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Structural priming and preposition omission compete in fragment responses to questions

Abstract: This paper sets out to explore the generality of structural priming effects in elliptical responses to prepositional and nonprepositional variants of a single question: *At what time do you close?* and *What time do you close?* The responses were originally collected by Chia et al. (2020) through a language production study that had experimenters call U.S. businesses. While structural priming effects persist in the dataset including both fragment responses (*At 10 pm*) and full-sentence responses (*We close at 10 pm*), they disappear in the fragments subset, where nonprepositional responses (*10 pm*) are the dominant pattern for both nonprepositional and prepositional questions. I propose that the absence of structural priming effects here follows from the experimental items providing a distinct environment that attracts preposition omission in fragments, which here avoids repeating the preposition *at* present in prepositional questions. This environment facilitates online resolution of fragments by providing accessible antecedents in combination with reliable retrieval cues from fragments themselves, and has not yet received systematic attention in the literature on preposition omission.

Keywords: structural priming, fragments, preposition omission, cue-based retrieval, efficiency

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1 Introduction

Syntactic structures that speakers have previously produced themselves or processed when listening to another person are often recycled across subsequent utterances. This tendency, known as structural priming, has been confirmed through experimental (Bock 1986; Pickering & Branigan 1998; Branigan et al. 2000; Scheepers 2003, Sturt et al. 2010; Chia et al. 2020; Chia & Kaschak 2024) and corpus work (Dubey et al. 2005; Gries 2005; Szmrecsanyi 2005; Jacobs et al. 2019). For instance, when the grammar offers options, speaker B can be expected to respond to the question in (1) with a structure parallel to the one that speaker A has produced, that is, one hosting a nonprepositional fragment (NP).

(1) *A: What time do you close?*
B_1: 5 o'clock.
B_2: We close 5 o'clock.

The less expected option would be to respond with a structure hosting a prepositional fragment (PP) (*At 5 o'clock* or *We close at 5 o'clock*). These options are connected to the possibility of expressing temporal adjuncts of this kind (and corresponding interrogative phrases) as either NPs or PPs in English. But given speaker A's question, speaker B's choice here will be impacted by structural priming, as Chia et al. (2020) and Chia and Kaschak (2022, 2024) have demonstrated through language production experiments.

My goal is to examine whether structural priming effects are equally robust across two kinds of responses in Chia et al.'s (2020) data. Notice that response options for the question in (1) include full sentences (*We close (at) 5 o'clock*) and what I refer to as fragments (*(At) 5 o'clock*). While we would, in principle, not expect structural priming effects to differ between full sentences and fragments, fragments have unique properties that could be pulling in the opposite direction than structural priming effects do. To see this, consider (2), a prepositional variant of the question in (1) along with the same two responses.

(2) *A: At what time do you close?*
B_1: 5 o'clock.
B_2: We close 5 o'clock.

The B_1-response is misaligned with structural priming since a prepositional question is responded to with a non-matching structure, an NP, instead of a PP. Thus, the B_1-response should be dispreferred. However, this response could equally well have been produced by P(reposition)-omission, which optionally removes prepositions from fragments if they are present in the preceding context and is independently attested in English (e.g., Merchant 2001; Nykiel 2015, 2017, 2025; Nykiel & Hawkins 2020; Lemke 2021) and in other languages (e.g., Rodrigues et al. 2009; Nykiel 2013a; Molimpakis 2019; Hassen 2025). As this condition is satisfied (i.e., the

preposition *at* is present in the question), *at* may have been omitted from the fragment through P-omission. Thus there are two potential routes that lead to the B_1-response, with the availability of P-omission potentially competing with the pressure to keep the structure parallel across the question-and-response pair. If P-omission wins the competition, structural priming effects can be weakened. Unlike in fragments, P-omission isn't available in full sentences that correspond to fragments, as exemplified in (3).

(3) *A: Before which game did they sing the national anthem?*
B_1: The Champions League Finale.
*B_2: *They sang the national anthem the Champions League Finale.*

Therefore, the B_2-response in (2), which is a full-sentence variant of the B_1-response, can be arrived at via only one route, that is, failure to produce a parallel structure. To anticipate the results, we will see that structural priming effects play out differently in full sentences and in fragments. While they are more robust for prepositional questions than nonprepositional ones in full sentences, they are more robust for nonprepositional questions than prepositional ones in fragments, suggesting a competition between structural priming and P-omission in fragments. Drawing on existing P-omission literature, I will offer an explanation for why P-omission has the ability to override structural priming by producing structures that violate the expected parallelism in the context supplied by the A-question in (2).

The remainder of the paper is structured as follows. Section 2 provides a background on structural priming and details the design and results of the experiments conducted by Chia et al. (2020) to explore structural priming effects in dialogue exchanges depicted in (1) and (2). This sets the stage for my statistical analyses of full-sentence and fragment responses in section 4. Before turning to the analyses, I offer a theoretical background on fragments, and in particular the phenomenon of P-omission, which can look like absence of structural priming, in section 3. The results of my analyses reveal other constraints beyond structural priming that operate on fragments, depending on the questions they serve as responses to. A distinctly novel constraint is the combination of an independently processable fragment and an accessible correlate, which boosts the frequency of P-omission, trumping structural priming effects. In section 5, I discuss the ramifications of these results for work on structural priming under ellipsis, and for work on constraints operating on P-omission under ellipsis. Section 6 concludes.

2 Structural priming and Chia et al.'s (2020) study

Chia et al. (2020) explore structural priming effects in a uniquely naturalistic setting. Experimenters called U.S. businesses to inquire about their closing time by means of one of the questions depicted in (1) and (2) and immediately wrote down their responses. This experimental

paradigm is a replication of Levelt and Kelter's (1982) study of structural priming effects in Dutch, and, like that study, provides a record of entirely unscripted linguistic behavior. When engaged in conversation in this manner, speakers must first comprehend a question produced by another person and then produce a response, choosing to recycle, or not, elements of the structure of the question. Chia and Kaschak (2022), following Jacobs et al. (2019), refer to this type of priming as comprehension-to-production priming as opposed to production-to-production priming, where speakers recycle self-produced linguistic structures. Comprehension-to-production priming can be explained in terms of the existing mechanisms that are assumed to support priming: memory-based models and error-based models.

In memory-based models, an activation boost connected to prior exposure to a linguistic structure carries over to later productions. The activation boost can be short-lived and triggered by a recent encounter with a structure (Dell 1986; Pickering & Branigan 1998; Branigan et al.1999) or it can persist over longer periods of time (Reitter et al. 2011). Regardless of its duration, the structure that has received an activation boost has better odds of being reused in subsequent productions than its competitors with lower activation levels. Activation associated with a given structure can spread within a single speaker, as much as it can spread across dialogue participants. Branigan et al. (2000) and Branigan et al. (2007) provide evidence for speakers aligning their choices of linguistic structures over conversational turns, and Pickering and Garrod (2004) articulate a model of language processing in dialogue (the "interactive alignment model") to capture how dialogue participants' linguistic representations become automatically aligned over the course of a conversation at phonetic, phonological, semantic, and syntactic levels. Pickering and Garrod (2004) argue that the possibility of recycling structures with increased activation levels facilitates language production, providing a motivation for the alignment of linguistic structures.

Error-based models are based on the assumption that linguistic structures produced by speakers reflect the statistical preferences present in the discourse that surrounds them (Chang et al. 2006; Fine & Jaeger 2013; Dell & Chang 2014). While an expected structure simply confirms the current statistics, an unexpected one triggers adjustments to them due to an error signal being generated when such an unexpected structure is encountered. As a result, that structure will be more available for immediate future productions than its less surprising competitor(s). Error-based models also predict longer-term priming effects inasmuch as repeated exposure to unexpected structures leads to a gradual accumulation of statistical adjustments until no error signal is generated. Note that structures that are unexpected are typically also low-frequency structures, suggesting that priming effects are stronger for these structures.

Both memory-based models and error-based models predict priming effects in the dialogues designed by Chia et al. (2020). There are three possibilities regarding the nature of these effects. First, we might observe structural priming effects driven by the structure of the temporal adjunct

(At) what time. If the adjunct is realized as a PP in the question, then the response repeats that structure by producing a PP, either as a fragment or inside a full sentence, as in (4).

(4) *A: At what time do you close?*
B: At 5 o'clock. or *We close at 5 o'clock.*

The structure of the adjunct in the fragment response is constrained by the alternation between a PP and an NP. Given the nonprepositional question, structural priming effects arise if the response is realized either as an NP fragment or a full sentence with an NP adjunct, as in (1), repeated here for convenience as (5).

(5) *A: What time do you close?*
B: 5 o'clock. or *We close 5 o'clock.*

As the driving force behind structural priming here is the syntactic category of the temporal adjunct, the prime is no larger than the adjunct itself. It is independent of whether the syntactic structure that fragments are assigned on various theoretical accounts is sentential or not. Defining the prime this way is also aligned with the set of structural retrieval cues that are available on cue-based retrieval models of sentence processing (the structure of fragments and cue-based retrieval models are both discussed in section 3). Although priming is an entirely separate mechanism from cue-based models of sentence processing, the two converge on the processing advantage of producing structurally matching responses, as we will see in section 3. I refer to this kind of priming as adjunct-based structural priming.

The second possibility is that we might observe the lexical boost above and beyond structural priming effects. The lexical boost, which manifests as increased magnitude of structural priming, is induced by content words like verbs or nouns if they are present both in the initial experience with a structure and the subsequent reuse of that structure (Pickering & Branigan 1998; Mahowald et al. 2016). Some research points to the lexical boost being a shorter-lived effect than structural priming (Hartsuiker et al. 2008; Mahowald et al. 2016; Tooley 2020). In Chia et al.'s (2020) experiments, the lexical boost could be induced by the preposition *at*, which is present in a subset of all primes, that is, all the prepositional questions, and observed as an increase in the proportion of responses also including *at*, like those depicted in (4). Because each response immediately follows the question, the lexical boost could be detectable. However, Chia and Kaschak (2022), following the same experimental design, report no evidence for the lexical boost on the basis of a nearly identical distribution of full-sentence responses containing the preposition *at* across all questions. They report weak evidence for the lexical boost under ellipsis, with fragment responses to prepositional questions showing a 6% increase in the frequency of the preposition *at* compared to fragment responses to nonprepositional questions. The statistical analyses we will see in section 4 also cast doubt on the presence of the lexical boost.

Finally, we might observe structural priming effects at a schematic level that represents the structure of a question. Chia and Kaschak (2022) take this route when they take fragments to be sentential structures, parts of which remain silent. For them, the prime is the entire structure of a question, including the preposition placement choice.[1] If the preposition *at* is pied-piped together with its complement (*At what time do you close?*), a fragment response follows this pattern by pied-piping the preposition as well so that it escapes deletion. If the question has no preposition (*What time do you close?*), a fragment response can strand *at* within its structure, leaving it to be deleted along with the rest of the silent material. However, this view is problematic for three reasons. First, it's unclear why a structure with no preposition should prime a structure with preposition stranding rather than a structure that simply includes no preposition either. Second, the assumption that fragments are sentential structures is biased toward one kind of theory of fragments, making the priming mechanism heavily theory-dependent. Third, this view implies that overt structures can prime partially silent ones, although this is far from a given. In fact, the data we will see in section 4 reveal overall higher frequencies of full-sentence responses than fragments, suggesting that overt and partially silent structures are not primed by overt structures equally strongly.

To avoid these problems and remain theory-neutral, I assume that priming effects, if observed, are generated by the structure of a temporal adjunct and the preposition *at*. In other words, I expect to see adjunct-based structural priming, possibly in conjunction with the lexical boost produced by the preposition. Even though our understanding of the exact nature of structural priming effects differs, the patterns that Chia et al. (2020) observe are fully aligned with patterns I expect to see.

Chia et al.'s (2020) argument is that they observe predominantly structural priming effects when using the Levelt and Kelter (1982) paradigm, but they note that these effects are smaller in magnitude than could be expected. Their point of reference is the results of in-lab experiments included in Mahowald et al.'s (2016) meta-analysis of structural priming. The Levelt and Kelter (1982) paradigm yields modest structural priming effects in comparison, even when Chia et al. (2020) introduce manipulations to the experimental conditions in order to examine whether the participants' level of engagement in the conversation might make a difference. One of their experimental conditions matched Levelt and Kelter's design exactly: an experimenter called, asked the critical (prepositional or nonprepositional) question, and recorded the response. In the remaining three conditions, the critical question was preceded by either another question or a polite introduction, or followed by a clarificational question. Responses were coded separ-

[1] Some researchers have argued that priming effects may be driven by abstract syntactic structure that is fully independent of individual lexical items, as priming effects persist even when that structure includes nonce words or words embedded in inappropriate structural configurations (e.g., an intransitive verb embedded in a transitive frame) (Ivanova et al. 2012).

ately following a close scheme and an inclusive scheme. The close scheme allowed responses to be nonprepositional if the preposition *at* wasn't included in them, but other prepositions (e.g., *around 5 o'clock*) were fine. Prepositional responses required the presence of the preposition *at* on this scheme. On the inclusive scheme, prepositions like *around* were permitted in addition to *at* in prepositional responses, while no prepositions were permitted in nonprepositional responses. Chia et al.'s (2020) results reveal structural priming effects that remain unaffected by either the coding scheme or experimental condition; that is, prepositional questions were answered with prepositional responses more frequently than nonprepositional ones. Their statistical models also provide evidence for an effect of fragments, such that prepositional responses are produced less often as fragments than they are as full-sentence responses regardless of the coding scheme. I follow up on this finding, which suggests that structural priming effects do play out differently in fragments compared to sentential responses. In section 4, we will look at a subset of Chia et al.'s (2020) dataset in an effort to better understand this difference.

3 Background on fragments

Fragments are reactions to the preceding linguistic or nonlinguistic context (antecedent) that appear to be nonsentential. Most characteristically, they function as responses to *wh*-question antecedents, as in (6) and (7).

(6) *A: What are we looking at?*
B: A new TV series.

(7) *A: How did they get in?*
B: Through the back door.

In this section, I discuss the structure of fragments and the way they are processed online.

From a theoretical perspective, fragments are accounted for as genuine nonsentential utterances on the direct interpretation approach (Ginzburg & Sag 2000; Culicover & Jackendoff 2005) and as sentences that are partially unpronounced on the movement-and-deletion approach (Merchant 2001, 2004). This theoretical distinction is relevant for understanding the nature of structural priming effects detected in Chia et al.'s (2020) data. While the structure of the fragments in (6) and (7) consists of no more than the phrases themselves on the direct interpretation approach, it is sentential on the movement-and-deletion approach, as shown in (8) and (9) (strikethrough indicates the unpronounced material).

(8) *A new TV series ~~we are looking at~~.*

(9) *Through the back door ~~they got in~~.*

On the movement-and-deletion approach, the structures of a fragment and of a full sentence are aligned in Chia et al.'s (2020) experimental items except that the fragment undergoes leftward movement to escape deletion, as in (10) and (11).

(10) *(At) 5 o'clock ~~we close~~.*

(11) *We close (at) 5 o'clock.*

This is why Chia and Kaschak (2022) expect structural priming to operate at the schematic level of the full sentential structure, with a sentential antecedent priming full-sentence responses as much as it does fragments. This expectation is consistent with the movement-and-deletion approach, but not the direct interpretation approach, which predicts fragments to not be primed by sentential antecedents because their structures are nonidentical.

Adjunct-based structural priming as described in the previous section is consistent with both approaches. The only structure that plays a priming role is the structure of an adjunct, which in turn is determined by one of the syntactic categories (NP or PP) chosen for it. This is straightforward on the direct interpretation approach, as fragments are generated "as is." On the movement-and-deletion approach, the phrase moved to the sentence-initial position is whatever phrase originally occupies the adjunct position in situ.

Another issue surrounding fragments is the manner in which we process them online. When addressing this issue, I adopt the comprehender's perspective more than the speaker's because resolution of fragments requires additional resources than those normally employed for the processing of non-anaphoric material. An influential model of sentence processing, the cue-based retrieval model (McElree 2000; McElree et al. 2003; Lewis & Vasishth 2005; Lewis et al. 2006; Van Dyke 2011; Van Dyke & Johns 2012; Caplan & Waters 2013), has been shown to be compatible with the way the parser arrives at an interpretation for fragments. The steps involved in online processing of fragments are at least: (1) interpreting fragments, (2) locating their correlates (i.e., corresponding phrases) in the antecedents, and (3) retrieving fragments' sentential semantics (Culicover & Jackendoff 2005; Goldberg & Perek 2019; Harris & Carlson 2019; Nykiel et al. 2023). The second step (i.e., locating the correlate) engages a sort of "search" for the relevant representations. The search could in principle be operationalized either as a (sequential or parallel) search through all existing memory representations or a mechanism that provides direct access to the relevant representations without going through non-target representations. Martin and McElree (2011) have argued that what applies to fragments is the latter type of search, a direct-access mechanism guided by fragments' semantic and morphosyntactic features. Features that are encoded by linguistic forms on cue-based retrieval models are item-based and include lexical content, structural information like case and syntactic category, and local parenthood and sisterhood relations (Parker 2018). It remains an open question, especially in the case of

fragments, which of these features are engaged as cues during retrieval, with some researchers suggesting that structural cues are prioritized (e.g., Dillon et al. 2014; Lyu & Kaiser 2021) and others suggesting that all cues are engaged in parallel (e.g., Lewis & Vasishth 2005; Van Dyke & McElree 2006). Representations that match many retrieval cues become more highly activated, but retrieval success depends on how much overlap there is between the linguistic form initiating retrieval, the target memory representation, and distractors. If several features are shared across all of them, the result could be a slowdown in retrieving the target or downright failure to do so (Watkins & Watkins 1975; Nairne 2002; Öztekin & McElree 2007; Martin 2018).

Research on fragments shows that matching features are preferred even in simple environments. Given no distractors, speakers prefer for fragments' structural properties, like case specifications, to be aligned with the properties of their correlates (Nykiel et al. 2023) and for fragments' lexical content to be similarly aligned with the correlates' lexical content (Nykiel 2013a), suggesting that matching properties play a facilitatory role at retrieval. This research makes it plausible that syntactic category could be another candidate for serving as a retrieval cue. If it is, then adjunct-based structural priming effects could be reinforced for fragments in Chia et al.'s (2020) experimental data, such that matching questions and responses would have reliably higher frequencies for fragments than for full-sentence responses. Capturing adjunct-based structural priming from the comprehender's perspective as it does, this hypothesis aligns with the speaker's perspective, for whom a facilitatory role of structural priming is also predicted by, especially, memory-based models of priming (see section 2). This is the main hypothesis I test in section 4, but I'll add some refinements to it later in this section.

On the other hand, adjunct-based structural priming effects could be countered by a phenomenon known as P-omission, which occurs in fragments and is illustrated in (6) above (see also (3)). The response in B is an NP but could be a PP (*At a new TV series*) in its place. It is uncontroversial that P-omission is available for English fragments that have overt correlates (Merchant 2001; Chung 2006; Nykiel 2015, 2017; Nykiel & Hawkins 2020; Lemke 2021). This is so in (2), repeated here as (12), making the fragment *5 o'clock* ambiguous between two sources: P-omission and change in syntactic category, both of which constitute a violation of structural parallelism.

(12) *A: At what time do you close?*
B: 5 o'clock.

If P-omission has a high probability of occurrence following the antecedent in (12), it will pull in the opposite direction than adjunct-based structural priming (which pulls in favor of the matching PP). This brings us to the question of whether (12) does constitute an environment that attracts P-omission.

Looking at P-omission from the viewpoint of efficient communication, Nykiel and Hawkins (2020) propose that it's costly unless it applies in appropriate circumstances. Their approach is aligned with Hawkins' (2004: 25) notion of efficiency defined as the expression of maximally informative content by means of minimally complex forms ("Express the most with the least"), and with the Efficiency Hypothesis, which takes language to be a system for transmitting messages with both precision and minimal effort, where ease of production and comprehension have a role to play (Gibson et al. 2019; Futrell et al. 2020). Nykiel and Hawkins (2020) support their proposal with a robust pattern observed in crosslinguistic data: P-omission is less preferred than retention across introspective judgments reported in the literature (Stjepanovic 2008, 2012; Szczegielniak 2008; Rodrigues et al. 2009; Philippova, 2014) and predominantly less acceptable in experiments (Merchant et al. 2013; Nykiel 2013b; Molimpakis 2019; Lemke 2021; Nykiel & Kim 2022, Hassen & Abeillé 2025; Hassen 2025). Corpus data show more mixed results so far, with present-day English and French preferring P-omission (Nykiel 2017; Nykiel & Hawkins 2020; Hassen & Abeillé 2025; Hassen 2025), but earlier English dispreferring it (Nykiel 2015). This isn't surprising, given empirical evidence that repetition of redundant material can be beneficial rather than disruptive in language comprehension (Levelt 1989; Arts 2004; Maes et al. 2004; Davies & Katsos 2009; Arts et al. 2011), and is clearly beneficial both under ellipsis (Harris 2015) and when ellipsis is compared with its nonelliptical counterparts (Dickey & Bunger 2011; Kertz 2013). However, Nykiel and Hawkins (2020) argue that certain environments favor P-omission despite the benefits of not applying it;[2] of these, we will review two that are relevant: accessibility of a correlate, and independent processability of a fragment.

Even though the linguistic features of a fragment are key to successful resolution, as predicted by cue-based retrieval models, some of the responsibility lies on the accessibility of the frag-

[2] An anonymous referee suggests that P-omission, like other kinds of reductions, is consistent with information-theoretic models (Hale 2001, 2006; Levy & Jaeger 2007; Levy 2008; Demberg & Keller 2008). These models propose that more predictable material carries less information, has lower surprisal, incurs a lower processing cost, and tends to be omitted more easily than less predictable material. It seems to me that examining whether P-omission is subject to information-theoretical constraints would require precise estimates of how predictable various prepositions are in contexts more diverse than Chia et al.'s (2020) materials. However, a small experiment can offer insight into the predictability of the responses collected by Chia et al. (2020), including the responses shortened through P-omission. Toward this end, I extracted average log probability per word given the context for each response to either question from GPT2LMHeadModel. The patterns that emerged are that all prepositional responses are overall more predictable (i.e., less surprising and easier to process) than nonprepositional responses regardless of the question, and that prepositional full sentence responses are more predictable than prepositional fragments. These patterns are partially aligned with the responses actually produced in Chia et al.'s (2020) experiments: prepositional full-sentence responses are by far the most frequent at 60.9%, but prepositional fragments account only for 6% of the responses. Speakers thus end up producing responses whose predictability falls at the lower end of the scale approximately 30% of the time, with nonprepositional fragments accounting for over 90% of these responses. Overall, this predictability pattern suggests that P-omission is used despite incurring a processing cost, which is in line with Nykiel and Hawkins' (2020) proposal. The surprisal per word values for each response can be found in Table 1 in Appendix 2.

ment's correlate. The role of a correlate that Nykiel and Hawkins (2020) have in mind doesn't follow from cue-based retrieval as such but has a basis in independent research examining how memory encoding impacts the accessibility of phrases of various size and complexity for future retrieval from memory. A phrase that is semantically contentful and syntactically complex (e.g., a lexical NP) is processed more deeply and becomes more highly activated than a phrase that is less contentful and less complex (e.g., a pronoun). This creates an advantage in the form of a future accessibility boost (Craik & Lockhart 1972; Gallo et al. 2008; Hofmeister 2007, 2008, 2011; Hofmeister et al. 2007; Hofmeister et al. 2013; Karimi et al. 2014). Simply put, the degree of activation is directly proportional to accessibility for future retrieval from memory. This future accessibility boost has the additional effect that more accessible phrases are typically picked up by anaphors with low content, while less accessible phrases are picked up by more contentful anaphors (Ariel 1990; Gundel et al. 1993; Karimi et al. 2014; Troyer et al. 2016; Nykiel et al. 2023). Nykiel and Hawkins (2020) argue that P-omission represents one of the ways of reducing the content of an anaphor whose function is to pick up an accessible correlate, that is, a correlate containing a lexical NP rather than an indefinite or interrogative pronoun. Their argument finds robust support in crosslinguistic data (Rodrigues at al. 2009; Nykiel 2013b; Nykiel & Kim 2022; Hassen 2025; Hassen & Abeillé 2025). But how exactly does accessibility impact example (12)? The correlate contains an interrogative *what*-NP phrase rather than an interrogative pronoun like *when* with corresponding temporal semantics. These phrases differ in their activation, with *what time* being more highly activated due to its higher semantic content and syntactic complexity compared to *when*. This is why the entire question supplies a context in which the fragment can be easily resolved to a temporal adjunct. Nykiel and Hawkins (2020) predict that, when referring back to the accessible correlate *at what time* by means of a fragment, speakers will tend to drop the preposition *at* in order to minimize the fragment's content. Their prediction follows from one of the efficiency principles proposed in Hawkins (2004: 38), Minimize Forms, which defines a preference for linguistic forms to encode minimal information when the missing information is inferable from the context.

The second environment to favor P-omission is linked to the independent processability of a fragment. Nykiel and Hawkins (2020) define this concept as a fragment's ability to be assigned all, or as many as possible, of its intended semantic and morphosyntactic features on the basis of its own linguistic make-up. That is, the parser should ideally be able to interpret as accurately as possible the fragment's semantics and grammatical role in relation to the antecedent, features which subsequently guide the cue-based search for the correlate. All else being equal, the presence of a preposition aids in achieving this goal, as it helps clarify the semantics and grammatical role of the fragment. A key term here, drawn from Hawkins (2004: 32), is a "domain," or the smallest sequence of linguistic forms that makes it possible to process all the syntactic and semantic relations among these forms. Applying this term to fragments, we can construe them

as domains in which their properties can be processed more or less successfully, and in which prepositions play a facilitatory role, if retained. However, one difficulty that can arise is the presence of a semantic dependency between a preposition that has been retained in a fragment and a higher verbal head that is only present in the antecedent. This case is illustrated in (13) from Nykiel and Hawkins (2020: 424).

(13) *A: And you're depending on what?*
B: On people going into the booth and changing their minds?

The preposition *on* and the higher verb *depend* form a semantic dependency extending beyond the fragment itself and into the antecedent, which disrupts successful interpretation of the fragment as a domain. Nykiel and Hawkins (2020) offer empirical support for the idea that prepositions which can't be processed within the bounds of a fragment tend to be dropped instead, as their presence would unnecessarily extend the domain in which a fragment can be processed. This idea is based on another efficiency principle defined in Hawkins (2004: 31), Minimize Domains[3], which favors, among other things, the kind of domain minimization that P-omission achieves for cases of semantically dependent prepositions.

The fragment in (12) doesn't pose a processing problem of this kind, as the preposition *at* is not semantically dependent on any higher verbal head. However, there is an entirely novel pattern here: the fragment's temporal semantics and the grammatical role of an adjunct are transparent with or without the preposition. This in turn means that the domain that the fragment constitutes can be minimized from a PP to an NP with no loss of semantic or morphosyntactic information. This is thus a situation where the presence or absence of a preposition quite plausibly neither disrupts nor improves the independent processability of a fragment. It's a distinct possibility that, when faced with a combination of an accessible correlate and an easy-to-process fragment, speakers choose to drop the preposition as a redundant cue, in effect minimizing the domain in which the fragment can be processed.

Nykiel and Hawkins (2020) report how each of these environments impacts the odds of P-omission. They offer evidence that the independent processability of fragments underlies high frequencies of P-omission in English (even though it's driven by semantically dependent prepositions, which are absent from Chia et al.'s (2020) data), with an effect size much larger than that of correlate accessibility. These findings allow us to reformulate the main hypothesis to test in this study: adjunct-based structural priming effects could be overridden by a combination of fragments' independent processability and correlate accessibility effects in Chia et al.'s (2020) fragments. The specific hypothesis is that if adjunct-based structural priming effects are weak

[3] Although Minimize Domains has had much success in explaining P-omission in English, it usually applies to word order phenomena (see, e.g., Hawkins 2004, 2014; Lohse et al. 2004; Wiechmann & Lohmann 2013).

or non-existent, then questions don't predict responses; that is, we will observe similar frequencies of nonprepositional fragments for both nonprepositional and prepositional questions. However, a note of caution is due. The direction in which the independent processability of fragments might impact P-omission remains an unknown in the data. Its effects could either boost the frequencies of nonprepositional fragments in order to remove redundant retrieval cues through P-omission or have no effects at all if all fragments' independent processability is at ceiling regardless of the presence of prepositions. We will have evidence for the former scenario if no adjunct-based structural priming effects emerge. But if adjunct-based structural priming effects do emerge, this can be interpreted as evidence that fragments' independent processability plays less of a role in the retrieval process than Nykiel and Hawkins (2020) argue for, at least whenever no semantically dependent prepositions are involved. We can draw this conclusion because Chia et al.'s (2020) data has the distinct advantage that the set of factors that might be driving P-omission can be limited to exactly two: independently processable fragments and accessible correlates. This brings us to statistical analyses of a subset of Chia et al.'s (2020) data.

4 Current data and method

The data selected for the current statistical analyses is a subset of questions and responses where we can examine the competition, if any, between structural priming and P-omission. This subset consists of full-sentence and fragment responses using the preposition *at* or no preposition at all, along with the questions they are intended as responses to. That is, only the questions and responses shown in (1)–(2) and (4)–(5) are included. Following this procedure, I retrieved 868 responses, of which 317 (36.5%) are fragments and 551 (63.5%) are full sentences. Before proceeding, let me summarize the two-fold purpose behind this study. First, we are probing the data for adjunct-based structural priming, potentially reinforced by the lexical boost. Second, we hypothesized that adjunct-based structural priming and P-omission compete for fragment responses, opening up the possibility that we fail to detect adjunct-based priming effects in the fragment subset. I begin by addressing the lexical boost, and do so on the basis of raw frequency data. The presence of adjunct-based structural priming and the competition between adjunct-based priming and P-omission are then tested by means of regression modeling.

Consistent with what Chia and Kaschak (2022) report, there is little evidence for the lexical boost based on the raw frequencies of full sentences and fragment responses shown in Figure 1 and Figure 2. Among full sentence responses, 97% are prepositional when produced in response to prepositional questions and 96% are prepositional when produced in response to nonprepositional questions. Among fragment responses, the corresponding values are 20% and 12.6%.

I don't have an explanation for the absence of the lexical boost in full-sentence responses, but its near-absence in fragments is clearly tied to adjunct-based structural priming effects themselves, such that the priming work that prepositional questions are doing is likely undone by P-omission. With little evidence for the lexical boost in fragments, there can be little hope for adjunct-based structural priming effects occurring there either.

When examining adjunct-based structural priming effects, I analyze full sentences and fragments first together and then separately. The results of these analyses are discussed below. Because we're concerned with fragments here, all separate analyses of full sentences can be found in Appendix 1.

4.1 Results and discussion

I begin by testing whether adjunct-based structural priming effects are still reliable across all responses, as the current sample is smaller than the original Chia et al. (2020) dataset. The model is a Bayesian multilevel probit regression analysis predicting the response (prepositional, nonprepositional) from Question Type (prepositional, nonprepositional) in the 2x2 design, with group-level intercepts and slopes for Experimenter (i.e., the person who asked questions). The population-level factor, Question Type, was treatment-coded. This analysis, and all subsequent ones, were conducted in R with the brms package with a logit link function (R core team 2021; Buerkner 2017; 2018). All models were fitted using weakly informative priors suggested by the brms package: improper flat priors for the population-level coefficients, a Student-t prior (3, 0, 2.5) for the population-level intercept, and a half-Student-t prior for the standard deviations of group-level effects, all on the logit scale. All analyses ignored the additional conditions Chia et al. (2020) introduced into the manner their questions were asked, given that no reliable differences were found among them. As expected, the first model revealed evidence for a main effect of Question Type such that prepositional questions triggered prepositional responses more often than nonprepositional questions ($\Delta = 0.46$, $CI(\Delta) = [0.17, 0.75]$, $P(\Delta > 0) = 1$). The remaining analyses examine adjunct-based structural priming in fragments more closely.

I first test whether adjunct-based structural priming effects emerge in fragments, and if they do so more than in full-sentence responses. These effects could be more robust for fragments due to increased processing demands placed on fragments as context-dependent utterances, as discussed in section 3. Figure 1 shows the raw frequencies of fragment responses, realized as either NPs or PPs, depending on whether the question is prepositional or not. Note the robust pattern: NPs are by far the more frequent responses than PPs across the board, even though there also is a slight increase in PPs for prepositional questions, keeping their structures aligned. The model I fitted to these data confirmed that the type of question doesn't

predict the response. The model included one population-level factor Question Type (prepositional, nonprepositional), which was treatment-coded, and group-level intercepts and slopes for Experimenter. The dependent variable was Response Type (NP, PP). I found no evidence for adjunct-based structural priming effects ($\Delta = -0.54$, $CI(\Delta) = [-1.19, 0.12]$, $P(\Delta < 0) = 0.94$); there was only a trend for prepositional questions to lower the frequency of NP responses compared to nonprepositional questions. Given the lack of evidence for adjunct-based structural priming in fragments, we can't expect that structurally matching adjuncts play more of a role in fragments than they do in full sentences. This conclusion is also suggested by the raw frequencies of full-sentence responses shown in Figure 2, where primarily prepositional responses were produced across the board. This dominance of one type of response in this subset as well suggests that full responses and fragments are equally unaffected by structurally matching adjuncts.[4] I confirmed this conclusion upon fitting a Bayesian multilevel probit regression model to the dataset consisting of full-sentence responses and fragments. This model's dependent variable was a binary factor: structurally matching or mismatching adjuncts for each question-and-response pair. The population-level factor was Response Type (fragment, full sentence), which was treatment-coded. Group-level intercepts and slopes for Experimenter were included as before. This analysis yielded no reliable difference between fragments and full sentences with respect to structural match ($\Delta = 0.14$, $CI(\Delta) = [-0.14, 0.43]$, $P(\Delta > 0) = 0.84$).

To get a better sense of whether the lack of adjunct-based structural priming effects in fragments can be attributed to high frequencies of P-omission, I fitted another Bayesian multilevel probit regression model to the fragments dataset. This model was designed to test whether structurally matching pairs of questions and responses were associated with nonprepositional questions more than prepositional ones, as Figure 1 suggests. In this model, the population-level factor was Question Type (prepositional, nonprepositional), treatment-coded as before, and group-level intercepts and slopes for Experimenter were also included. The results revealed that prepositional questions favored matching responses to a much lesser extent than nonprepositional ones ($\Delta = -3.43$, $CI(\Delta) = [-4.11, -2.77]$, $P(\Delta < 0) = 1$). This effect indicates that it's specifically responses to prepositional questions that fail to align with the pattern motivated by adjunct-based structural priming. In other words, P-omission competes with adjunct-based structural priming and wins the competition much of the time.

[4] It is potentially interesting to note that, even though neither the fragment responses nor the full-sentence responses show adjunct-based structural priming effects in separate analyses, the patterns are reversed. The set of full-sentence responses reveals stronger priming effects for prepositional questions than nonprepositional questions (see Appendix 1). This difference can be partially explained away by the unavailability of P-omission in full sentences.

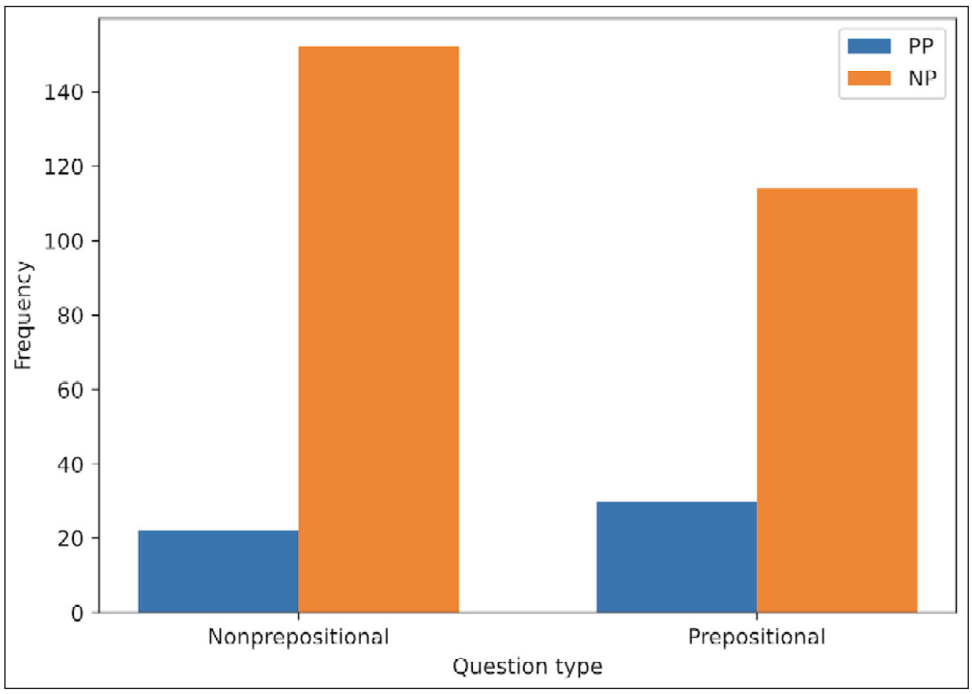


Figure 1: Raw frequencies of NPs and PPs by Question Type

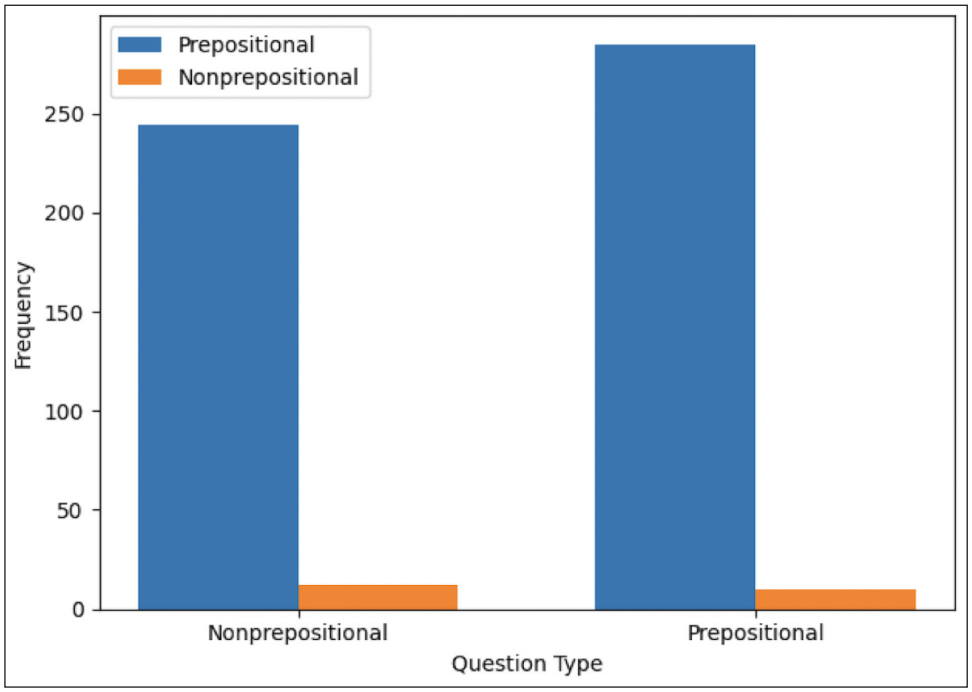


Figure 2: Raw frequencies of full-sentence responses by Question Type

5 General discussion

The current results reveal that while reliable adjunct-based structural priming effects can be seen across all responses, post-hoc analyses of fragment responses offer insight into how these effects interact with forces driving P-omission, a phenomenon that affects fragments in specific environments. I have tested and confirmed the hypothesis that adjunct-based structural priming and P-omission compete when P-omission is available, that is, when fragments serve as responses to prepositional questions. The novel finding is that P-omission wins the competition with the result that we no longer observe adjunct-based structural priming effects in the fragments dataset. This finding is both surprising and not. The unique nature of fragments as utterances relying on the surrounding context for their interpretation makes it a plausible idea that structural parallelism between them and the surrounding context has a processing advantage, as argued by Nykiel et al. (2023). On the other hand, P-omission is known as a process that readily engages when fragments are easy to interpret (Nykiel & Hawkins 2020). As discussed in section 3, there is good reason to think that fragments are indeed easy to interpret in the environment designed by Chia et al. (2020).

However, there is a dissociation between nonprepositional and prepositional questions. Robust adjunct-based structural priming effects arise in fragment responses to nonprepositional questions, where P-omission is unavailable and where there is no reason to think that something else interferes with the structure of a response. In these cases, the corresponding grammatical roles of fragments and correlates are realized by the same syntactic categories, NPs, increasing the ease with which they can be paired together during the search for the correlates, if this search engages the direct-access mechanism that cue-based retrieval models assume. Because prepositional questions pattern very differently, we are left with a situation that has ramifications for both structural parallelism on the level of individual elliptical constructions and for constraints on P-omission under ellipsis.

Although a subset of the current data reveals an actual preference for nonparallel syntactic categories, fragments aren't the only elliptical construction to tolerate such mismatch. Another example is Poppels and Miller (2023), who examine nonparallel syntactic categories under English pseudogapping. In pseudogapping, a stranded auxiliary is followed by a phrase similar to a fragment, as in (14) from Poppels and Miller (2023: 303).

(14) *They will give Dana books just as they will to Tim.*

The nonparallelism in (14) is due to the dative alternation, an alternation between the double object construction (*give Dana books*) and the prepositional object construction (*give books to Dana*). The post-auxiliary PP *To Tim* located in the right clause thus corresponds to the NP *Dana* in the antecedent clause. Compare this with the parallel PP structures in (15) (Poppels & Miller 2023: 303).

(15) *They will give books to Dana just as they will to Tim.*

What Poppels and Miller (2023) find is that although nonparallel structures do receive a penalty, the magnitude of this effect is reduced by perceived semantic similarity between the parallel and nonparallel structures. That is, when speakers perceive *give Dana books* and *give books to Dana* as semantically similar, the penalty for the nonparallel structure is reduced, pointing in the same direction as the current results: the preference for structural parallelism competes with and can be trumped by nonsyntactic constraints.

At the same time, there is general agreement that both fragments and other elliptical constructions obey structural parallelism constraints by favoring matching structures over mismatching ones (Frazier & Clifton 1998; Carlson 2002; Dickey & Bunger 2011; Carlson & Harris 2018; Kim & Runner 2018; Nykiel et al. 2023; Poppels & Miller 2023) or disallowing mismatching structures altogether (Orth & Yoshida 2025). This is so despite finer-grained construction-specific variation, where, for instance, Verb Phrase ellipsis is quite generous with respect to the range of possible structural mismatches (Arregui et al. 2006; Kertz 2013; Kim & Runner 2018; Parker 2018), but gapping appears not to be (Kim et al. 2020; Overfelt 2024; Orth & Yoshida 2025). While we're still far from understanding both the full extent of this variation and how much of it is specific to ellipsis, the current results highlight one reason why the mechanisms supporting fragments can be oblivious to structural parallelism.

The choice to produce an NP fragment as a response to a prepositional question is a principled departure from structural parallelism. I propose this departure happens not only because P-omission is available, but also because Chia et al.'s (2020) data provide one of the easy-to-process environments that have been shown to attract P-omission. Growing crosslinguistic work offers both experimental and corpus evidence to support the idea that accessible correlates have facilitatory effects on P-omission. Typical accessible correlates look like *in which department* in (16) and *to a wedding* in (17). Typical responses lack prepositions (note that the response in (17B) is a sluice), which Nykiel & Hawkins (2020) offer evidence for in English.

(16) *A: And you're in which department?*
B: Linguistics (department).

(17) *A: I'm going to a wedding.*
B: Whose (wedding)?

Nykiel (2013b) and Nykiel and Kim (2022) demonstrate experimentally that there is no penalty for P-omission in Polish exactly when correlates contain lexical NPs rather than pronouns. Hassen and Abeillé (2025) and Hassen (2025) offer French experimental and corpus data pointing in the same direction. In their corpus data, P-omission is observed almost exclusively with accessible correlates. As discussed in section 3, each question in Chia et al.'s (2020) dataset contains an accessible correlate.

Furthermore, fragment responses to Chia et al.'s (2020) questions can all be assigned their temporal adjunct semantics immediately upon being processed and independently of the antecedents. I speculated in section 3 that this could either lead to a spike in the frequency of P-omission or leave it unaltered. As we have observed the former scenario, explaining the high frequency of P-omission is clearly within the reach of Nykiel and Hawkins' (2020) processing-based proposal. Speakers perceive prepositions as redundant retrieval cues when fragments are already easy to process due to their correlates' accessibility and their own independent processability and, therefore, tend to remove them. This tendency could be seen as reflecting additive effects of correlate accessibility and the independent processability of fragments on P-omission, and represents an entirely novel finding in work focused on constraints on P-omission. It hasn't yet been explored in detail to what extent the parser does prioritize the ease with which fragments can be processed independently. As discussed in section 3, Nykiel and Hawkins (2020) propose that the independent processability of fragments is a main source of crosslinguistic differences in the frequency of P-omission and, as such, deserves scholarly attention in future research. They themselves focus on one dimension of this factor, namely, the presence of a semantic dependency between prepositions and verbal heads, and single it out as the best predictor of P-omission in English. To take this line of inquiry further, we could systematically examine how other features of fragments (e.g., repetition of the head nouns *department* and *wedding* in (13)–(14)) may impact their independent processability and how they may guide speakers' preferences for P-omission.

6 Conclusion

My goal in this paper has been a detailed examination of structural priming effects in fragment responses to two variants of a single question. While the experimental data collected by Chia et al. (2020) reveal reliable adjunct-based structural priming effects across all pairs of questions and responses (both fragment and full-sentence responses), it turns out that these effects disappear in the subset of fragment responses. I have proposed that this is due to the availability of P-omission for prepositional questions and the nature of Chia et al.'s (2020) experimental items, which provide a novel and distinctly supportive environment for P-omission.

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Appendix 1

These are Bayesian multilevel probit regression analyses of the subset consisting of the full-sentence responses shown in Figure 2. The structure of the two models below corresponds to the structures of the two models of fragments described in section 4.1. The first model looked for traces of adjunct-based structural priming in full sentences, and the second model compared the preference for matching structures in prepositional questions and nonprepositional questions.

Model 1: Question Type doesn't predict the response (i.e., no adjunct-based structural priming effects)

Model structure: Question Type (prepositional, nonprepositional) as a population-level factor, with group-level intercepts and slopes for Experimenter

Results: No reliable difference between prepositional and nonprepositional questions with respect to the frequency of prepositional responses ($\Delta = 0.35$, $CI(\Delta) = [-0.51, 1.24]$, $P(\Delta > 0) = 0.79$).

Model 2: Structurally matching pairs of questions and responses are favored by prepositional questions compared to nonprepositional ones

Model structure: Question Type (prepositional, nonprepositional) as a population-level factor, with group-level intercepts and slopes for Experimenter

Results: Prepositional questions have significantly higher frequencies of structurally matching questions and responses than nonprepositional questions ($\Delta = 6.97$, $CI(\Delta) = [5.92, 8.30]$, $P(\Delta > 0) = 1$).

Appendix 2

Table 1: Surprisal per word for each response extracted from GPT2LMHeadModel

Response	Question: What time	Question: At what time
Nonprepositional fragment (NP)	6.4	6.6
Nonprepositional full sentence	6.1	6.1
Prepositional fragment (PP)	5.6	5.8
Prepositional full sentence	4.3	4.2

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