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On the role of semantic priming in selecting contextually relevant focus-alterantives

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On the role of semantic priming in selecting contextually relevant focus-alternatives

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by

Christian Jorge Muxica

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ABSTRACT OF THE THESIS

On the role of semantic priming in selecting
contextually relevant focus-alternatives

by

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Prior research connecting alternative semantics and language processing has proposed a two-stage model under which the alternative set is derived from the set of word semantically primed by processing an element in focus (Braun and Tagliapietra, 2010; Husband and Ferreira, 2016; Gotzner and Spalek, 2019). However, due to its dependence on semantic priming, the two-stage model faces a number of conceptual issues. Chiefly, foci are not always semantically related to their contextually relevant alternatives. To address this concern, I run two cross-modal probe-recognition task experiments on discourses that make salient an alternative which is semantically related to the focus and another which is semantically unrelated to the focus. In doing so, I test the predictions of two proposed models for the selection of alternatives which emphasize the role of discourse representations over that of semantic priming: the *immediate-access* model and the *delayed-access* model. The results suggest that both related and unrelated alternatives are available almost immediately after focus is encountered. I take these results to support the immediate-access model.

The thesis of Christian Jorge Muxica is approved.

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CHAPTER 1

Introduction

1.1 Overview

Information structure describes the interface between discourse and other modules of grammar such as syntax, semantics, and intonation. Out of all the phenomena which reside under this broad umbrella, focus has undoubtedly received the most attention in theoretical and experimental linguistics.

Focus can be marked in a variety of ways: prosodically with a pitch accent, syntactically with a cleft, or through preceding context such as a question (Selkirk, 1984; Kiss, 1998). It has often intuitively been described as the most *important* or *informative* portion of an utterance (Chomsky, 1972; Jackendoff, 1972). However, almost all modern theories of focus emphasize the role of contrast that it plays, typically with respect to a contextually determined set of alternatives (Rooth, 1985, 1992).

For instance, the sentence in (1) conveys that *Merle Haggard* plays the fiddle, but it also conveys that there is some set of individuals who do not play the fiddle.

(1) Only [Merle HAggard]$_F$ plays fiddle.

The members of this set, referred to as alternatives, are determined by the context. If the discourse concerns other country singers, then individuals like *Willie Nelson* or *Dolly Parton* might be relevant alternatives. Crucially though, any individual could theoretically serve as an alternative if warranted by the context.

Successful comprehension of any utterance containing focus requires inferring the alternative set intended on the part of the speaker. Given that almost every sentence within a discourse will contain focus, deriving this inference is an inescapable aspect of language processing. How then does a comprehender arrive at the contextually appropriate alternative set? One proposal claims that semantic priming plays a crucial role.

Under Husband and Ferreira (2016)'s two-stage model, the alternative set is realized through differences in lexical activation. In the first stage, immediately after encountering focus, semantic priming will take place and words closely related to the focus will become highly activated. Among these highly activated words will be potential alternatives. In the second stage, a focus-sensitive mechanism selects the relevant alternatives from among the primed words and maintains their raised activation. Thus, over time, only the relevant alternatives will remain highly activated, yielding a representation of the alternative set.

However, due to its dependence on semantic priming, the two-stage model faces a number of conceptual issues. Chiefly, foci are not always semantically related to their contextually relevant alternatives. For instance, *aliens* is clearly the relevant alternative to *cowboys* in (2) despite the fact that these words presumably do not semantically prime one another.

(2) **A:** I heard Merle's new song is about aliens.

B: No, his new song is about [COWboys]$_F$.

Without the raised activation provided by semantic priming in the first stage, it is unclear how *aliens* could ever be represented as an alternative via selection in the second stage. Such unrelated alternatives have been neglected by the literature.

To address these concerns, I run two cross-modal probe-recognition task experiments on discourses that make salient an alternative which is semantically related to the focus and another which is semantically unrelated to the focus. In doing so, I test the predictions of two proposed models for the selection of alternatives which emphasize the role of discourse representations over

that of semantic priming in selecting alternatives: the *immediate-access* model and the *delayed-access* model. These models differ only in the point at which the contextual information identifying relevant alternatives becomes available during processing: immediately after focus is encountered or at a delay from when focus is encountered respectively. The results of these experiments suggest that both related and unrelated alternatives are highly activated almost immediately after focus is encountered. I take these results to support an immediate-access model of alternative selection.

1.2 A brief survey of focus

Given different contexts, English speakers will produce the sentence in (3) with different intonation. Specifically, the most prominent syllable (underlined and in small caps) will vary according to the target of the preceding question.

(3) Dolly ate crawfish yesterday.

a. Who ate crawfish yesterday? — DOlly ate crawfish yesterday.

b. What did Dolly eat yesterday? — Dolly ate CRAWfish yesterday.

c. When did Dolly eat crawfish? — Dolly ate crawfish YESterday.

Here, prominence refers to the intuitive sense of strength behind a given syllable relative to surrounding material. In English, the perception of prominence is correlated with increases in duration/intensity and local minima/maxima in *f0* known as pitch accents (Ladd, 2008). Broadly, focus is the phenomenon whereby such differences in prominence are associated with differences in interpretation. In this section, I present a brief survey of focus describing its interpretive effects, its context dependence, and its formalization within the framework of Alternative Semantics (Rooth, 1985, 1992). I conclude by discussing some of the questions that focus raises with respect to language processing.

1.2.1 Interpretive effects

The responses in (3) are all instances of *presentational* focus in which the speaker uses prominence to highlight *discourse new* material against *discourse given* material. Many definitions of givenness have been proposed, but for present purposes, the following will suffice: an element is considered given if it has been previously introduced in the discourse. Consequently, an element is new if it has not yet been introduced in the discourse. As (4) shows, these responses make the new material in the answer prominent relative to the material which is given from the preceding question. This prominent element is described as being *in focus* or as *the focus* of an utterance.

(4) Who ate crawfish yesterday?

[DOlly]$_{new}$ [ate crawfish yesterday]$_{given}$.

Prominence-marking in a language like English can only target a single syllable within a single word. Thus, prominence will often under-specify the scope of focus. Although each response in (5) is realized with the same pattern of prominence, the target of the question and consequently the size of the constituent in focus differs dramatically.

(5) a. What did Willie write a song about? — Willie wrote a song about [COWboys]$_F$.

b. What did Willie write? — Willie wrote [a song about COWboys]$_F$.

c. What did Willie do? — Willie [wrote a song about COWboys]$_F$.

d. What happened? — [Willie wrote a song about COWboys]$_F$.

This is known as *focus projection* and it is typical for one prosodic form to be compatible with multiple *focus structures* in this way. The scope of focus can range from *broad* focus like that in (5d) where the entire expression is focused to various *narrow* foci like those in (5a-c) where some subconstituent of the expression is focused.[1] Such mismatches are standardly handled with

[1]The literature varies with respect to terminology here. It is not uncommon for any focus larger than a word to be

F-marking whereby each element composing the focus bears a privative syntactic feature *F* (Jackendoff, 1972; Selkirk, 1984). The scope of focus can then be interpreted with respect to this feature rather than a potentially ambiguous surface prosodic form.

Importantly, focus is not limited to highlighting new material. For instance, *Dolly* is prominent in the second utterance of (6) despite being discourse given.

(6) Guess what? Dolly ate crawfish yesterday

If [DOlly]$_F$ ate crawfish, then it must have been good.

Here, the effect of focus is one of contrast: it specifically was *Dolly* who ate crawfish out of all the individuals who might have done so. The sentence in (7) makes this *contrastive* use of focus more explicit. Here, focus emphasizes that *Dolly* ate crawfish rather than *Merle* a potential alternative mentioned in the discourse.

(7) I heard that Merle ate crawfish yesterday.

Actually [DOlly]$_F$ ate crawfish, Merle refused.

The prominence-marking for contrastive focus often surfaces differently than presentational focus. Specifically, the pitch accents indicating contrastive focus typically rise more sharply than those indicating presentational focus (Selkirk, 1984; Ladd, 2008). This is the difference between an L+H* pitch accent and an H* pitch accent in the ToBI transcription system (Silverman et al., 1992; Pierrehumbert and Hirschberg, 1990). Of course, a variety of factors determine the intonation with which an element is realized, but the L+H* pitch accent is widely considered the canonical realization of contrastive focus.[2]

described as *broad* reserving the term *narrow* for foci consisting of a single word. I will not use this terminology, but that is a matter of personal preference.

[2] An H* pitch accent is in fact compatible with contrastive focus, though this realization is less common. For this reason it is often debated whether the distinction between these pitch accents is categorical or continuous in nature (Bartels and Kingston, 1994; Ladd and Morton, 1997). In any case, an H* pitch accent is undeniably a weaker cue to the presence of contrastive focus.

Lastly, focus can *associate* with certain operators known as focus particles. These operators modulate the interpretive effects of focus in various ways. For instance, the particle *only* strengthens contrastive focus to be truth-conditional. Lacking *only* (8a) can convey a contrastive interpretation, but as the follow-up demonstrates, it is an implicature and thus cancellable.

(8) a. [DOlly]$_F$ eats crawfish.

$\sim$ *no other individual eats crawfish*

In fact, Willie eats crawfish too.

b. Only [DOlly]$_F$ eats crawfish.

no other individual eats crawfish

In fact, Willie eats crawfish too.

With *only* in (8b) though, this implicature becomes an assertion and thus attempts to negate it are infelicitous. Other focus particles such as *also* and *even* have quite different effects, but all depend upon the scope of focus as partially determined by prominence marking (Büring, 2016a).

1.2.2 Context dependence

It is important to note that focus is a fundamentally context-dependent phenomenon. As discussed, preceding material such as a question can determine the location of prominence and the scope of focus. However, discourse context is also crucial for determining the alternatives in contrastive focus. For instance, lacking context, (8) seems to assert that every possible alternative individual to *Dolly* does not eat crawfish. Yet, in any real-world context, such an assertion is certainly false as many people eat crawfish. Instead, most speakers of (8) presumably intend to restrict the alternatives to *Dolly* to some smaller contextually relevant set. This can be seen in (9) where the alternative set is restricted to two discourse given individuals *Willie* and *Merle*.

(9) I think Dolly, Willie, and Merle eat crawfish.

No, only [DOlly]$_F$ eats crawfish.

Willie does not eat crawfish, Merle does not eat crawfish

Alternatives do not always need to be provided so explicitly though. Focus in (10) is clearly restricted to edible marine life despite the fact that no individual member of this set was mentioned. Here, the use of a hypernym *seafood* in the preceding question was sufficient to make these alternatives relevant.

(10) What kind of seafood should I make?

Dolly only eats [CRAWfish]$_F$.

Dolly does not eat shrimp, Dolly does not eat mussels, ...

As (11) further demonstrates, questions in general contribute to determining which alternatives are possible.

(11) What kind of food should I make?

Dolly only eats [CRAWfish]$_F$.

Dolly does not soup, Dolly does not eat salad, ...

Here, the use of a larger hypernym *food* makes a correspondingly larger set of alternatives possibly relevant. Due partially to such examples, both explicit and implicit questions have been proposed to be a crucial component of focus (Roberts, 1996; Beaver and Clark, 2009).

In general, there is no single factor which determines what is and what is not a relevant alternative. Rather, a plethora of pragmatic variables are involved which—for one reason or another—make some alternatives more relevant than others in a given context.

1.2.3 Formalizing focus

There are many theoretical accounts of focus, but Alternative Semantics is undoubtedly the most influential (Rooth, 1985, 1992). In this framework, a focus-marked expression evokes a contextually determined set of expressions in addition to itself. For instance, a focus-marked expression like (12) might evoke expressions such as *Willie likes cookies* and *Willie likes cupcakes* in addition to *Willie likes donuts*. Crucially, these additional expressions only differ from the original with respect to the constituent in focus. In other words, they only differ from the original with respect to the *alternatives* to the focus.

(12) Willie likes $[\underline{\text{DO}}\text{nuts}]_F$.

a. $[\![\text{Willie likes } [\underline{\text{DO}}\text{nuts}]_F]\!] = \text{LIKE}(w, d)$

b. *Willie likes cookies, Willie likes cupcakes*

In (12) the alternatives are restricted to a small set of baked goods. While this seems plausible, it is far from the only option. As previously discussed, focus is highly context-dependent. Theoretically, any element which could take the place of *donuts* in (12) could serve as an alternative given the appropriate context.

To account for this, Rooth (1992) utilized a phonologically null anaphor C which has as its referent a set of expressions. Being that C is an anaphor, the set of expressions which serve as its referent is subject to the influence of pragmatics. Thus, Rooth (1992) assumed that C refers to the specific set of expressions replacing the focus with each of its contextually relevant alternatives. Using the previous set of baked goods as alternatives, C would take the form of (13) below.

(13) $ALTS = \{cookies,\ cupcakes\}$

$C = \{Willie\ likes\ cookies,\ Willie\ likes\ cupcakes\}$

However, depending upon the context, C might look quite different. The relevant alternative set might be the set of everything edible or maybe the set of all circular objects. One can imagine an

infinite number of contexts each making a different alternative set relevant. Treating alternatives anaphorically provides this high level of context-dependence which focus seems to require.

Lastly, Rooth (1992) used C to describe how focus associates with its operators. Recall that the focus particle *only* yields a truth-conditional contrastive interpretation. In (14) this conveys that Willie like *donuts* and does not like any of the contextually relevant alternatives. Rooth (1992) proposed that operators such as *only* quantify over the contents of C yielding their respective interpretive effects. In the case of *only* this is exhaustification: affirm the original focus-marked expression and negate each of the additional alternative-derived expressions. Importantly, because C is context-sensitive, so are these operators.

(14) Willie likes only $[\underline{\text{DO}}\text{nuts}]_F$.

a. $[\![\text{Willie likes only } [\underline{\text{DO}}\text{nuts}]_F]\!] = \forall_{P \in C}[P \rightarrow P = \text{LIKE}(w, d)]$

b. $C = \{\text{Willie likes cookies, Willie likes cupcakes, } \ldots\}$

I have briefly summarized how Alternative Semantics captures the components of focus-sensitive material here. While there are other theories of focus, virtually all of them share with Alternative Semantics an intuitive core (Büring, 2016b; Von Stechow, 1991; Krifka, 1992). Focus is conceptualized as a kind of context-dependent abstraction that enriches the meaning of an expression. There is almost always some notion of a set of alternatives against which the focus is contrasted. Implementational details may vary, but these long-standing intuitions are frequently preserved. Thus, although much of this paper and the experimental literature in general is framed in terms of Alternative Semantics, the majority of discussion should extended to the many related frameworks.

1.2.4 Psycholinguistic questions

As we have seen, focus is a complex interface-spanning phenomenon. It enriches the meaning of an expression, establishing a contrastive relationship between the focus and a contextually relevant set of alternatives. Interpreting focus requires a comprehender to infer the contents of this set.

In what follows, I discuss some of psycholinguistic questions raised by the inferences involved in interpreting focus.

Firstly, how does focus influence measures of online processing such as reading times? Given that focus enriches the meaning of an expression, one might expect that an element in focus would be costly to process. Presumably, additional cognitive resources must be dedicated to identifying which elements are possible alternatives, identifying which of these possible alternatives are the contextually relevant ones, and finally deriving the appropriate interpretation using these alternatives. It seems likely that the speed of incremental processing would suffer as a result. This prediction follows quite naturally from Alternative Semantics and the offline judgments which motivated it. Put simply, an element in focus is associated with additional context-sensitive computations and performing these computations should be costly. However, real-time processing might not align with theory and introspective judgments so directly.

Under Alternative Semantics, every instance of focus involves setting the contextually appropriate set of expressions as *C*'s referent. Recall though that only instances of associated focus utilize the set of alternatives to truth-conditional effect. In cases of *bare* focus (i.e. those lacking a particle), the interpretive effects are merely an implicature. Further, presentational uses of focus seem to make even less direct use of alternatives. While explicitly setting the referent of *C* might be useful to describe focus formally, alternatives and their interpretive effects might regularly go under-specified online.

Comprehension proceeds miraculously fast despite the complex representations which language seems to demand. One potential explanation for this miracle is under-specification (Ferreira et al., 2002; Ferreira and Patson, 2007). Broadly, under such *Good-enough* models, the representations utilized in real-time comprehension are often left incomplete unless the current context or linguistic material requires them to be specified. Assuming this view of language processing, focus might not be expected to yield processing difficulty, at least not always. Perhaps, the contents of the alternative set is not specified whenever focus is encountered, but only if the context or some operator requires it be specified. Under this view, the selection of alternatives and the interpretation

of focus might largely be a post-sentential process rather than an incremental one. For these reasons, one might not (always) predict processing difficulty immediately after focus is encountered. In short, the question of how focus impacts incremental processing depends upon the question of what representations are involved in processing focus online.

Recall that focus is a pragmatic phenomenon. It must be interpreted with respect to the surrounding linguistic context. This naturally raises perennial questions concerning the role of context in real-time comprehension. Historically, this debate has involved two broad camps: the one-stage view and the two-stage view.[3] Under one-stage models, contextual information is always available, and thus, can influence early processing behavior such as parsing decisions (Altmann and Steedman, 1988; Crain, 1985). Under two-stage models, contextual information is not immediately available, and thus, early processing behavior reflects other non-contextual information sources (Frazier and Fodor, 1978; Frazier, 1979). When then does the contextual information required to select alternatives and subsequently interpret focus become available?

Likely, a one-stage view would predict that such information is available immediately after focus is encountered. A two-stage view on the other would predict that a delay is required for such information to become available. Thus, assuming a single stage, early processing behavior immediately following focus should be context-sensitive in nature, reflecting whichever focus-alternatives the context at hand makes relevant. Assuming two stages though, this early processing behavior should not reflect contextually relevant alternatives. Instead, later processing in the second stage will reflect such information. More needs to be said about what exactly is involved in processing focus before these questions can be addressed, but the inference of relevant alternatives is almost certainly one component. And in any case, the answer will likely prove informative with respect to this debate.

There are many other psycholinguistic questions which focus raises, but the ones discussed

[3]Both of these views are associated with a number of architectural commitments beyond the timing of context such as parallelism and specific reanalysis strategies. It is not my intention to invoke any of these commitments here. For present purposes at least, the timing of context alone is what distinguishes these two views.

above—processing behavior under focus, incremental representations of the alternative set, and contextual timing—are arguably some of the most foundational. Further, these are the questions which the literature has made the greatest strides in addressing. In the following sections, I review a sample of this literature.

1.3 The processing of focus

1.3.1 Focus incrementally

A large body of experimental research had addressed how focus influences incrementally processing. In this section I review a sample of this work below. To summarize, an element in focus is associated with increased allocation of attention and increased reading times. Further, comprehenders appear to make rapid use of the acoustic cues signaling focus, triggering a search for relevant alternatives. Together, these findings suggest that the processor eagerly incorporates focus into its unfolding representations.

Cutler and Fodor (1979) is one of the earliest studies investigating the comprehension of focus. Subjects listened to stimuli containing focus and were asked to indicate as quickly as possible when they heard a phoneme chosen by the experimenters. Cutler and Fodor (1979) found that subjects were faster to identify a phoneme when the constituent containing it was in focus. For instance, reaction times were faster to identify /k/ in (15a) where *on the corner* was in focus than in (15b) where *the blue hat* was in focus. The reverse was true for subjects instructed to monitor for /b/ instead.[4]

(15) a. **Question:** Which man was wearing the blue hat?

Target: The man [on the c̲orner]$_F$ was wearing the b̲lue hat

b. **Question:** What hat was the man wearing?

[4]These findings were recently replicated (Beier and Ferreira, 2022).

Target: The man on the c̲orner was wearing [the b̲lue hat]$_F$

Identifying a phoneme in such monitoring tasks is generally taken to require the allocation of attentional resources (Foss, 1969). Thus, Cutler and Fodor (1979) argued that a focused constituent attracts attention, yielding faster reaction times when the target phoneme occurs within that constituent. In any case, this study suggests that an element in focus immediately influences processing behavior.

Considering Cutler and Fodor (1979)'s analysis, one might imagine that putting an element into focus will decrease reading times for that element—allocating more attention to the focus could facilitate processing. However, as discussed, focus enriches the meaning of an expression, so one might expect focus to increase reading times instead. The results from the literature appear at odds.

Some studies have found that putting an element into focus increased reading times (Birch and Rayner, 1997; Benatar and Clifton, 2014), while others have found that it decreased readings times (Morris and Folk, 1998; Birch and Rayner, 2010). Recently though, Hoeks et al. (2023) pointed out that this literature has often conflated focus with the related but independent notion of newness.[5] While focus can be used presentationally to highlight new information, recall from the previous section that a focus can be given as well. Naturally, when an element is given (i.e. previously mentioned), it will take less time to process than when it is new. As a result, assuming all foci to be given or new presents a potential confound.

To address this concern, Hoeks et al. (2023) ran a maze task experiment[6] crossing newness with broad/narrow focus. The authors presented subjects with two-speaker question/response dialogues such as (16) below.

(16) **A:** This company often makes bad decision, but…

[5]Under Alternative Semantics newness and focus are entirely independent notions, but some theories such as Schwarzschild (1999) propose a stronger connection between the two.

[6]The maze task is similar to self-paced reading, but subjects are exposed to two words at each step rather than one. Subjects must choose the word from the pair which yields the most coherent continuation of the sentence. The maze task has a number of purported advantages such as increasing the number of attentive subjects (Forster et al., 2009).

i *Given Narrow* Did they hire a **lawyer** last fall, or an accountant?

ii *Given Broad* Did they hire a **lawyer** last fall?

iii *New Narrow* Did they hire a an accountant?

vi *New Broad* What did they hire last fall?

B: I think they announced they hired a **lawyer** last fall.

The focus structure of the response was manipulated using the question. Depending on the condition, the question either triggered narrow focus on a critical word in the response (*lawyer*) or broad focus on the entire response. Additionally, the newness of the critical word was manipulated. Depending on the condition, the question either mentioned the critical word or left it unmentioned. Comparing reaction times on this critical word across conditions teased apart the effect of newness from that of (narrow)[7] focus.

Hoeks et al. (2023) found a slowdown for critical words in narrow focus as compared to broad focus. A slowdown for new foci as compared to given foci was also found, but this penalty was reduced when alternatives to the new foci were contextually mentioned (*accountant* in 16i). Given these results, Hoeks et al. (2023) argued that focus requires additional processing and that previously mixed findings could be attributed to a lack of controls.

Taken as a whole, these studies suggest that focus triggers additional processing immediately after focus encountered. This provides further evidence that focus is processed incrementally rather than post-sententially. Further, given that the prior presentation of alternatives reduced the penalty incurred by focus, this processing seems to involve identifying relevant alternatives from the discourse context.

A number of visual-world studies provide converging evidence that comprehenders work to select alternatives immediately after encountering focus. Ito and Speer (2008) recorded the eye-movements of subjects hanging ornaments onto a holiday tree according to auditory instructions.

[7]While a critical word like *lawyer* would still technically be focused in the broad conditions, it is not the focus and consequently *accountant* would not be an alternative.

On each trial, subjects were instructed to hang two ornaments, one after the other. By changing the shape and color of the ornaments on a given trial, the authors manipulated the felicity of contrastive focus on the color adjective of the second ornament. In addition, the authors manipulated whether this color adjective bore a contrastive L+H* pitch accent or a non-contrastive H* pitch accent. Sample items illustrating the conditions are depicted in (17) below.

(17) a. **L+H* contrastive:** Hang the green drum. . . Now, hang the BLUE drum.

b. **H* contrastive:** Hang the green drum. . . Now, hang the blue drum.

c. **L+H* non-contrastive:** Hang the red angel. . . Now, hang the BLUE drum.

d. **H* non-contrastive:** Hang the red angel. . . Now, hang the blue drum.

Notice that the L+H* non-contrastive condition is infelicitous. The L+H* pitch accent on the color adjective of the second ornament (*blue*) indicates the presence of contrastive focus. While the context provides a relevant alternative in the form of the color adjective of the previous ornament (*red*), the shape of these ornaments differs as well (*angel* vs. *drum*). Consequently, replacing the focused adjective with its alternative does not yield the appropriate ornament (*blue angel* rather than *blue drum*).

The authors found that adjectives produced with an L+H* pitch accent generated a high percentage of early fixations toward ornaments contrasting in color with the previously mentioned one (i.e. contextually relevant alternatives). This was a significantly higher percentage of fixations than for adjectives produced with an H* pitch accent. This effect was observed early as well, within 100ms of the onset of the noun in the target instructions. This was early enough to trigger fixations toward the ornament indicated by the pitch-accent (*blue angel*) in the infelicitous L+H* non-contrastive condition. A number of other visual-world studies concerning focus have found similar results (Dahan et al., 2002; Kim et al., 2015; Watson et al., 2008; Weber et al., 2006). Namely, that contrastive pitch accents trigger more early fixations toward relevant alternatives than non-contrastive pitch accents. Similar to the previous reading studies, these results indicate that

subjects work to identify relevant alternatives immediately after encountering focus.

It is clear given this literature that selecting alternatives is a crucial to processing focus. Placing an element into focus—either through context or intonation—triggers additional processing which involves identifying contextually relevant alternatives. Importantly, this identification process is not post-sentential. Rather, comprehenders seem to seek out alternatives at the focus or shortly afterwards. However, what remains unclear is the exact nature of this processing and the representations involved.

Language processing is often argued to involve some degree under-specification. The previous studies do suggest that some representation of relevant alternatives is being constructed when focus is encountered, but these studies do not indicate how *fine-grained* this representation is in nature. The *C* of Alternative Semantics only utilizes the unique set of contextually relevant alternatives, but the online equivalent of this representations might be more coarse. Perhaps this representation is less *restricted* containing both the contextually relevant alternatives and a large set of possible yet irrelevant (or at least unmentioned) alternatives. Relatedly, the timing of context in language processing is hotly debated. How soon after focus is encountered can the contextually relevant alternatives be identified? If contextually relevant and irrelevant alternatives are simultaneously represented, when are these distinguished from one another? Further, some cognitive mechanism must be responsible for generating this representation. Is this mechanism specific to focus or more general in nature? Does this mechanism predict alternatives before focus is encountered or only search for them afterwards? There are many other questions one might ask with respect to representing alternatives, but these ones are foundational and directly relevant to the literature discussed in the following section.

1.3.2 Representing alternatives

A number of cross-modal forced-choice task experiments have investigated the representation of alternatives. Here the emerging picture is that something resembling the *C* of Alternative Seman-

tics is generated when processing contrastive focus. This alternative set appears to be restricted to contextually relevant alternatives rather than including plausible yet irrelevant alternatives. However, it takes time for this restricted alternative set to be generated. In the earliest moments of processing focus, contextually relevant alternatives seem to be represented alongside plausible yet irrelevant alternatives and certain non-alternatives as well. Given this pattern, multiple researchers have argued for a two-stage model of selecting alternatives.

Fraundorf et al. (2010) investigated whether deriving an interpretation for contrastive focus would strengthen the encoding of the focused element and its alternatives in memory. Subjects listened to short recorded dialogues which introduced two alternatives (*British* and *French* in 18a) and then selected one of them in a continuation (*British* in 18b). The use of contrastive focus in the continuation was manipulated by pitch accent (H* vs L+H*) on the selected alternative.

(18) a. Both the British and the French scientists had been searching Malaysia and Indonesia for the endangered monkeys.

b. Finally, the [BRItish]$_F$ spotted one of the monkeys in Malaysia and planted a radio tag on it.

Twenty four hours after the initial test, subjects were given one of the three probe sentences in (19) targeting their memory for the continuation and were asked to indicate if the sentence was accurate.

(19) a. **Focus:** The British scientists found the endangered monkey.

b. **Alternative:** The French scientists found the endangered monkey.

c. **Unmentioned:** The Portuguese scientists found the endangered monkey.

Fraundorf et al. (2010) found that contrastive focus helped subjects to correctly accept probe sentences containing foci and correctly reject probe sentences containing mentioned alternatives.

This suggests that contrastive focus not only causes to subjects to represent contextual alternatives, but to negate them during processing. Deriving this interpretation seems to cause a stronger encoding in memory and an advantage in recognition. However, contrastive focus did not help subjects to correctly reject probe sentences containing unmentioned alternatives (*Portuguese*). One possible explanation is that these less contextually relevant alternatives are not represented in the alternative set and consequently are not negated when contrastive focus is processed. This could make them harder to correctly reject as alternatives later on. This provides some evidence for a fine-grained restricted representation of the alternative set, one which excludes plausible yet unmentioned alternatives.

Importantly though, Fraundorf et al. (2010)'s experiment is an offline one. The linguistic representations under investigation are those stored in long-term memory long after incremental processing of focus has taken place. While these results suggest—in-line with offline judgments—that the alternative set is fine-grained and restrictive in nature, generating such a representation might require time from when focus is encountered online. Other forced-choice task experiments have targeted these more incremental representations.

(20)

Condition	**Prime/Target**
Focused	In the spring, they went on [saFAri]$_F$.
Unfocused	In the spring, they went on safari.
Alternative	*HIKING TOUR* (*TREKTOCHT* in Dutch)
Related non-alternative	*JUNGLE*
Control	*KARATE*

In the first of these studies, Braun and Tagliapietra (2010) hypothesized that the alternative set is realized through lexical activation online. Under this view, alternatives are those words which are highly activated relative to others after focus is encountered. The authors exposed subjects to recorded sentences in Dutch containing or lacking contrastive focus as indicated by pitch ac-

cent.[8] Immediately after hearing the potential focus, subjects performed a lexical-decision task. The targets were either plausible alternatives semantically related to the focus (*hiking tour*), non-alternatives semantically related to the focus (*jungle*), or non-alternative controls semantically unrelated to the focus (*karate*).

Across two experiments, Braun and Tagliapietra (2010) found that alternatives were accepted faster than controls, but only given a contrastive pitch accent. They also found a weak priming effect for related non-alternatives that was not influenced by the presence of focus. The authors argue that alternatives receive increased activation after encountering focus which distinguishes them from non-alternatives during processing. This difference in lexical activation can be thought of as instantiating the alternative set.

In order to investigate how the representation of alternatives evolves over time, Husband and Ferreira (2016) followed-up on Braun and Tagliapietra (2010) by varying the point at which the lexical-decision task was administered. The authors hypothesized that alternatives are selected in a similar process to that of meanings for ambiguous words. In order to determine the meaning of an ambiguous word, comprehenders must infer which sense the speaker intended. In a cross-modal priming study, Swinney (1979) demonstrated that this inference occurs in a two-stage process. Immediately after an ambiguous word is encountered, all candidate meanings are initially activated. However, shortly afterwards, only the contextually appropriate meaning remains activated. As with other two-stage models, this involves a delayed influence of context. Husband and Ferreira (2016) noted that semantic priming will take place after encountering focus, raising the activation of words related to the focus, including alternatives. They predicted that after a delay only alternatives will remain highly activated similar to contextually appropriate meanings.

The authors ran a cross-modal lexical-decision experiment with a stimulus onset asynchrony (SOA) manipulation. In one experiment, the lexical-decision task was administered immediately

[8]Focus and information structure in general is quite similar across the Germanic languages Büring (2016a). For this reason, comparing the results of studies conducted in English, Dutch, and German as I do here should not be a cause for concern.

after a potentially focused word in the prime (*sculptor*) and in the other experiment it was administered after a 750ms delay.

(21)

Condition	**Prime/Target**
Focused	The museum thrilled the [SCULPtor]$_F$ ...
Unfocused	The museum thrilled the sculptor ...
Alternative	*PAINTER*
Related non-alternative	*STATUE*
Control	*REGISTER*

Without a delay, the authors find a priming effect such that related alternatives (*painter*) and related non-alternatives (*statue*) were accepted faster than controls (*register*) independent of the pitch accent manipulation. Given a delay though, an effect of focus is observed such that related alternatives were accepted faster than related non-alternatives and unrelated controls, but only in the presence of a contrastive pitch accent.

Husband and Ferreira (2016) argued for a two-stage model of selecting alternatives given these results. In the first stage, semantic priming takes place and words which are semantically related to the focus receive increased activation. In the second stage, a focus-sensitive mechanism selects the contextually relevant alternatives and maintains their activation—raised from priming—over time while that of non-alternatives decays. This model would explain both the observed effect of semantic priming and the delayed influence of focus in the lexical-decision task. Crucially, processing in the first stage is independent of both context and the presence of focus. Semantic priming will occur automatically for any word regardless if it is focused or not. Further, the pattern of activation generated by semantic priming will reflect the organization of the lexicon rather than contextual factors like the relevance of certain alternatives. In short, Husband and Ferreira (2016) proposed that the earliest moments of processing focus purely reflect semantic priming because additional time is required for the activation of non-alternatives to decay and reveal the selected

alternatives.

The results of Braun and Tagliapietra (2010) and Husband and Ferreira (2016) both suggest a delayed role of focus and context in selecting alternatives. However, it is important to note that neither of these studies included discourse material making relevant any of the potential alternatives tested. While it is certainly the case that relevant alternatives are not always explicitly provided to comprehenders, focus is still a pragmatic phenomenon. For instance, under the Alternative Semantics framework, the alternative set is derived anaphorically. In this sense, studying focus without providing contextually relevant alternatives is akin to studying anaphora without providing any contextually relevant referents. This is not to say that such studies are not informative. However, these studies certainly do not provide a complete picture of how focus is processed.

Helping to complete this picture, Gotzner et al. (2016) performed a cross-modal probe-recognition experiment in German concerning associated focus. The authors hypothesized that the truth-conditional nature of associated focus might encode alternatives more strongly in memory yielding different behavior from standard contrastive focus. Subjects were presented with short two speaker discourses such as (22) below.

(22)

Dialogue	
A: In the fruit bowl, there are peaches, cherries, and bananas. I bet Carsten has eaten cherries and bananas. **B:** No, he (only) ate [PEAches]$_F$.	
Condition	**Probe**
Mentioned	*CHERRIES*
Unmentioned	*MELONS*
Control	*CLUBS*

The first speaker introduced a set of three alternatives (*peaches*, *cherries*, and *bananas*) and the second speaker selected one (*peaches*) using contrastive focus with or without a focus particle.

Roughly two seconds (2050ms) after hearing the focus, subjects were presented with a written word and asked to indicate as quickly as possible whether or not that word had occurred anywhere in the audio. These probe words came in one of three conditions: mentioned alternatives (*cherries*), unmentioned yet plausible alternatives (*melons*), and unmentioned non-alternative controls (*clubs*).

The authors found that the correct rejection of controls was fastest, followed by the correct rejection of unmentioned alternatives, and lastly the correct recognition of mentioned alternatives. The addition of a focus particle only increased average reaction times. The authors argued that this increase reflects stronger competition between elements for membership in the alternative set. More relevantly though, Gotzner and Spalek (2019) followed-up by performing the same experiment with an SOA of 0ms instead. Here, the authors found that controls were correctly rejected faster than the other two conditions which did not significantly differ from one another. Again, the addition of a focus particle only increased average reaction times.

Gotzner and Spalek (2019) take these results to support the two-stage model that Husband and Ferreira (2016) proposed. In the earliest stages after processing focus, the alternative set is not restricted, both mentioned alternatives and unmentioned yet plausible alternatives are highly activated leading to similar recognition times. However, given a delay, the activation of the less contextually relevant unmentioned alternatives might have decreased, allowing them to be correctly rejected faster. Arguably, this pattern mirrors what Husband and Ferreira (2016) found for related alternatives and related non-alternatives.

Taken together, these studies seem to paint a cohesive picture for selecting alternatives. A representation of the alternative set is realized through lexical activation and is generated in a two-stage process. Early on, the alternative set is unrestricted by context and reflects semantic priming from focus. This unrestricted set contains mentioned alternatives, unmentioned yet plausible alternatives, and non-alternatives semantically related to the focus. After a short amount of time though, the alternative set becomes more restricted so that it only contains mentioned alternatives. It appears that this restricted representation is the set with which contrastive focus is interpreted and stored in long-term memory.

1.4 Evaluating the two-stage model

While the experimental literature appears to support a two-stage model for selecting alternatives, there are a number of reasons to doubt such a model. In particular, the two-stage model—specifically the one Husband and Ferreira (2016) proposed—emphasizes the role of semantic priming in processing focus. This choice unintentionally neglects the highly flexible context-sensitive nature of focus empirically. There are a number of problematic examples which the two-stage model seemingly cannot capture and which the experimental literature has not previously tested. I discuss these concerns below.

The two-stage model is attractively parsimonious. While focus may have nothing to do with semantic priming formally, perhaps the processor rapidly leverages this pre-existing mechanism in order to enrich its interpretation in an economical fashion. However, prioritizing economy in this way comes at a cost to the contextual flexibility of alternatives and the category flexibility of foci.

Recall that almost any element that is inter-substitutable with the focus is capable of serving as an alternative given the appropriate context. The two-stage model lacks this level of contextual flexibility. Imagine a context in which a group of artists has painted a mural that depicts a tank driving through a meadow. In such a context, *tank* is a likely alternative to *flower* in (23) despite the fact that these words presumably do not prime one another.

(23) Simon only painted the [FLOwers]$_F$ on the mural.

Under the two-stage model, the activation which will eventually determine membership to the alternative set comes from the initial boost of semantic priming. The second stage only selects the relevant alternatives and maintains their current level of activation. It is unclear then how *tank* could ever become an alternative without the raised activation from semantic priming. While contextually relevant alternatives are often semantically related to the focus, it is not difficult to come up with examples such as (23) which violate this constraint. For instance, *Pete* is clearly the relevant alternative to *Linda* in (24) but do these names prime one another? Presumably not. This

will be an issue for the two-stage model any time proper names are contrasted.[9]

(24) **A:** Pete didn't like the borscht I made yesterday.

B: Well, only [LINda]$_F$ likes borscht.

Further, although the experimental literature has predominantly investigated the processing of focused nouns, elements of other categories can be focused as well. In general, constituents of any category or size can be put into focus, at least theoretically. The two-stage model lacks this level of category flexibility, again on account of the initial priming phase. Does the focused VP in (25) prime the VPs which serve as its contextually relevant alternatives? Presumably not. Though, semantic priming is typically conceptualized with respect to individual lexical items, so it is unclear whether the question is even a well-formed one.

(25) **A:** I went to the gym and made borscht yesterday.

B: I only [played VIdeo games]$_F$ yesterday.

As these examples reinforce, focus and the alternative set are highly flexible with respect to context and category. These are fundamental aspects of focus and part of what makes it such a rich phenomenon for linguistics inquiry. For such reasons, constraining the mechanism responsible for alternative selection to a context-independent stage of semantic priming appears conceptually unlikely.

1.5 Priming-independent models

While there are many possible forms that the alternative set could take during processing, Fraundorf et al. (2010) gives us reason—beyond offline judgements—to believe that the end prod-

[9]Certain strongly associated names such as *Jack* and *Jill* or *Simon* and *Garfunkle* are infrequent yet possible exceptions.

uct is restrictive in nature (i.e. limited to contextually relevant alternatives). The immediate question then is what mechanism generates this final restrictive set? Again, there are many possibilities, but clearly this mechanism cannot rely purely on semantic priming and subsequent selection while maintaining the flexibility of focus. The representation of alternatives (at least those unrelated to their focus) must derive from some other information source independent from semantic priming. I do not attempt to characterize the precise nature of this source here, but presumably it is some discourse representation which distinguishes alternatives from non-alternatives.

Here, echoing the historical single-stage vs. two-stage debate (Frazier, 1987), I consider the point at which such information becomes available to the processing architecture after encountering focus. I consider two broad possibilities: a *delayed-access* model under which time is required for this information to become available and an *immediate-access* model under which this information becomes available immediately after encountering focus. I refer to these jointly as the *priming-independent* models.

Despite the aforementioned issues with the two-stage model, selecting alternatives could still proceed two stages. Perhaps, the contextual information identifying relevant alternatives is not available during the initial moments of processing focus. Thus, reflecting semantic priming, only related alternatives and related non-alternatives will be highly activated immediately after encountering focus. Unrelated alternatives on the other hand would not be highly activated. Given additional time though, contextual information becomes available, activating contextually relevant alternatives regardless of how primed they are by the focus. Only at this later stage is the full alternative set represented. I call this the delayed-access model.

While there are two stages in this model, it crucially differs from Husband and Ferreira (2016)'s two-stage model in that the stages are independent from one another. The second stage of the two-stage model relies upon the initial activation from the first stage in order to represent alternatives. However, the second stage of the delayed-access model does not rely upon the first stage to generate activation. Instead, some focus-sensitive mechanism utilizes the available contextual information to identify and activate the relevant alternatives. Under this model, priming and focus are wholly

Model	Stage	Information utilized	High activation for…
Two-Stage	Early	Semantic Association	Words Primed by the Focus
	Late	Discourse Information	Primed Relevant Alternatives
Delayed-Access	Early	Semantic Association	Words Primed by the Focus
	Late	Discourse Information	All Relevant Alternatives
Immediate-Access	Early	Discourse Information	All Relevant Alternatives
	Late	Discourse Information	All Relevant Alternatives

Table 1.1: Schema of the information available at and behavior reflected by each stage of the original two-stage model, the delayed-access-focus model, and the immediate-access model

independent processes. The only thing which connects them are the changes in lexical activation that both trigger. Consequently, the delayed-access model is not a two-stage model in the classic sense. There are not two-stages comprising a single process, but rather, two independent processes with different time courses that both influence lexical activation.

Selecting alternatives could also proceed in a single context-sensitive stage independent from semantic priming. Under such a model, the contextual information identifying relevant alternatives would be available during the earliest moments of processing focus. Thus, immediately after encountering focus, both related and unrelated alternatives will be highly activated. Non-alternatives semantically related to the focus will be activated as well, but this fact simply reflects semantic priming rather than the mechanism responsible for generating the alternative set. Again, although an effect of semantic priming will be present, this reflects an independent process. I call this the immediate-access model.

At first glance, the immediate-access model appears to be incompatible with the previously discussed cross-modal forced-choice task experiments. Husband and Ferreira (2016) found that alternatives (*painter*) were not distinguished from semantically related non-alternatives (*statue*) immediately after the presentation of focus. Similarly, Gotzner and Spalek (2019) found that

mentioned alternatives (*cherries*) were not distinguished from unmentioned alternatives (*melons*) immediately after the presentation of focus. In either case, no evidence was found that response times differed between these conditions.

However, recall that these studies only tested related alternatives, confounding the words semantically primed by the focus with the set of possible alternatives. It is possible that both of these alternatives and non-alternatives are highly activated purely on account of semantic priming. But, it is also possible that the alternatives and non-alternatives are drawing activation from independent sources, specifically, discourse representations identifying relevant alternatives and semantic priming respectively. It is impossible to determine if these early moments are truly context-insensitive, as prior studies have claimed, without considering contextually relevant alternatives which are semantically unrelated to their focus.

Take the discourse in (26) below. In this example, the focus (*cake*) has two contextually relevant alternatives. One of these is semantically related to the focus (*muffin*) and the other is not (*pistol*). Testing such examples would tease apart the role of context from that of semantic priming in selecting alternatives.

(26) **A:** Andy used a muffin and a pistol as props in an independent movie that he was directing.

B: No, he only used a [cake]$_F$

If the earliest moments of processing focus purely reflects semantic priming as the two-stage and delayed-access models predict, then only related alternatives should be highly activated immediately after encountering focus. On the other hand, if the earliest moments of processing focus are context-sensitive as the immediate-access model predicts, then both related and unrelated alternatives should be highly activated immediately after encountering focus.

Further, should early SOAs be found to purely reflect semantic priming, then investigating later SOAs would tease apart the two-stage model from the delayed-access model. If selecting alternatives truly depends upon semantic priming, then only related alternatives should be highly

Model	SOA	RT	Condition
Two-Stage	Early	Faster	Related
		Slower	**Unrelated**, control
	Late	Faster	Related
		Slower	**Unrelated**, Control
Delayed-Access	Early	Faster	Related
		Slower	**Unrelated**, Control
	Late	Faster	Related, **Unrelated**
		Slower	Control
Immediate-Access	Early	Faster	Related, **Unrelated**
		Slower	Control
	Late	Faster	Related, **Unrelated**
		Slower	Control

Table 1.2: Schema of the probe task response time predictions made at each SOA by the original two-stage model, the delayed-access model, and the immediate-access model; commas indicate that two conditions are not strictly ordered with respect to one another

activated after encountering focus, even given a delay. This finding would be surprising as it runs counter to offline judgments, but it is logically possible. On the other hand, if selecting alternatives is independent from semantic priming, then both related and unrelated alternatives should be highly activated given a delay.

In order to test these possibilities, I run two cross-modal probe-recognition task experiments. I probe subjects on related focus-alternatives, unrelated focus-alternatives, and unrelated non-alternative controls all of which were discourse given in a three condition design. In both experiments, I find that even at 0ms SOA subjects are faster to correctly accept related and unrelated alternatives than non-alternative controls. Further, I find no evidence that the related and unrelated alternative conditions elicited different response times. These results provides evidence in favor of a priming-independent immediate-access model for selecting alternatives and experimental evidence against the original two-stage model.

CHAPTER 2

Experiments

2.1 Materials

Thirty critical items such as those in (27) and (28) were written.

(27)

Dialogue	
A: Andy used a muffin and a pistol as props in an independent movie that he was directing.	
B: No, he only used a [CAKE]$_F$.	
Condition	**Probe**
Related	*MUFFIN*
Unrelated	*PISTOL*
Control	*MOVIE*

(28)

Dialogue	
A: For her article in a nature magazine, Sarah used pictures of a monkey and a boulder.	
B: No, she only used pictures of a [goRIlla]$_F$.	
Condition	**Probe**
Related	*MONKEY*
Unrelated	*BOULDER*
Control	*MAGAZINE*

A set of four nouns was selected for each item: one to serve as the focus (*cake*), one to serve as an alternative which was semantically related to the focus (*muffin*), one to serve as an alternative which was not semantically related to the focus (*pistol*), and lastly one to serve as a non-alternative control which was not semantically unrelated to the focus (*movie*).

The three non-focus words to be used as probes were controlled for length, frequency, orthographic nieghborhood size, and number of morphemes as these factors are known to influence the speed and accuracy of written word recognition (Balota et al., 2007). Measures of central tendency for these factors are summarized in Figure 2.1 by condition. The frequency of each probe word was estimated with the SUBTLEXus English subtitle corpus (Brysbaert and New, 2009). These differences in log frequency were not significantly different according to pairwise t-test comparisons (control vs. related: $t(29) = 1.94$, $p > 0.1$; control vs. unrelated: $t(29) = 2.37$, $p > 0.05$; related vs. unrelated: $t(29) = 0.363$, $p > 0.5$). Differences in length were not significantly different according to pairwise t-test comparisons either (control vs. related: $t(29) = -0.189$, $p > 0.5$; control vs. unrelated: $t(29) = 0$, $p > 0.5$; related vs. unrelated: $t(29) = 0.226$, $p > 0.5$). Similarly differences in orthographic neighborhood size were not found to be significantly different (control vs. related: $t(29) = 0.69$, $p > 0.5$; control vs. unrelated $t(29) = -0.15$, $p > 0.5$; related vs. unrelated: $t(29) = -1.14$, $p > 0.5$).[1] Lastly, probe words for a given item were controlled such that all had the same number of morphemes (max: 2, min: 1).

Latent semantic analysis was utilized in order to estimate the strength of semantic relatedness and the corresponding effect of semantic priming from the focus to each probe word (Landauer and Dumais, 1997). Probe words were compared against the focus using a one-to-many comparison with the *General Reading up to 1st year college* embedding space. Measures of central tendency for cosine similarity values are shown in Figure 2.1 by condition. Differences in cosine similarity were insignificant between the unrelated alternatives and unrelated controls, while the remaining two comparisons reached significance according to pairwise t-test comparisons (control vs. related: $t(29) = -24.9$, $p < 0.001$; control vs. unrelated: $t(29) = -1.28$, $p > 0.5$; related vs.

[1] Bonferroni correction was utilized for all of these t-tests to adjust the p-values for multiple comparisons.

Condition	Length	Orth. Neigh.	Frequency	LSA Sim.
Related	5.80 (0.18)	3.37 (0.70)	2.87 (0.11)	0.59 (0.02)
Unrelated	5.77 (0.21)	4.30 (0.86)	2.83 (0.12)	0.09 (0.01)
Control	5.77 (0.20)	4.13 (0.93)	3.20 (0.12)	0.08 (0.01)

Table 2.1: Mean and standard error in parentheses of lexical factors (length, orthographic neighborhood size, log frequency according to SUBTLEX_US, and cosine similarity with focus according to latent semantic analysis) by condition

unrelated $t(29) = 22.1$, $p > 0.001$). Given the high mean cosine similarity between foci and related alternatives, I predict a semantic priming effect between them. Given the low mean cosine similarity between foci and unrelated alternatives as well as foci and controls, I predict no such priming effect or at least a relatively weak effect.

Every critical item consisted of a two utterance dialogue between two native English speakers. In the first utterance, Speaker A described a situation using the related alternative, the unrelated alternative, and the control. The alternatives were always arguments of a main verb. The control was always within an adjunct which occurred utterance initial in half of the items (as in example 28) and utterance final in the other half (as in example 27). This between-items control ensured that neither condition was more active or prominent in memory across the experiment purely on account of recency. In the second part, Speaker B would negate Speaker A's utterance with a focus particle *only* in an instance of corrective contrastive focus. All of the material in Speaker B's utterance was discourse given except for the focus which was always discourse new. Speaker B was ToBI trained and was instructed to produce the focus with an L+H* pitch accent, the canonical prosodic marking for focus in English. It is important to note that the focus was always the final word in Speaker B's utterance. As a result, this L+H* pitch accent was technically ambiguous between marking focus and English's default Intonation Phrase (IP) final placement of Nuclear Pitch Accent (NPA). However, due to the presence of *only* and the givenness of the non-focused material in Speaker B's utterance, the focus structure was in fact unambiguous. Thus, this pitch accent served more

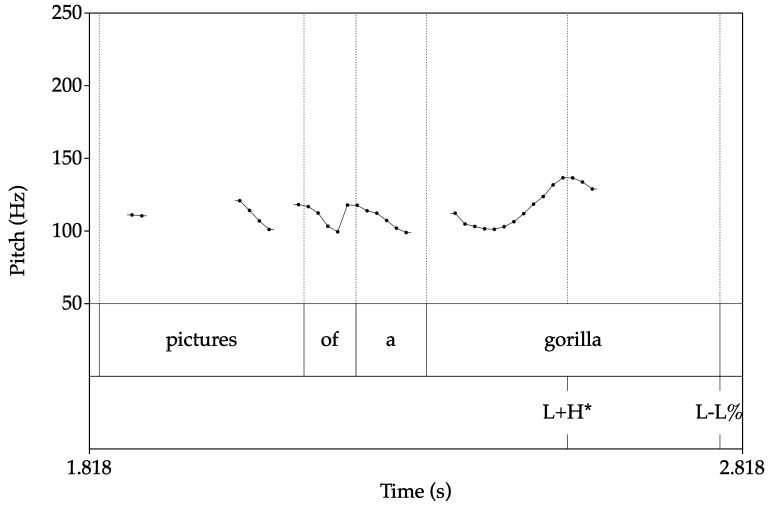

Figure 2.1: Portion of the pitch track for the item in (28) including the final focused word; ToBI transcription is provided in the bottom tier

to generate perceptual salience for the word in focus, rather than to determine focus structure. Before each of Speaker B's recordings, another experimenter produced Speaker A's corresponding utterance to license the use of corrective focus and make production more natural. Speaker A was not ToBI trained and was instructed to produce the items naturally rather than with a specific contour.

In addition to the 30 critical items, another 60 filler items were written and recorded as well. These followed the same two utterance two speaker structure as the critical items. Speaker A either described some situation or asked some question to which Speaker B responded. However, unlike in the critical items, many of these were told in the first person. Speaker B's responses were of a similar length to the critical items, but never involved negation or corrective focus. For instance, Speaker B might agree with Speaker A, answer a question, add some additional detail, or express surprise. Again, many of these were expressed in the first person. Unlike the critical items where the probe words were all mentioned nouns, the probe words in the fillers were of various parts of speech and the majority were not mentioned in the audio dialogue. Of the 60 filler items, 30 had a

probe word which was not a noun (predominately adjectives, verbs, and prepositions) and 45 had a probe word which not mentioned. This meant that across the full set of items 2/3 of probes were nouns and 1/2 of probes were mentioned and thus "Yes" was the correct response in the probe task. In five of the filler items, the probe word was identical to the final word in Speaker B's utterance. These fillers acted as catch trials. The speakers were not instructed to produce any of the filler items with a specific contour.

2.2 Experiment 1

The first experiment served as a pilot for the larger second experiment. This pilot was administered online using a subset of the 90 items which were created.

2.2.1 Participants

79 native English speaking undergraduates from the University of California Los Angeles Psychology Department subject pool participated in this study. All subjects were given course credit in exchange for participation.

2.2.2 Materials

Three lists from 12 of the 30 critical items were created in a Latin square design— one for each probe word condition. This yielded 4 observation per experimental mean per participant. 18 of the 60 filler items were added to each of these lists resulting in a total of 30 trials. Each participant saw only one list.

2.2.3 Procedure

Experiment 1 was conducted online and subjects completed it on a personal computer in an environment of their choosing. Subjects were directed to a PC-IBex script hosting the experiment

(Zehr and Schwarz, 2018). This script described the procedure with written instructions, quizzed subjects on their understanding of these instructions, then administered two practice trials which were not related to the manipulation. Subjects then moved on to the real experiment. Subjects were instructed to complete the experiment using wired headphones in a quiet distraction-free environment.

On each trial, participants listened to the audio dialogue while presented with a fixation cross in the center of the computer screen. Immediately after the audio completed, a written probe word appeared in the center of the screen. Participants then indicated using a keyboard whether or not this probe word occurred anywhere in the preceding audio. Pressing the J key indicated "Yes, this word did occur in the previous audio" and pressing the F key indicated "No, this word did not occur in the previous audio". After every trial, participants were presented with a blank screen and an opportunity to take a self-paced break. Once the participant pressed the spacebar the next trial would begin. The experiment took around 12 minutes to complete on average.

2.2.4 Results

Exclusion

Out of the 79 subjects recruited, 47 were used in the final analysis. The 32 excluded subjects were rejected on the basis of performance either in the probe task or the quiz during the instruction phase. 23 subjects were rejected for answering one of the questions in the instructions quiz incorrectly making it unclear if they understood the task fully. Subjects with a mean accuracy less than 75% in the probe task were excluded as well. For the filler trials this resulted in the exclusion of 1 subject and for the critical trials this resulted in the exclusion of a further 8 subjects. After implementing these criteria, around 59% of the subjects recruited were utilized in the final analysis.

Accuracy

Accuracy in the probe task was highest in the related condition on average (93.18%), followed by the unrelated condition (89.77%), and lastly by the control condition (79.54%). This shows a

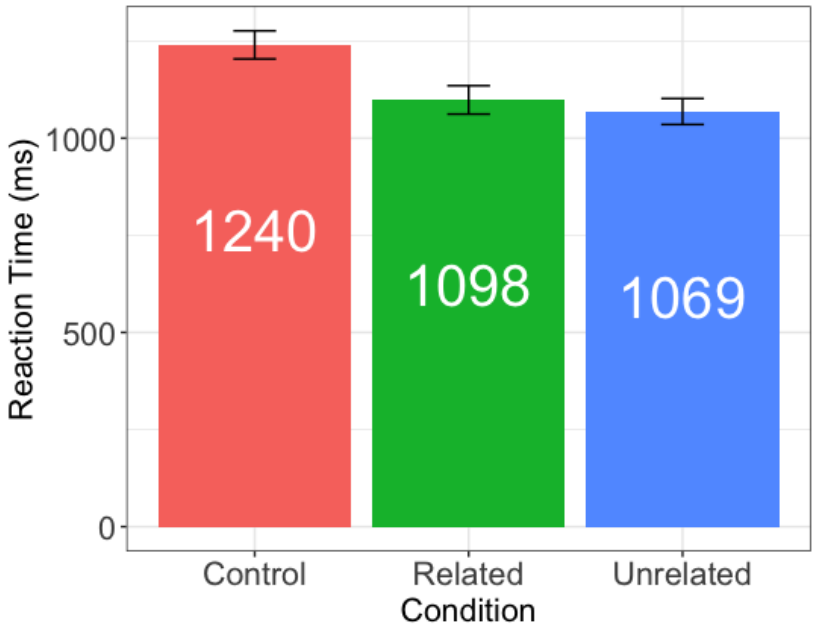

Figure 2.2: Mean response time by probe word condition in experiment 1

small advantage for the correct recognition of alternatives over that of non-alternatives. In addition, this advantage is slightly larger when these alternatives are semantically related to the focus.

Response times

Only trials where the subject provided a correct response in under 2500ms were analyzed.[2] This response time cutoff resulted in less than 10% data loss across conditions and was implemented to ensure the results reflected only the earliest stages of processing focus. On average, subjects were faster to correctly recognize probe words in the related ($M = 1098.46$, $SE = 36.54$) and unrelated conditions ($M = 1068.56$, $SE = 33.44$) than the control condition ($M = 1240.06$, $SE = 36.09$). Again, I observe that alternatives have an advantage over that of non-alternatives in correct recognition.

Mixed-effects model

A linear mixed-effects model was fit to the log transformed response times of correct responses

[2]Similar results were obtained for various cutoffs, in particular at 5,000ms and for no threshold (i.e. when all response time scores were used in the analysis).

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	6.97	0.04	161.13
Alternative vs non-alternative	-0.15	0.03	-4.98
Related vs unrelated	0.00	0.03	0.045

Table 2.2: Fixed effects of the linear mixed-effects model for experiment 1; Model: $log(RT) \sim Condition + (1 + Condition|Subject) + (1|Item)$

in the probe recognition task using the package lme4 in R (Bates, 2010). I began with the maximal random effects structure with subjects and items as random effects, then incrementally reduced this model to deal with convergence errors (Barr et al., 2013). In the end, the by-item and by-subjects random slopes were removed resulting in a model with by-item and by-subjects random intercepts.

I was interested in the potential effects which alternative status and semantic relatedness to focus would have on response times. To this end, user-defined coding of the response times was utilized to compare alternatives against non-alternatives (i.e. the related and unrelated conditions vs. the control condition) and related alternatives against unrelated alternatives (i.e. the related condition vs. the unrelated condition) as fixed effects.[3] The first comparison allowed us to investigate the effect of alternative status, while the second allowed us to investigate the effect of semantic relatedness specifically among alternatives. For the alternative/non-alternative comparison, the related and unrelated conditions were coded as positive while the control condition was coded as negative. For the related/unrelated comparison, the related condition was coded as negative and the unrelated condition was coded as positive, the control was coded as 0 such that it would have no influence on the comparison.

The model indicates that alternative vs. non-alternative probe type had a strong effect on response times. I find that probe words which are alternatives lower response times as compared to probe words which were simply mentioned (i.e. the control). Further, while there is almost no

[3]The fixed effects for a more standard sum-coded model is provided in the appendix for both experiments. The results mirror that of the pairwise comparisons performed. These are not discussed in the main text for sake of brevity.

Contrast	Estimate	StdErr	df	t-ratio	p-value
Control vs related	0.15	0.03	396	4.40	$p < 0.0001$
Control vs unrelated	0.14	0.04	403	4.30	$p < 0.0001$
Related vs unrelated	-0.00	0.03	402	-0.05	$p = 0.99$

Table 2.3: Estimated marginal means of the linear mixed-effects model for experiment 1; Model: $log(RT) \sim Condition + (1 + Condition|Subject) + (1|Item)$

effect of related alternative vs. unrelated alternative probe type on response times.

Estimated marginal means were calculated using the package emmeans in R (Lenth et al., 2018). This package calculates estimated mean reaction time for each probe type on the basis of my previously fit model. I perform a pairwise t-test comparison of probe type using these estimates. There is a significant difference in the estimated means for the control vs. related and control vs. unrelated comparisons such that control probes took longer to correctly recognize than either alternative probe. However, there was no significant difference in the estimated means for the related vs. unrelated comparison.

Lastly, Cohen's d effect sizes were calculated for these estimated pairwise comparisons. I find a large effect size (>0.5) for the control vs. related and the control vs. unrelated comparisons and a minimal effect size (<0.1) for the related vs. unrelated comparison. This further suggests that alternatives yielded faster response times as compared to purely mentioned probes and that any difference between the related and unrelated focus-alternative probes is minimal.

2.2.5 Discussion

Across all measures, an advantage for alternatives over controls in the probe recognition task is observed. Responses to both related and unrelated alternatives are faster and more accurate on average than controls. I find this effect at 0ms SOA immediately after subjects encountered the focus. This suggests that the earliest stages of processing focus do not purely reflect semantic

Contrast	Effect Size	StdErr	lower CL	upper CL
Control vs. related	0.52	0.12	0.29	0.76
Control vs. unrelated	0.52	0.12	0.28	0.76
Related vs. unrelated	-0.00	0.11	-0.23	0.22

Table 2.4: Cohen's d effect size based on pairwise differences of estimated marginal means of the linear mixed-effects model for experiment 1; Model: $log(RT) \sim Condition + (1 + Condition|Subject) + (1|Item)$

priming. Rather, contextually relevant alternatives seem to immediately receive some privileged representation independent of semantic priming from the focus.

The linear mixed-effects model and post-hoc tests support this interpretation. The fixed effect of alternatives vs. non-alternatives indicates that alternative probes were recognized faster on average than non-alternative probes. Further, pairwise comparisons indicate that both related and unrelated alternatives were recognized significantly faster than controls. Importantly, the advantage for unrelated alternatives cannot be explained in terms semantic priming from the focus. The pairwise comparison between related and unrelated alternatives suggests that any differences observed between these conditions were insignificant as well.

These results are most compatible with the immediate-access model. Under this model, the contextual information identifying contextually relevant alternatives is available immediately after focus is encountered. Importantly, this contextual information is entirely independent from semantic priming. This predicts the observed advantage for both related and unrelated alternatives over unrelated non-alternative controls.

These results provide evidence against the delayed-access model and the original two-stage model. Under both, the earliest stages after processing focus should purely reflect semantic priming. This predicts that unrelated alternatives and the unrelated non-alternative controls will be similarly represented, yielding similar behavior in the probe recognition task. Specifically, slower

and less accurate response times are predicted for these unrelated probes as compared to the related alternatives probe which are semantically primed by the focus. None of the measures fit this pattern nor does any component of the models and post-hoc testing.

In short, I take the results of experiment 1 to provide strong evidence in favor of an immediate-access model of alternative selection.

2.3 Experiment 2

The second experiment was a larger version of the first. This version was run in-person using the full set of items with the addition of comprehension questions. Otherwise, the design for this experiment was identical to that of the first.

2.3.1 Participants

99 native English speaking undergraduates from the University of California Los Angeles Psychology Department subject pool participated in this study. All subjects were given course credit in exchange for participation.

2.3.2 Materials

30 comprehension questions were written for the second experiment. These questions were designed to encourage deeper processing of the stimuli. The majority of the questions probed Speaker A's utterance, but around 20% probed Speaker B's utterance. All of these questions were two-alternative forced choice (2AFC). 10 questions were written for the critical items and 20 questions were written for the filler items.

Three lists of the 30 critical items were created in a Latin square design, one for each probe word condition. This yielded 10 observation per experimental mean per participant. The 60 filler items were added to each of these lists, resulting in a total of 90 trials. Each participant saw only

one list.

2.3.3 Procedure

During the experiment, participants sat in front a desktop computer in a sound attenuated booth wearing a pair of headphones. A researcher initiated a Linger script hosting the experiment and then briefly explained the procedure (Rhode, 2001). Under the supervision of the researcher, participants read through a series of instructions and completed three practice trials which were not related to the manipulation. After answering any questions, the researcher left the subject to complete the experiment alone.

On each trial, participants listened to the audio dialogue through the headphones while presented with a fixation cross in the center of the computer screen. Immediately after the audio completed, a written probe word appear in the center of the screen. Participants then indicated using a keyboard whether or not this probe word occurred or did not occur anywhere in the preceding audio. Pressing the J key indicated "Yes, this word did occur in the previous audio" and pressing the F key indicated "No, this word did not occur in the previous audio". Participants were instructed to provide this response as quickly as possible without sacrificing accuracy. On 1 out of every 3 trials participants were presented with a comprehension question. Again, participants utilized the J and F keys to provide their response. Subjects were specifically instructed to prioritize accuracy over speed in responding to these comprehension questions. After every trial, participants were presented with a blank screen and an opportunity to take a self-paced break. Once the participant pressed the spacebar the next trial would begin. The experiment took around 30 minutes to complete on average.

2.3.4 Results

Exclusion

Out of the 99 subjects recruited, 61 were used in the final analysis. The 39 excluded subjects

were rejected on the basis of accuracy in the probe task and with the comprehension questions on both critical and filler trials. Subjects with less than a mean accuracy of 75% in the probe task were excluded. For the filler trials this resulted in the exclusion of 1 subject and for the critical trial this resulted in the exclusion of 5 subjects. Most participants were removed on the basis of comprehension question performance. Subjects with less than a mean accuracy of 75% for the comprehension questions were excluded. For the filler trials this resulted in the exclusion of 17 subject and for the critical trial this resulted in the exclusion of 16 subjects. After implementing these criteria, around 40% of the subjects recruited were utilized in the final analysis.[4]

Accuracy

Accuracy in the probe task mirrored the results from the first experiment. The related condition was highest (90.75%), followed shortly by the unrelated condition (90.61%), and lastly by the control condition (82.58%). Again, I find an advantage for the correct recognition of alternatives over that of non-alternatives.

Response times

As in the first experiment, only trials where the subject provided a correct response in under 2500ms were analyzed.[5] This response time cutoff resulted in less than 10% data loss across conditions as well. On average response times to correctly recognize the probe word were faster for the related ($M = 1103.46$, $SE = 16.43$) and unrelated condition ($M = 1114.38$, $SE = 16.43$) than the control condition ($M = 1282.46$, $SE = 18.16$). This is the same pattern that was observed in the first experiment.

Mixed-effects models

[4]Two other exclusion criteria were investigated in exploratory analyses. A more *liberal* criterion was tested under which subjects were only rejected on the basis of the probe task (>75% accuracy) and not the comprehension questions. And a *minimal* criterion under which no subject was excluded, but by-subject accuracy was utilized as a predictor in the mixed-effects model. These models did differ substantially from the criterion reported here, thus I do not discuss them in the main text for sake of brevity. However, fixed effects for both of these models can be found in the appendix.

[5]Again, similar results were obtained for various cutoffs, in particular at 5,000ms and for no threshold (i.e. when all response time scores were used in the analysis).

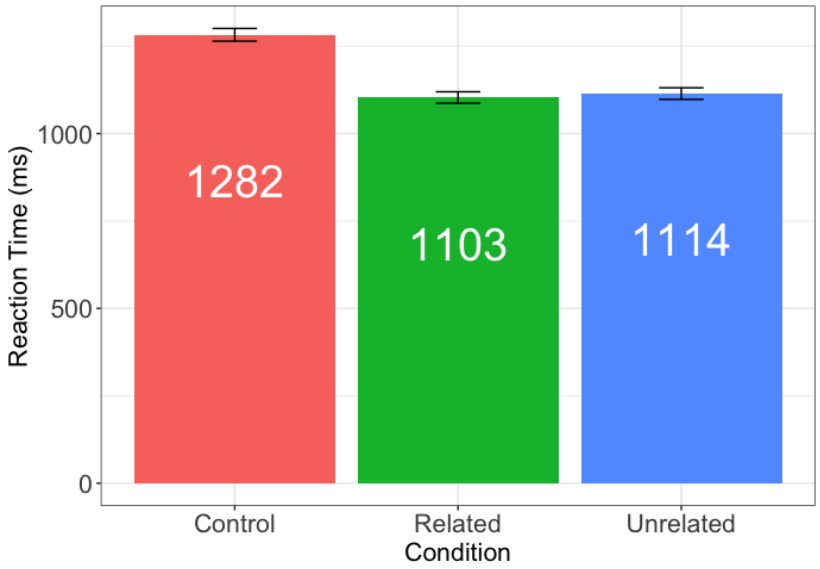

Figure 2.3: Mean reaction time by probe word condition in experiment 2

A linear mixed-effects model was fit to the log transformed response times of correct responses in the probe recognition task using the package lme4 in R (Bates, 2010). Again, I began with the maximal random effects structure with subjects and items as random effects, then incrementally reduced this model to deal with convergence errors (Barr et al., 2013). The by-item and by-subjects random slopes were removed resulting in a model with by-item and by-subjects random intercepts.

I utilized the same user-defined coding from the first experiment with alternatives vs. non-alternatives and related alternatives vs. unrelated alternatives as fixed effects. As before, the related and unrelated conditions were coded as positive while the control condition was coded as negative for the alternative vs. non-alternative comparison. For the related vs. unrelated comparison, the related condition was coded as negative and the unrelated condition was coded as positive. Again, the control condition was coded as 0 such that it would not influence the comparison.

Non-alternative vs. alternative probe type had a strong effect on response times in the model. I find lower response times for probe words which are alternatives as compared to probe words which were simply mentioned. This is the exact pattern observed in the model for the first experiment.

Again, estimated marginal means were calculated using the emmeans R package (Lenth et al.,

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	7.01	0.02	284.90
Non-alternative vs. alternative	-0.16	0.01	-10.38
Related vs. unrelated	0.01	0.02	0.88

Table 2.5: Fixed effects of the linear mixed-effects model for experiment 2; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

Contrast	**Estimate**	**StdErr**	**df**	**t-ratio**	**p-value**
Control vs. related	0.16	0.02	1704	9.50	$p < 0.0001$
Control vs. unrelated	0.15	0.02	1706	8.57	$p < 0.0001$
Related vs. unrelated	-0.01	0.02	1700	-0.878	$p = 0.65$

Table 2.6: Estimated marginal means of the linear mixed-effects model for experiment 2; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

2018). I perform a pairwise t-test comparison of probe type and find a significant differences in the estimated means for the control vs. related and control vs. unrelated comparisons. Specifically, I find that control probes take longer to correctly recognize than either related or unrelated probes. On the other hand, there was no significant difference in the estimated means for the related vs. unrelated comparison.

Cohen's d effect sizes were calculated for these estimated pairwise comparisons. Much like in the first experiment, I find a large effect size (>0.5) for the control vs. related and the control vs. unrelated comparison, but only a minimal effect size (<0.1) for the related vs. unrelated comparison. Again, this indicates that alternatives were recognized faster than non-alternatives.

Contrast	Effect Size	StdErr	lower CL	upper CL
Control vs. related	0.55	0.06	0.44	0.67
Control vs. unrelated	0.50	0.06	0.39	0.62
Related vs. unrelated	-0.05	0.06	-0.16	0.06

Table 2.7: Cohen's d effect size based on pairwise differences of estimated marginal means of the linear mixed-effects model for experiment 2; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

2.3.5 Discussion

As a whole, the results of the second experiment mirror that of the first. An advantage for alternatives over mentioned non-alternatives is observed across all measures in the probe recognition task. Again, this effect was found at 0ms SOA suggesting that the earliest stages of processing focus reflect more than semantic priming and are sensitive to presence of alternatives in the context.

The linear mixed-effects model and the post-hoc tests do not deviate substantially from those in the first experiment. I find a fixed effect of alternatives vs. non-alternatives indicating that both related and unrelated alternatives were recognized faster on average than non-alternatives.

This significant advantage for the recognition of both related and unrelated alternatives is most compatible with the immediate-access model. It is unclear how the delayed-access model or the original two-stage model could explain this finding. If the earliest stages of processing focus purely reflected semantic priming, then one would not expect such fast response times for the recognition of unrelated alternatives. Thus, I take the results of experiment 2 to provide further support for an immediate-access model of alternative selection.

CHAPTER 3

General Discussion

In two cross-modal probe-recognition experiments, I find that focus-alternative conditions elicited faster response times than non-alternative controls. Further, I find no evidence that response times to the related and unrelated alternative conditions differed from one another. Lastly, these results were observed at 0ms SOA immediately after the presentation of focus. It is unclear how unclear a two-stage model dependent upon the initial activation from semantic priming could explain the observed advantage for unrelated focus-alternatives. It is also unclear how a delayed-access model which requires time to access the discourse representations relevant for selecting alternatives could explain the early appearance of this advantage. Only an immediate-access model appears to be fully compatible with my results.

Husband and Ferreira (2016)'s original two-stage model is *destructive* in nature. Under this model, a large set is generated initially which contains both alternatives and non-alternatives. Over time, members are removed from this set through a combination of decaying activation and focus-sensitive selection. Eventually, this yields a restricted set comprising just the relevant mentioned alternatives (Gotzner et al., 2016; Gotzner and Spalek, 2019) or at least possible alternatives when no contextual alternatives are provided (Husband and Ferreira, 2016). Given that unrelated words can serve as alternatives according to introspective judgments, the strictest conception of such a priming-dependent destructive model appears to be untenable. Thus, I proposed two *priming-independent* models which utilize discourse representations rather than semantic priming to generate the alternative set. These models are *constructive* in nature. Under both, semantic priming and alternative selection are independent processes. The fact that behavior in a forced-choice task

might be influenced by either of these processes does not make them interrelated cognitively. My results suggest that limiting prior forced-choice task studies to related alternatives has possibly obscured the independence of these processes.

While I have argued in favor of a constructive model here, it is still theoretically possible to maintain a destructive model given my results. Although theoretically possible, I believe that such a model remains undesirable for a number of reasons. Under the two-stage model, the alternative set is realized through differences in lexical activation between alternatives and non-alternatives, specifically at the second stage. It is true that if the initial stage of lexical activation is restricted to semantic priming from focus, then unrelated alternatives can never be represented in this set. There should be no difference in activation, at either stage, between words semantically unrelated to the focus. However, if both semantic priming and contextual information can influence lexical activation during the initial stage, then unrelated alternatives could receive raised activation. Thus, unrelated alternatives could be selected in the second stage and differences in lexical activation would then reflect offline judgments.

This model is possible in principle, but arguably suffers with respect to parsimony. Under such a destructive model, the discourse representations necessary to raise the activation of unrelated alternatives must be immediately accessible. Crucially, to account for my results, these discourse representations must privilege unrelated alternatives mentioned in the discourse over unrelated non-alternatives mentioned in the discourse. In other words, the raised activation for unrelated alternatives cannot derive purely from givenness. If such information is already available, it is unclear why semantic priming would be necessary to the establish related words as alternatives. A constructive model is arguably far more parsimonious in that the selection of related and unrelated words as alternatives would derive from a single source[1] (discourse representations) rather than multiples sources (discourse representations and semantic priming).

[1]This is not to imply that the relevant discourse representations are homogeneous in nature. Undoubtedly the contextual information which identifies relevant focus-alternatives is multifaceted. However, one can consider all of these information sources as a single body in contrast with one as different as semantic priming.

As previously discussed, many factors determine whether a possible alternative is a relevant one within a given discourse. However, there is no theory to my knowledge which claims that semantic priming from focus is one of these factors. Despite this, it is possible that there exists an initial stage of confusion where the mixed lexical activation from semantic priming and discourse representations leads to uncertainty as to the contents of the alternative set. At a later stage, following the decayed activation of related non-alternatives, this confusion would subside. This predicts that subjects might confuse relevant alternatives, possible yet unmentioned alternatives, and semantically related non-alternatives in the earliest moments after encountering focus. My results do not speak to this possibility. It is a limitation of my study, and other forced-choice tasks, that one cannot know whether response times for a given word are fast because a subject has interpreted it as an alternative or is merely considering it to be a possible alternatives. Future work, likely using different methods, will have to address this possibility.

I have been intentionally vague thus far in describing the discourse representations involved in the priming-independent models. This is because there are many possibilities and my design largely does not help to distinguish them. Undoubtedly though, focus is a context-sensitive phenomenon and my results do suggest that the early processing of focus is similarly context-sensitive in nature. Importantly, the probe words in each condition were previously mentioned in my design. Despite this fact, faster response times were observed for unrelated focus-alternatives than controls. Thus, the representations involved seemingly must distinguish previously mentioned entities with respect to their ability to serve as alternatives for potential foci.

One promising candidate for this representation comes from the Question-Under-Discussion (QUD) approach to information structure (Roberts, 1996; Beaver and Clark, 2009). A great deal of theoretical research has argued that questions, and consequently focus, guide much of discourse organization: some shared line of inquiry between interlocutors introduces a set of alternatives and a focus selects one of these as a possible answer. Previous experimental work has already demonstrated that both implicit and explicit QUDs can influence incremental processing (Clifton and Frazier, 2018, 2012). Perhaps comprehenders are predicting possible QUDs and evaluating

the ability of discourse given material to serve as answers/foci. While the prior literature makes this analysis appealing, my results do not speak to it directly.

There are a number open question with respect to semantic priming, timing, and associated focus. Starting with semantic priming, I did not include a condition for non-alternatives semantically related to the focus in my design. This condition was left out in order to improve statistical power and to reduce the burden of constructing these highly controlled items. However, such an unrelated non-alternative condition would undoubtedly be informative. I find no evidence that related alternatives and unrelated alternatives evoked different response patterns, indicating that semantic priming had little influence on these probe words. Thus, it is unclear what the effect of semantic priming would be alone. Would response times for related non-alternatives pattern like that of alternatives, non-alternatives, or somewhere in-between?

Given prior forced-choice task experiments, one might expect related non-alternatives to pattern like alternatives. However, Husband and Ferreira (2016) provided no discourse context explicitly mentioning the target words. While the discourse context that Gotzner et al. (2016) and Gotzner and Spalek (2019) included did mention a related alternative, it did not mention a related non-alternative.[2] These differences make it difficult to extrapolate the relevant predictions. Regardless, testing such a condition would provide further insight into how semantic priming and alternative-status independently influence response times in probe-recognition tasks.

Moving on to timing, I only investigated response times at an early SOA of 0ms in my design. Prior forced-choice tasks studies in this literature have utilized both early SOAs and late SOAs (Husband and Ferreira, 2016; Gotzner et al., 2016; Gotzner and Spalek, 2019). Given prior studies, as well as offline judgments, I would predict that both related and unrelated alternatives maintain their activation over time. Again though, differences between my design and prior ones makes it difficult make such predictions with confidence. Though seemingly unlikely, it is logically possible that unrelated alternatives would not maintain their activation. Future research will have to address

[2]Gotzner et al. (2016) and Gotzner and Spalek (2019) did include related alternatives which were unmentioned and thus not contextually relevant, but crucially related impossible alternatives were not included.

this possibility.

Lastly, there are some open questions with respect to associated focus. Recall that focus was always associated with a particle (*only*) in my design. This was done for two reasons. First, an overt operator provided subjects with a strong cue to the presence of focus in addition to the cue provided by prosody. Second, the particle *only* strengthens the interpretative effect of focus from an implicature to a truth-condition. I imagined that strengthening the role of focus in this way might further pressure subjects to generate a representation of the alternative set for interpretation. While the overall pattern that Gotzner et al. (2016) and Gotzner and Spalek (2019) found did not differ between bare and associated focus, response times were significantly longer given associated focus. The authors argued that the truth-conditional effect of associated focus triggered increased competition between potential members of the alternative set generating a penalty in response times. My design does not provide any evidence for or against this analysis, but further comparisons of bare and associated focus using my design could prove informative.

Relatedly, Gotzner et al. (2016) did not find any evidence for response time differences between focus particles, specifically comparing *only* and *even* in German. Still, there might be reason to investigate behavior under different focus particles going forward. Compare the two uses of associated focus in (29) below.

(29) **A:** Andy used a muffin and a pistol as props in an independent movie that he was directing.

B: No, he only used a CAKE.

B': Ya, he also used a CAKE.

Notice that the relevant alternatives (*muffin* and *pistol*) can each felicitously replace the focus (*cake*) in B but not in B' on account of the different focus particles. Perhaps given *only* in B the parser predicts that the relevant alternatives will occupy the position of the focus, but given *also* in B' it does not make this prediction. Potentially then, at least some of, the initial activation generated for these relevant alternatives comes from this kind of lexical predictability. If so, are the relevant

alternatives in B' still highly activated early on? Again, my results do not speak this possibility, but a future study investigating stimuli like B' would provide the relevant data.

To conclude, in two cross-modal probe-recognition task experiments, I find an early advantage for focus-alternative conditions over non-alternative controls. I find no evidence that response times were different between the two alternative conditions. These results indicate that the initial moments of processing focus reflect more than semantic priming. Specifically, these early moments seem to reflect the selection of contextually relevant focus-alternatives, regardless of how semantically related they are to the focus. It remains unclear how the two-stage model or the delayed-access model could explain these findings. While much more work need to be done to clarify the representations involved, these results support an immediate access-model where discourse information is utilized to select alternatives immediately after focus is encountered.

Focus is a pervasive phenomenon in natural language—both in terms of use and typology. Naturally then, the field is obligated to characterize the inference processes involved in comprehending focus. Further, focus is fundamentally context-dependent. Thus, studying the selection of alternatives will not only serve to better our understanding of focus, but also our understanding of context in language processing at large.

APPENDIX A

Mixed-effects models

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	6.99	0.04	161.13
Control vs related	-0.05	0.02	-2.67
Control vs unrelated	-0.05	0.02	-2.55

Table A.1: Fixed effects of the sum-coded linear mixed-effects model for the first experiment; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	7.01	0.02	284.90
Control vs related	-0.06	0.01	-6.05
Control vs unrelated	-0.04	0.01	-4.50

Table A.2: Fixed effects of the sum-coded linear mixed-effects model for the second experiment; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	7.13	0.03	249.66
Non-alternatives vs. alternatives	-0.19	0.02	-11.10
Related vs. unrelated	0.01	0.02	0.63

Table A.3: Fixed effects of the liberal removal scheme user-coded mixed-effects model for the second experiment; Model: $log(RT) \sim Condition + (1|Subject) + (1|Item)$

Fixed effect	**Estimate**	**StdErr**	**t-value**
Intercept	6.97	0.46	15.09
Non-alternatives vs. alternatives	-0.20	0.02	-10.82
Related vs. unrelated	0.02	0.02	1.06
By-Subject Accuracy	0.18	0.51	0.35

Table A.4: Fixed effects of the minimal removal scheme user-coded mixed-effects model for the second experiment; Model: $log(RT) \sim Condition + Accuracy + (1|Subject) + (1|Item)$

APPENDIX B

Critical Items

1. For her article in a nature magazine, Sarah used pictures of a monkey and a boulder.

   No, she only used pictures of a gorilla.

   Related: *MONKEY* Unrelated: *BOULDER* Control: *MAGAZINE*

2. Andy used a muffin and a pistol as props in an independent movie that he was directing.

   No, he only used a cake.

   Related: *MUFFIN* Unrelated: *PISTOL* Control: *MOVIE*

3. As a final touch to the mural along the streets, Marge added the bushes and the clocks.

   No, she only added the trees.

   Related: *BUSHES* Unrelated: *CLOCKS* Control: *STREETS*

4. Jonah brought the guitar and the pizza to band practice yesterday at the new house.

   No, he only brought the violin.

   Related: *GUITAR* Unrelated: *PIZZA* Control: *HOUSE*

5. Yesterday, at various art supply stores in town, Sylvia bought crayons and frames.

   No, she only bought pencils.

   Related: *CRAYONS* Unrelated: *FRAMES* Control: *STORES*

6. Dennis stole shoes and jewelry right in front of security cameras at the thrift store last week.

No, he only stole pants.

Related: *SHOES* Unrelated: *JEWELRY* Control: *CAMERAS*

7. Before playing in the next game, Lola talked to the nurse and the coach at school.

   No, she only talked to the doctor.

   Related: *NURSE* Unrelated: *COACH* Control: *GAME*

8. Roxie cleaned the spoons and the lamps in preparation for a luncheon with the donors.

   No, she only cleaned the forks.

   Related: *SPOONS* Unrelated: *LAMPS* Control: *DONORS*

9. For the poster advertising an upcoming Halloween party, Jack drew a witch and a skull.

   No, he only drew a wizard.

   Related: *WITCH* Unrelated: *SKULL* Control: *PARTY*

10. Chloe found steak and beer in a remarkably small aisle of the supermarket yesterday.

    No, she only found chicken.

    Related: *STEAK* Unrelated: *BEER* Control: *AISLE*

11. Andrew spotted a spider and a rabbit while playing outside in a forest today.

    No, he only spotted a beetle.

    Related: *SPIDER* Unrelated: *RABBIT* Control: *FOREST*

12. Lady Alba invited the duke and the monk in an attempt to bring some order to the event.

    No, she only invited the king.

    Related: *DUKE* Unrelated: *MONK* Control: *EVENT*

13. On the train headed downtown, Janet brought the drill and the helmet that she needed for work.

No, she only brought the wrench.

Related: *DRILL* Unrelated: *HELMET* Control: *TRAIN*

14. Jerry spoke with the director and the animal trainer in the trailer behind the studio.

    No, he only spoke with the actor.

    Related: *DIRECTOR* Unrelated: *TRAINER* Control: *TRAILER*

15. Desperately trying to entertain her niece yesterday, Lila paid for the magic show and the lunch.

    No, she only paid for the dinner.

    Related: *LUNCH* Unrelated: *SHOW* Control: *NIECE*

16. Tyler spoke with a teacher and a dentist while volunteering at a homeless shelter this week.

    No, he only talked to a student.

    Related: *TEACHER* Unrelated: *DENTIST* Control: *SHELTER*

17. After coming home drunk from a club, Gregor accidentally broke a chair and a mirror.

    No, he only broke a table.

    Related: *CHAIR* Unrelated: *MIRROR* Control: *CLUB*

18. Luna interviewed a sculptor and a plumber for an article that she was writing for the local paper.

    No, she only interviewed a painter.

    Related: *SCULPTOR* Unrelated: *PLUMBER* Control: *ARTICLE*

19. Back when he lived with friends from college, Jeffrey collected stamps and comics.

    No, he only collected coins.

    Related: *STAMPS* Unrelated: *COMICS* Control: *FRIENDS*

20. In a gift shop next to the aquarium, Maria bought photos of a squid and a volcanic rock.

    No, she only bought photos of a shark.

    Related: *SQUID* Unrelated: *ROCK* Control: *SHOP*

21. According to cards that he wrote to Santa Claus, Billy wanted dogs and toys for Christmas this year.

    No, he only wanted cats.

    Related: *DOGS* Unrelated: *TOYS* Control: *CARDS*

22. Lewis ordered toast and water from the café using a computer screen next to the register.

    No, he only ordered coffee.

    Related: *TOAST* Unrelated: *WATER* Control: *SCREEN*

23. Cleaning up the yard for the visitor last week, Donna put away the plants and the buckets.

    No, she only put away the seeds.

    Related: *PLANTS* Unrelated: *BUCKETS* Control: *VISITOR*

24. Cameron played soccer and piano in order to appease his ever demanding mother.

    No, he only played tennis.

    Related: *SOCCER* Unrelated: *PIANO* Control: *MOTHER*

25. While walking along a trail near the airport this morning, Olga saw an eagle and a plane.

    No, she only saw a hawk.

    Related: *EAGLE* Unrelated: *PLANE* Control: *TRAIL*

26. Harry had worked as a lawyer and a janitor before he became a successful editor.

    No, he had only worked as a judge.

    Related: *LAWYER* Unrelated: *JANITOR* Control: *EDITOR*

27. Tanya destroyed the tulips and the statues in the yard the second her parents were out of sight.

    No, she only destroyed the roses.

    Related: *TULIPS* Unrelated: *STATUES* Control: *PARENTS*

28. Larry bribed an officer and a senator in order to get out paying taxes on his new houses.

    No, he only bribed a detective.

    Related: *OFFICER* Unrelated: *SENATOR* Control: *HOUSES*

29. Searching through an abandoned barn late last night, Lydia found an antique truck and a couch.

    No, she only found a car.

    Related: *TRUCK* Unrelated: *COUCH* Control: *BARN*

30. Owen read about knights and churches in order to prepare for some upcoming history essays.

    No, he only read about castles.

    Related: *KNIGHTS* Unrelated: *CHURCHES* Control: *ESSAYS*

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