of utterances that had and contraction and those that did not.

7. Discussion

The durational results indicated that within the Critical Condition, phrases that contain elided material have larger boundaries than phrases that do not contain any elided material, even though these phrases have the same surface structure. Furthermore, the fact that there is no significant difference between the differences Δ_1 and Δ_2 suggests that the source of the prosodic difference within the Critical Condition is syntactic–clausal coordination vs. DP-coordination. This shows that prosody is sensitive to structural differences, whether or not the underlying structure contains elided material. This is expected if elided material is present in prosody.

I suspect the reason for the lack of statistical significance for *and*-contraction may be the low rate of *and*-contraction to begin with: not all speakers contracted *and*, and those who did did not do it often, even in the sentences with DP-coordination. Therefore, it may be difficult to detect a further reduction in the rate of contraction for sentences with clausal coordination. Because there was no significant difference even within the Control Condition, data on *and*-contraction failed to replicate previous findings of close syntax-prosody correspondence in fully overt sentences, and thus I do not consider the data on *and*-contraction to bear on any research question in this paper.

We should have a better understanding of the factors that may affect *and*-contraction before we can use *and*-contraction as a reliable measure of prosodic boundaries. I leave this question to future research, but just want to mention a possible direction. My intuition is that speakers are less likely to contract *and* in the current experimental setting because they tend to speak more formally and slowly in this setting, and *and*-contraction may be less likely with formal and slow speech. To fix this, it may be worth developing an experimental method in the future that encourages speakers to produce more casual and faster speech.

8. Possible alternative explanations

This section addresses two types of alternative explanations. The first type suggests that semantic and pragmatic factors may affect the prosodic structure in ways this paper has not considered so far. The second type has a different view of syntax-prosody mapping that distinguishes between syntactic clauses and subclauses. I first discuss the first type of alternatives and challenges to it, and then discuss the second type and its issues.

8.1. Type 1 of alternative explanations

Sentences (6A1) & (7A1) on the one hand and (6A2) & (7A2) on the other hand differ not only in coordination size, but also in two other factors: what I call *focus* and *going-beyond-the-question*. Because the leading question is a *where*-question for all of them, (6A1) & (7A1) not only answer that question, but they go beyond by providing additional information on when she went to the restaurant. In contrast, (6A2) & (7A2) only answer the *where*-question and nothing more. Also, because of the way the question-answer pair was set up, (6A1) & (7A1) put double focus on *the restaurant* and *at midnight*, while (6A2) & (7A2) put a single focus on *the restaurant and the giftshop*. Thus, we might interpret the experimental results differently, and say that they do not tell us anything about the prosodic effect of ellipsis because the results are completely due to the prosodic effect of focus or going-beyond-the-question. To be concrete, suppose the alternative hypotheses are (a) information that goes beyond the question is preceded by a stronger prosodic boundary than information that does not go beyond the question; and (b) focused material is surrounded by a stronger prosodic boundary than unfocused material.[3] I will present two empirical challenges to these alternative hypotheses in the next two subsections. First, they have difficulty accounting for the experimental results of this experiment. Second, they are excluded by additional data.

8.1.1. Empirical challenge 1 for the Type 1 alternatives

To understand why the alternative hypotheses fail to account for the results of this experiment, let me spell them out in more detail. These alternative hypotheses posit that the effects found in this experiment are not due to the presence of silent structure in one sentence of the Critical Condition (7A1) but absence of silent structure in the other sentence (7A2). Whether there is ellipsis in (7A1) does not matter to prosody because prosodic structure only depends on overt material, and elided material is ignored by the mapping process. The reason for the observed differences is solely the difference in going-beyond-the-question or focus.

3 A variant of the going-beyond-the-question hypothesis might also claim that there is a surprising effect created by the second conjunct *at midnight* because it may be surprising to go to the restaurant at midnight, and perhaps the speaker would pause before it to highlight the surprise. We could address this by replacing this adverb with a mundane one like *on Saturday*, and the prosodic differences are still present by informal observation.

While the alternative hypotheses may be able to account for the significant difference within the Critical Condition, they cannot account for the crucial result here, which is the lack of difference between the difference in the Critical Condition Δ_2 and that of the Control Condition Δ_1.

It has already been demonstrated experimentally by Wagner (2005, 2010) that coordination size affects prosody: clausal coordination is mapped onto larger phonological phrases than DP-coordination. This effect is confirmed by this experiment, and realized as the significant difference within the Control Condition. Following the alternative hypotheses that prosody ignores silent structure, because on the surface, (7A1&2) have the same coordination size, we should expect the prosodic effect due to coordination size to be zero in the Critical Condition, in contrast to a statistically significant effect in the Control Condition. Assuming that the prosodic effects due to going-beyond-the-question or focus for the Critical Condition are the same as the Control Condition, then the alternative hypotheses would predict a smaller prosodic difference within the Critical Condition than the difference within the Control Condition, contrary to the results of this experiment.

8.1.2. Empirical challenge 2 for the Type 1 alternatives: Follow-up experiment

Not only do the alternative hypotheses fail to account for the results of this experiment, but they also fail to account for results of a follow-up experiment, where I made all the questions double *wh*-questions to address the objections raised by the alternative hypotheses:

(9) Context: Loretta went on a road trip.
   a. *Critical Condition; Clausal Conjuncts*
      Q: Where did Loretta go and when?
      A1: McDonald's and on Sunday.
      A2: She went to McDonald's and on Sunday.
   b. *Critical Condition; DP Conjuncts*
      Q: Which restaurant and which giftshop did Loretta go to?
      A1: McDonald's and Walt Disney.
      A2: She went to McDonald's and Walt Disney.

Now all the target sentences just answer the question, and do not go beyond it. Also, in the target sentences, each conjunct bears its own focus. Holding constant the question-answer relationship and the focus structure across conditions, if the results across conditions are the same as what we saw with the previous experiment (i.e., there is still a significant difference in the Critical Condition, and that difference does not differ significantly from the difference in the Control Condition), then we can attribute them to the effect of ellipsis (i.e., we can say that there is a significant difference in the Critical Condition because elided material is present in the prosodic structure; there is no difference between differences because the elided material is mapped onto the prosodic structure, just like overt material is).

8.1.2.1. Methods

I conducted a production study with five sets of items (which were modified version of the items in the previous experiment) and three native speakers. The methods of the follow-up study were identical to those of the previous experiment with two exceptions. First, since the pandemic was over, recording took place in a sound-attenuated booth in the Linguistics Department of X

University instead of at participants' homes. Second, there were two measures: (a) the duration of the last rime; and (b) the sum of the duration of the last rime and the duration of the pause. I chose the sum duration rather than the pause duration as the second measure because a model with the pause duration as the dependent variable always resulted in a singular fit, no matter how much I simplified the random effect structure, and therefore I do not consider its results. Because each duration is correlated with the strength of the boundary of interest, their sum should also be correlated.

8.1.2.2. Results

Within the Critical Condition, the final rime before *and* is on average 14.7 ms longer in clausal coordination than in DP coordination ($p < 0.01$; Figure 10), and the sum of the rime duration and the pause duration is on average 22.8 ms longer in clausal coordination than in DP coordination ($p < 0.05$; Figure 11). There is no significance in the interaction between coordination type and condition for either the duration of the rime or the sum of the rime duration and the pause duration.

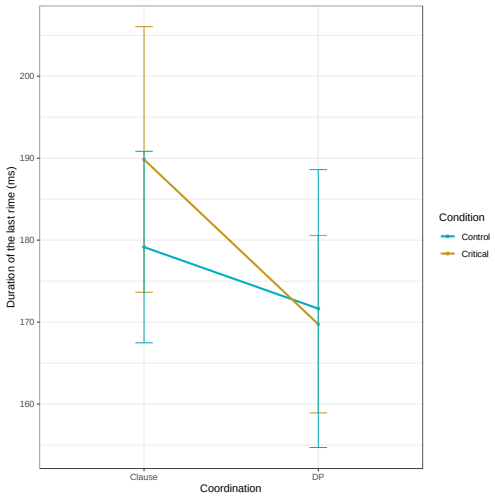


Figure 10: Duration of the final rime before *and*.

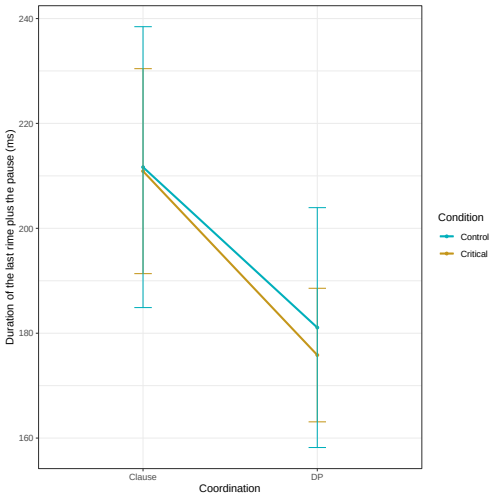


Figure 11: Duration of the final rime plus the pause before *and*.

8.1.2.3. Discussion

Holding constant the information structure across all conditions, there is still a significant prosodic difference within the Critical Condition, which suggests that the reason for this prosodic difference is the different underlying syntactic structures. This is further supported by the lack of interaction, which suggests that the different syntactic structures led to the different prosodic realizations in both the Critical Condition and the Control Condition. This is exactly the prediction if elided material is fully present in the prosodic structure just like overt material.

8.2. Type 2 of alternative explanations

So far I have assumed only one prosodic category above the word level–phonological phrase (φ). All syntactic XPs are mapped to φs, regardless of the type of the XP. This follows Elfner's (2015) analysis of Irish, for which she noted that there was no evidence suggesting that another prosodic category was necessary. But many theories in the prosodic literature posit another prosodic category above the word level–intonational phrase (ι) (e.g. Selkirk 1986, 1995, 2009, 2011). These

theories distinguished between syntactic clauses (roughly TP or CP) and subclauses (anything smaller than a TP, e.g., a DP), and claimed that syntactic clauses should correspond to ɩ, while subclauses to φ.

These approaches that distinguish between syntactic clauses and subclauses can account for the experimental results without having to bear on the research questions at all. I first show how they can account for the contrast within the Control Condition. Assuming that syntactic clauses are mapped to ɩs, we have the following prosodic structures for the sentences in the Control Condition (6A1-2):

(10) *Prosodic structure of (6A1)*
$_{ɩ}$($_{ɩ}$(She went to the restaurant) $_{ɩ}$(and at midnight))

(11) *Prosodic structure of (6A2)*
$_{ɩ}$(She went to $_{φ}$(the restaurant) $_{φ}$(and the giftshop))

In (6A1), *restaurant* is at the right edge of the ɩ that corresponds to the first clause. In (6A2), *restaurant* is at the right edge of just a φ. Assuming that the last rime in an ɩ undergoes more lengthening than the last rime in a φ, this can account for the durational difference within the Control Condition.

These approaches can also account for the significant prosodic difference within the Critical Condition (7A1-2), and the lack of difference between differences. But it does not tell us if elided material is represented prosodically because even if it is not, this approach can still derive the results correctly. First, I repeat the syntactic analyses of (7A1-2) below:

(12) *Syntactic analysis of (7A1)*
[$_{CP}$ [The restaurant]$_{i}$ ~~she went to t$_{i}$~~] and [$_{CP}$ [at midnight]$_{i}$ ~~she went there t$_{i}$~~].

(13) *Syntactic analysis of (7A2)*
[$_{CP}$ [The restaurant and the giftshop]$_{i}$ ~~she went to t$_{i}$~~].

Following are the prosodic structures of (7A1-2) assigned by a theory that matches NP and CP to φ- and ɩ respectively:

(14) *Prosodic structure of (7A1)*
$_{ɩ}$($_{ɩ}$(The restaurant) $_{ɩ}$(and at midnight))

(15) *Prosodic structure of (7A2)*
$_{ɩ}$($_{φ}$(The restaurant) $_{φ}$(and the giftshop))

Whether elided material has prosodic representation does not matter here. In (12), *the restaurant* moves out of the ellipsis site to Spec, CP. In (13), the entire DP-conjunction also moves to Spec, CP, but *the restaurant* is embedded inside this DP-conjunction. These CPs are aligned to ɩ, and it does not matter whether these CPs contain elided material, or whether that elided material has prosodic representation. These prosodic structures give us the effect that the last rime of *restaurant* is longer in (7A1) than (7A2) because it is final in an ɩ in (7A1) but final in a φ in (7A2). Therefore,

a theory that posits ι and a prosodic distinction between clauses and subclauses can derive the experimental results, whether or not elided material has prosodic representation.

Theories that posit two prosodic categories above the word level have two potential issues. First, there is no evidence for two prosodic categories above the word level. In a perception study conducted by Krivokapić (2023), speakers listened to recordings of four types of English sentences that involve a within-ω, ω, φ and ι boundary respectively according to theories that do distinguish between φ and ι. They were asked to distinguish among the prosodic boundaries in these sentences. A Gaussian mixture model analysis examined the number of clusters that best fit the observed data without a predetermined number of clusters, and found that three clusters gave the best fit, suggesting there were only three distinguishable categories, and collapsing the distinction between φ and ι.

Second, since we already need recursive φs, we may not need the φ-vs.-ι distinction, and a theory without such distinction is preferred for its simplicity. If we allow recursive φs, then what used to be considered to be ι may be re-analyzed as maximal φ–φ that is not dominated by any other φ. Until we find independent evidence supporting the presence of a separate ι-category, we should adopt the simpler theory that does not assume a separate ι-category.

9. Conclusion

This paper has argued with experimental results that elided material affects prosody, despite being silent. Elided material may be mapped onto the prosodic structure, and surrounded by prosodic boundaries just like pronounced material.

Following a derivational view of the syntax-prosody mapping, the findings suggest that elided material must be present in the syntactic structure to begin with. Phonological deletion of this material takes place after the creation of prosodic boundaries, so that at the point of prosodification, elided material is still present.

If previous findings were correct that other silent material does not have prosodic representation (e.g., Chen 1987; Lin 1994; Truckenbrodt 1999), then my result here suggests a dichotomy of silence, with elided material having prosodic representation on the one hand, and null heads and their projections (and perhaps traces) not having prosodic representation on the other.

My findings are compatible with the following order of operations: Vocabulary Insertion precedes prosodification, which then precedes deletion of elided material, so that prosody knows which heads are silent and should be ignored, and at the point of prosodification, elided material has not been fully deleted yet.

This study also demonstrates the value of experimental methods in understanding theories of ellipsis. Theories make concrete testable predictions about prosody, which are borne out by subtle effects in prosodic boundaries. These boundary effects are so subtle that they may not be detectable impressionistically, but only by careful phonetic measures such as durations. Furthermore, the key effect is an interaction term–a durational difference between differences–which can only be tested by measurements in lab settings and statistical analyses.

Ethics and consent

The study was approved by the Committee on the Use of Humans as Experimental Subjects of X University. The study was performed in accordance with the ethical standards as laid down in the Federal Regulations for the Protection of Human Subjects (45 CFR 46) and its later amendments.

Competing Interests statement

The authors declare that they have no competing interests.

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